Memorandum from the Office of the Inspector General

May 18, 2012

Tom Kilgore, WT 7B-K

REQUEST FOR FINAL ACTION – INSPECTION 2010-13088 – WATTS BAR NUCLEAR PLANT UNIT 2 PROJECT SET-UP AND MANAGEMENT ISSUES AFFECTED COST AND SCHEDULE

Attached is the subject final report for your review and action. Your written comments, which addressed your management decision and actions planned or taken, have been included in the report. Please notify us when final action is complete.

Information contained in this report may be subject to public disclosure. Please advise us of any sensitive information in this report that you recommend be withheld.

If you have questions or wish to discuss our findings, please contact me at (865) 633-7450. We appreciate the courtesy and cooperation received from your staff during the inspection.

Robert E. Martin
Assistant Inspector General
(Audits and Evaluations)
ET 3C-K

MLC:HAC
Attachment
cc (Attachment):
Micheal B. Fussell, WT 9B-K
Peyton T. Hairston, Jr., WT 7B-K
Joseph J. Hoagland, WT 7B-K
Raymond A. Hruby, OSA 1A-BLN
Richard W. Moore, ET 4C-K
Emily J. Reynolds, OCP 1L-NST
Michael D. Skaggs, LP 6A-C
Kelly D. Stinson, Jr., OSA 1A-BLN
Preston D. Swafford, LP 3R-C
John M. Thomas III, MR 6D-C
Robert B. Wells, WT 9B-K
Oswald J. Zeringue, EQB 1B-WBN
OIG File No. 2010-13088

Tennessee Valley Authority
Office of the Inspector General

Inspection Report

WATTS BAR NUCLEAR PLANT UNIT 2 PROJECT SET-UP AND MANAGEMENT ISSUES AFFECTED COST AND SCHEDULE

Inspection 2010-13088
May 18, 2012

ABBREVIATIONS

ASME	American Society of Mechanical Engineers
BFN	Browns Ferry Nuclear Plant
DSEP	Detailed Scoping, Estimating, and Planning
EPC	Engineering, Procurement, and Construction
ETC	Estimate to Complete
FY	Fiscal Year
NGDC	Nuclear Generation Development and Construction
NRC	Nuclear Regulatory Commission
OIG	Office of the Inspector General
PEG	Procurement Engineering Group
QA	Quality Assurance
QC	Quality Control
Rev	Revision
SVP	Senior Vice President
TVA	Tennessee Valley Authority
VP	Vice President
WBN	Watts Bar Nuclear Plant

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A. LETTER DATED MAY 7, 2012, FROM JAMES M. MCLEMORE TO ROBERT E. MARTIN

B. MEMORANDUM DATED MAY 14, 2012, FROM TOM KILGORE TO ROBERT E. MARTIN

Inspection 2010-13088 – Watts Bar Nuclear Plant Unit 2 Project Set-Up and Management Issues Affected Cost and Schedule

EXECUTIVE SUMMARY

Why the OIG Did This Review

Since the Tennessee Valley Authority (TVA) began construction on Watts Bar Nuclear Plant (WBN) Unit 2 in October 2007, the OIG (Office of the Inspector General) has had staff assigned to attend meetings at the project site in order to keep abreast of management challenges as the OIG conducts its various reviews. As a result of the OIG's work, it became evident in 2010 that many of the issues raised in meetings were symptomatic of much broader problems that increased the risk of exceeding the project's schedule and budget. We conducted this review to (1) assess TVA's schedule and cost performance on this project and (2) identify any weaknesses in the project's set-up and management and recommend actions to improve schedule and cost performance on this and future projects.

In mid-2011, we met with TVA executives to brief them on our concerns surrounding the project. In August 2011, we briefed the Audit, Risk, and Regulation Committee on our concerns and the preliminary findings of this report.

What the OIG Found

The WBN Unit 2 construction project has experienced significant schedule and cost overruns. The project was originally expected to be completed in October 2012 at a cost of just under $2.5 billion. However, TVA will not meet these targets. On April 5, 2012, TVA announced an additional $1.5 billion to $2 billion would be required to complete the project with an estimated time of completion between September and December 2015. TVA's Board of Directors approved the revised schedule and budget on April 26, 2012.

We found two primary reasons for the schedule and cost overruns. Based on our assessment of the individual issues raised in various meetings, discussions with WBN Unit 2 and TVA personnel, and reviews of project documentation, we determined that the poor performance experienced at WBN Unit 2 was attributable primarily to (1) deficiencies in project set-up and (2) ineffective management oversight.

Problems with the original project set-up included the following:

- The project's detailed scoping, estimating, and planning study was not as robust as it should have been to provide accurate schedule and cost estimates.

- Planned prime subcontractor agreements were not implemented, ultimately requiring TVA to enter into direct contracts because of Bechtel Power Corporation's inability to finalize those agreements.
- TVA's ability to remove Bechtel from the project if problems occurred was limited because Bechtel was the American Society of Mechanical Engineers certification holder.
- Construction began before engineering progress had reached a sufficient level, causing significant productivity and work quality issues.

Project management in key areas was also ineffective. Specifically, TVA management did not:

- Perform effective oversight of the engineering, procurement, and construction contractor.
- Address certain warning signs that the project was in trouble.
- Adequately mitigate known problems related to staffing, work order packages, timeliness and quality of information provided to the Nuclear Regulatory Commission, and the procurement of materials that require a long lead time to obtain.

TVA recognizes the problems associated with the construction of WBN Unit 2 and has publicly acknowledged them. For example, on April 5, 2012, the Chief Executive Officer and Senior Vice President, Nuclear Construction, held a public meeting at WBN in which they discussed the revised schedule and budget and factors that caused the cost and schedule slippage. In addition, TVA has taken several actions to address the problems identified at WBN Unit 2. These actions included:

- Developing an updated estimate to complete.
- Conducting an extensive root cause analysis to understand the underlying issues, including the development of corrective actions to address the identified issues.

In addition, TVA has taken actions to offer an accurate reflection of the progress of the project, engage and improve the relationship with the project workers, and promote transparency. These include developing:

- Weekly project and high-level status reports.
- An alignment and engagement strategy.
- A communication plan.

- Team rules.
- Other corrective actions related to improved productivity, which are planned or in process.

In addition, Nuclear Construction and TVA Corporate's corrective actions, including a planned review of the accuracy of the Bellefonte estimate, restructuring the independent Project Assurance Organization, and developing a contracting strategy for various project classifications are planned or in progress. TVA's actions are positive and should help to improve the process for WBN Unit 2 and future projects.

What the OIG Recommends

To improve the schedule and cost performance of nuclear construction projects, we recommend TVA's Nuclear Construction organization:

- Develop a consistent and thorough approach for planning and estimating nuclear construction projects including, but not limited to, a range of estimates with probabilities, key risk assumptions, and contingency amounts.
- Develop contingencies for supplementing contractors' expertise in case they are unable to provide qualified resources.
- Develop contingencies for obtaining the American Society of Mechanical Engineers certifications for future projects as applicable.
- Require design engineering to be substantially complete before starting construction on nuclear projects.
- Establish controls over the development and reporting of project performance data and provide for independent verification of the data.
- Assess the cultural climate to determine if the actions of certain former key management have affected the organizational culture. Additionally, provide an opportunity for WBN Unit 2 personnel to voice their concerns about the culture that exists currently and views about what should be done to create a more transparent culture.
- Evaluate project incentives to ensure they will deliver the desired results.
- Address aging nuclear workforce issues by developing a program for transferring knowledge.
- Work collaboratively with TVA's Board of Directors to evaluate the benefits of retaining the services of nuclear construction experts to

monitor large nuclear construction projects' progress and report results directly to the Board.

We requested and received written comments from Bechtel and TVA management on a draft of this report, which are reproduced in their entirety in the appendices. Their comments and our evaluation of them are discussed briefly below and in more detail later in the *Bechtel's Response* and *TVA's Response* sections of this report.

Bechtel's Response to the Draft Report

Bechtel management disagreed with "several of the Draft Report's implications" and identified conclusions they asserted were not supported by the project record. We carefully reviewed Bechtel's comment letter and reevaluated the report and supporting documentation, and remain confident in the report's information and conclusions; therefore, we made no changes to the report based on Bechtel's comment letter. Additional discussion of Bechtel's comments and our evaluation of them is included in the *Bechtel's Response* section of this report. Bechtel management also separately provided technical and clarifying comments that we evaluated and incorporated into the final report, as appropriate.

See Appendix A for Bechtel's complete response.

TVA Management's Response to the Draft Report

TVA management agreed with our recommendations, and we concur with their planned actions; however, we suggest management consider additional actions to assess the culture at WBN Unit 2. TVA also suggested a wording change for clarity and consistency, which has been incorporated. Additionally, TVA provided an overall opinion that Bechtel's response to the OIG's draft report ignored Bechtel's contributions to the project's problems.

See Appendix B for TVA's complete response.

BACKGROUND

The Tennessee Valley Authority (TVA) began its nuclear construction in the 1960s as a new source of economical power. In 1966, TVA announced plans to build 17 nuclear units at 7 sites in Tennessee, Alabama, and Mississippi. This included 2 units at the Watts Bar Nuclear Plant (WBN) in Spring City, Tennessee. By 1985, however, TVA had cancelled construction on 8 units because of a reduction in the predicted growth of power demand and the rising construction costs, as did other utilities around the nation. Although major structures were in place and equipment had been installed, such as the reactor coolant system piping, work at WBN U2 was suspended.

Eventually, the need for power again increased, and TVA restarted the nuclear program. WBN Unit 1 received a full-power operating license in early 1996 and is presently the last power reactor to be licensed in the United States. On October 13, 1999, TVA filed a request for extension of the completion date for WBN Unit 2. In July 2000, TVA informed the Nuclear Regulatory Commission (NRC)[1] that Unit 2 met the NRC's definition for deferred nuclear plant units, as described in the NRC's *Policy Statement on Deferred Plants*. Currently operating nuclear power plants have been licensed under a two-step process described in Title 10 of the Code of Federal Regulations, Part 50. This process requires both a construction permit and an operating license. Subsequently, on October 24, 2000, the NRC issued an order extending the Unit 2 construction permit to December 31, 2010.

During the nuclear restart effort in May 2002, TVA's Board of Directors approved the restart of Browns Ferry Nuclear Plant (BFN) Unit 1 at an estimated cost of $1.8 billion over a 5-year period. After an extensive recovery effort, BFN Unit 1 was restarted in May 2007, adding approximately 1,150 megawatts of cost-effective, emission-free generation to help TVA responsibly meet power demands while maintaining a strong reserve margin and becoming the nation's first nuclear unit to come online in the twenty-first century.

[1] The NRC is responsible for licensing and regulating the operation of commercial nuclear power plants in the United States. NRC approval is necessary before a nuclear power plant can be built and operated. The NRC maintains oversight of the construction and operation of a facility throughout its lifetime to ensure compliance with NRC regulations for the protection of public health and safety, common defense and security, and the environment. The approval process includes public hearings, environmental impact reviews, and safety reviews.

Completion of WBN Unit 2

On November 14, 2006, TVA informed the NRC of its intent to perform a study of the feasibility of completing WBN Unit 2 with the goal of producing power from the reactor in 2013. In December 2006, TVA contracted with Bechtel Power Corporation to perform a 6-month Detailed Scoping, Estimating, and Planning (DSEP) study to develop the project scope. The DSEP process allocated the estimated cost by year and explored three options: 48-, 54-, and 60-month plans to completion.

- The 48-month option had an estimated cost of $2.35 billion and required a highly aggressive engineering ramp rate. Under this scenario, peak staffing levels could possibly go beyond what the industry would supply at reasonable rates.
- The 54-month option had an estimated cost of $2.45 billion and required a reasonably achievable engineering ramp rate (similar to that used during the BFN Unit 1 Restart). Under this scenario, peak staffing levels for the 54-month schedule would be approximately 12 percent higher than the 60-month schedule.
- The 60-month option had an estimated cost of $2.49 billion and also required a reasonably achievable engineering ramp rate (similar to what was used during the BFN Unit 1 Restart). Peak staffing levels would also be reasonably achievable and similar to BFN Unit 1 Restart.

In August 2007, the TVA Board unanimously approved the construction of WBN Unit 2 at the DSEP estimated cost of $2.49 billion[2] for a 60-month project. When completed, WBN Unit 2 will provide approximately 1,200 megawatts of electricity, or enough power to serve about 650,000 Tennessee Valley homes.

On August 29, 2007, TVA issued a revision to the DSEP with an addendum that included a 54-month alternative schedule instead of the 60-month schedule as approved. This 54-month target completion became the driver of the project's schedule.

On July 7, 2008, the NRC issued an order extending the WBN Unit 2 construction permit completion date to March 31, 2013.

The BFN Unit 1 Restart project was performed under separate contracts for engineering design services and construction modifications, while TVA managed procurement. Operating two units while reconstructing another unit at BFN created challenges related to the use of resources, coordination of activities, and available facilities. As a result of these challenges, TVA established the NGDC organization to manage all aspects of the new WBN Unit 2 project, up to the completion of hot functional testing.[3]

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[2] As discussed on page 6 of this report, a range of cost estimates is more appropriate because of the complexities and risks associated with a nuclear construction project.

[3] Hot functional testing tests the reactor coolant system at a temperature and pressure at which the nominal design parameters are at zero-power criticality.

For the WBN Unit 2 project, TVA decided to award an Engineering, Procurement, and Construction (EPC) contract. On October 19, 2007, TVA entered into a $1 billion EPC contract[4] with Bechtel for completion of WBN Unit 2. A former Site Vice President (VP) for the BFN Unit 1 Restart was assigned to oversee the WBN Unit 2 project. He served as Site VP until February 2011. His replacement served from February 2011 until February 2012, when a General Manager, WBN Unit 2, Technical Services, and a General Manager, WBN Unit 2, Engineering and Construction, were named to lead the project. For the purposes of this report, the Site VPs will be referred to as the original and second (Site VP, WBN Unit 2). There has also been a change in the Senior Vice President (SVP), Nuclear Generation Development and Construction (NGDC).[5] In October 2011, the SVP, NGDC, retired and a replacement was named. For the purposes of this report the SVPs will be referred to as the former and existing (SVP, NGDC).

Since the project began, the Office of Inspector General (OIG) has had staff assigned to WBN Unit 2 in order to keep abreast of management challenges as the OIG conducts its various reviews.[6] During meetings attended by the OIG at the WBN Unit 2 project site, construction issues discussed were characterized by management as recoverable or normal construction problems. Each project schedule, based on its associated assumptions, showed how everything was on track for meeting the early target finish date. Additionally, pertinent information critical of the project's performance was not provided to the OIG by TVA when requested by our office. These actions made it harder to identify the extent and potential consequences of the problems on the project. In 2010, it became evident that many of the issues raised in those meetings were symptomatic of much broader problems that could increase the risk of exceeding the project's schedule and budget.

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4 Additional contracts for the completion of WBN Unit 2 included Westinghouse Electric Company, Siemens, and Day and Zimmermann. Westinghouse was included for (1) upgrading and replacing most instrumentation and control systems; (2) supplying new reactor coolant pumps and cranes; and (3) servicing steam generators and conducting probabilistic risk assessments, licensing services, and safety analyses. Siemens was included for (1) refurbishing and upgrading the turbine island and (2) supplying one new high-pressure turbine and three new low-pressure turbine rotors. Day and Zimmermann was included for providing managed task, maintenance, modification, and refurbishment services, including the replacement, refurbishment, modification, and installation of major components in the plant's turbine building.

5 As of February 10, 2012, NGDC became known as Nuclear Construction.

6 These reviews include: Inspection 2007-11443 – Review of Contractor Background Checks Applicable to the Watts Bar Nuclear Plant Unit 2 Construction Project; Inspection 2008-11591 – Review of Contractor Qualifications for Bechtel Employees Assigned to the Watts Bar Nuclear Plant Unit 2 Construction Completion Project; Inspection 2008-11874 – Review of Bechtel's Cost Accounting Activities for the Watts Bar Nuclear Plant Unit 2 Construction Completion Project; Inspection 2008-11899 – Review of Material Ordered by Bechtel Construction; Inspection 2008-11911 – Review of the Contractor Tool Program for the Watts Bar Nuclear Plant Unit 2 Construction Project; Audit 2009-12916 – Review of Bechtel's Management of Subcontractors for the Watts Bar Nuclear Plant Unit 2 Construction Project; Audit 2009-12968 – Follow-up Review of Contractor Tool Program for Watts Bar Nuclear Plant Unit 2 Construction Project; Audit 2010-13143 – Rework at Watts Bar Nuclear Unit 2; and Audit 2010-13264 – Review of the Effectiveness of the Remediation of Problem Evaluation Reports at Watts Bar Nuclear Plant Unit 2.

We began this review in order to report on the status of the project and the issues that could put the schedule and budget at risk. However, during our review, it became clear that risks to the schedule and budget had become a reality, and the project would not meet schedule and was over budget. Our focus then was to review the project schedule and cost performance and note any weaknesses in the project's set-up and management.

OBJECTIVE, SCOPE, AND METHODOLOGY

We conducted this review to (1) assess TVA's schedule and cost performance on this project and (2) identify any weaknesses in the project's set up and management and recommend actions to improve schedule and cost performance on this and future projects. We reviewed the schedule and cost performance at WBN Unit 2. The scope of our review was October 2007 through February 10, 2012. Specifically, we:

- Obtained and reviewed various (1) WBN Unit 2 reports, including Plan of the Day packages, weekly update reports, and management review packages, and (2) TVA reports, presentations, and other documentation to determine the current status of the project's budget and schedule and any other issues that might be relevant to schedule and budget performance.
- Interviewed (1) WBN Unit 2 personnel, (2) WBN Unit 2 contractor personnel (Bechtel, Day and Zimmerman, and Westinghouse), (3) NGDC personnel, (4) other current and former TVA personnel, and (5) TVA's external consultants to obtain an understanding of the status of the project.

This review was conducted in accordance with the *Quality Standards for Inspection*s.

FINDINGS

As TVA officials publically stated on April 5, 2012, the schedule and cost targets for completing WBN Unit 2 will not be met. We identified two of the primary reasons for the schedule and cost overruns were (1) deficiencies in project set up and (2) ineffective management oversight. In mid-2011, we met with TVA executives to brief them on our concerns surrounding the project. On August 3, 2011, we met with TVA's Audit, Risk, and Regulation Committee to advise them of our findings. In addition, we noted that TVA has taken several actions to address the problems identified at WBN Unit 2. Key actions include developing an updated Estimate to Complete (ETC) and conducting an extensive root cause analysis to understand the underlying issues, including the development of corrective actions to address the identified issues.

SCHEDULE AND COST GOALS WILL NOT BE MET

The WBN Unit 2 construction project experienced significant schedule and cost overruns. The project was originally expected to be completed in October 2012 at a cost of just under $2.5 billion. However, TVA will not meet these targets. On April 5, 2012, TVA announced an additional $1.5 billion to $2 billion would be required to complete the project with an estimated time of completion between September and December 2015. TVA's Board of Directors approved the revised schedule and budget on April 26, 2012. TVA's fiscal year (FY) 2012 10-Q filing on February 3, 2012, stated the project was ". . . experiencing challenges with schedule and costs." TVA attributed these challenges to lower productivity slowing the pace of construction and expected increased costs due to regulatory considerations from the NRC related to the Fukushima event in March 2011.

Although there can be many reasons for a project not meeting its schedule and budget, we identified two primary factors that have had an impact on TVA's ability to meet schedule and budget. First, decisions made during the set-up of the project negatively impacted the project's progress. Second, ineffective management oversight created other problems that the project could not overcome. Going forward, changes required because of the Fukushima nuclear event could impact the project. What, if any, changes will be required is not known at this time.

In mid-2011, we met with TVA executives to brief them on our concerns surrounding the project. In August 2011, we briefed the Audit, Risk, and Regulation Committee on our concerns and the preliminary findings of this report.

PROJECT SET-UP PROBLEMS IMPACTED THE COMPLETION OF WBN UNIT 2

Front-end planning is an essential process of developing sufficient, strategic information with which owners can address risks and make decisions to commit resources in order to maximize the potential for a successful project. However, several problems developed with how the project was planned and eventually executed. Specifically,

- The DSEP study was not as in-depth as it should have been.
- Inability to implement prime subcontractors' agreements contributed to project delays.
- Bechtel was the American Society of Mechanical Engineers (ASME) certification holder, limiting TVA's ability to remove them from the project if problems occurred.
- Construction began before adequate engineering had been completed.

DSEP Was Not Sufficiently Thorough to Develop Accurate Estimates

For engineering and construction projects, accurate early cost estimates are extremely important to the sponsoring organization and the engineering team. For the sponsoring organization, early cost estimates are often a basis for business unit decisions. In June 2005, TVA published a study on the cost of finishing construction on WBN Unit 2. This 2005 study was simply a 1994 study escalated to 2005 dollars. At the time of the 2005 study, the estimated cost for completion was $2.182 billion. In December 2006, TVA contracted with Bechtel to perform a DSEP on the WBN Unit 2. The DSEP Summary Report was issued on July 30, 2007, and estimated a 60-month schedule at a cost of $2.49 billion. This estimate included a management contingency of approximately 6 percent. However, several occurrences point to the DSEP not being as detailed as it should have been to fully estimate the work needed to complete the unit. According to some TVA nuclear personnel, the original Site VP, WBN Unit 2, decided to halt the DSEP in May 2007 before walkdowns had been completed. The original Site VP, WBN Unit 2, felt that enough work had been done to present the project to the Board. This lack of detail was pointed out in NGDC's February 7, 2012, presentation to the Board's Nuclear Oversight Committee (a standing committee of TVA's Board of Directors), which stated that an ". . . inadequate understanding of the work to be done led to low initial estimates and impeded planning." Specifically, "The DSEP was developed using conceptual data, unit rates from BFN Unit 1 did not account for the complexity of the work, contingency was well below industry standard, and risk ranging did not conform to TVA standards."

According to the existing SVP, NGDC, the new ETC will contain a range of cost estimates instead of a point estimate as was originally done for WBN Unit 2. A project of the complexity of WBN Unit 2 had too many risks and unknowns to offer a single point estimate. According to McKinsey and Company,[7] the variance between the low and high estimates in the range is dependent on the amount of work done to determine the estimate. Based on the amount of work performed on the estimate, McKinsey personnel stated that the contingency for the WBN Unit 2 project should have been higher than the contingency used.

Planned Prime Subcontractor Agreements Were Not Implemented

The Bechtel proposal stated:

> In order to provide all the resources and the nuclear infrastructure for a project of this magnitude, Bechtel will supplement its substantial experience with the professional resources of Washington Group International, Sargent & Lundy, and Areva.

[7] McKinsey and Company was tasked with evaluating the root cause analysis performed by TVA to identify any gaps or weaknesses.

The combination of these companies creates the ability to offer:

- Depth and breadth of a dedicated team of highly qualified professionals who are experienced in all the relevant areas necessary for the Watts Bar Completion Project.
- Effective mobilization of the necessary resources during the critical early stages of the project.
- A Supply Chain management team with global alliances for cost savings in procurement.
- A Qualified nuclear craft supervision, workable craft labor plan, and labor relations expert.

When Bechtel was awarded the EPC in October 2007, its contract included supplementing its team with Washington Group International and Sargent & Lundy. However, by June 2008, TVA was questioning Bechtel on its failure to procure the prime subcontractors. Even though Bechtel identified the prime subcontractor agreements as critical to the project, those agreements were never implemented. In its September 10, 2008, response to TVA, Bechtel cited the subcontractors' refusal ". . . to accept reasonable terms for liability, warranty, fee and other Prime Contract flowdown issues . . ." required by the prime contract as the reason the agreements were not finalized.

In September 2009, TVA took approximately 25 percent of Bechtel's scope of work and awarded it to another construction company. TVA also directly contracted with three additional engineering firms to help meet a milestone for completion of design engineering. However, even with the additional resources, design engineering was completed about 9 months later than originally planned.

Bechtel Was the ASME Certification Holder, Which Limited TVA's Ability to Remove Them From the Project if Problems Occurred

Title 10 of the Code of Federal Regulations requires nuclear plants to be built in accordance with the ASME Boiler and Pressure Vessel Code, Section III. ASME is the leading international developer of codes and standards associated with the art, science, and practice of mechanical engineering. ASME conformity assessment programs assess and certify that an individual or company demonstrates the ability to meet the requirements of an ASME standard. The ASME "N-stamp" indicates that items stamped comply with the Quality Assurance (QA) Requirements of Section III.

The WBN Unit 2 contract required Bechtel to obtain and maintain the appropriate N-stamp certifications and authorization. Part of the application process requires a review of the applicant's QA program and its implementation. This review, or survey, is conducted by an ASME survey team. Any findings are discussed between the team and applicant, and a report is submitted to the ASME Committee on Nuclear Certification, which either issues the Certificate(s) of Authorization or requests additional action by the applicant. According to Bechtel

personnel, the survey requires demonstration of implementation of the QA manual.

In March 2008, a schedule showed ASME approval would occur in early August 2008. However, according to WBN Unit 2 Bechtel management, Bechtel's submittal for the N-stamp survey occurred in August 2008. In March 2009, 6 months after the estimated ASME approval date, the ASME survey team performed the required survey on the QA program at WBN Unit 2. This survey determined that the requirements had not been met and remediations were needed. This resulted in a follow-up ASME audit in October 2009 to determine if the deficiencies had been corrected. Bechtel was finally awarded the stamp on December 7, 2009, with an authorization period from November 27, 2009, through November 27, 2012. The delay in obtaining ASME approval caused inefficiencies and problems in determining if existing ASME valves could be repaired or needed to be replaced. However, according to the existing SVP, NGDC, problems with Bechtel obtaining the ASME stamp did not cause any delays in the overall project schedule.

Bechtel was the sole ASME stamp holder, limiting TVA's ability to remove them from the project if problems occurred. Over a year passed from the original scheduled completion date until Bechtel was awarded the stamp. The ASME stamp is not transferable; another organization would have had to go through the complete process to obtain a stamp for the project. Once the decision was made to make Bechtel the stamp holder, Bechtel became essential to the project. TVA could not completely remove Bechtel from the project if problems occurred without greatly increasing the project schedule.

Starting Construction Without Adequate Engineering Progress Impacted Work Planning and Productivity

Normally, design engineering should be well underway before construction activities begin. To shorten the project, TVA decided to start construction prior to engineering being sufficiently complete. Once engineering completes the design package, the work is sent to work planners who take the design specifications and complete work order packages.[8] The work order packages provide the detailed instructions for construction to complete the physical work.

The August 29, 2007, revision to the DSEP stated:

> Prior to the start of the detailed engineering sequence, walkdowns will be performed to provide as-built information to be used as design input. These have also been sequenced in support of the implementation plan. After Engineering evaluates the walkdown data and issues the appropriate design output, Construction will plan in detail the work implementation

[8] A work order package consists of work order forms, a description of work to be performed, and all written instructions and/or plant-approved instructions necessary for performance and documenting work. It may contain information from controlled manuals, controlled drawings, approved field change requests, work plans, approved design documents, or plant approved instructions.

activities, with the plan of utilizing the scaffold and any other temporary commodities that were installed for the walkdowns. The system completion sequence and work volume will determine the order in which areas must be worked to support the schedule. The plan is to optimize opportunities for the work scope related to a particular area to be performed in a single time frame. In this manner schedule gains can be obtained through effective use of resources and eliminating the need to install/remove temporary support commodities more than once.

Design engineering is required for construction to be able to do physical work; otherwise, construction delays occur. However, starting construction without adequate engineering progress prevented the development of an adequate backlog of work order packages. This resulted in construction delays that the project was unable to overcome.

INEFFECTIVE TVA MANAGEMENT OVERSIGHT

Many of the decisions made during the project set-up caused delays and problems, but the project also suffered from ineffective management oversight. TVA management failed to respond to red flags and was unsuccessful in fixing problems, while the communication upward within TVA continued to indicate that the project was on time and on budget. Management actions interpreted as retribution by some who raised concerns related to schedule and budget; restricting access of those charged with performing independent assessments of the status of the project; and the rigid command and control management style exhibited by the original Site VP, WBN Unit 2, and the former SVP, NGDC, are hostile to transparency and tend to inhibit a free flow of information necessary to accurately assess the current status of a mega project, such as this one. These leadership failures contributed to poor communication, delaying remediation of the problems encountered and driving the costs of the project much higher due to delayed discovery of systemic problems. The collateral damage is the corrosive effect on TVA's culture caused by a "hide-the-ball" mentality of these two managers that had a chilling effect on WBN Unit 2 personnel exposed to this dysfunctional leadership style.

On February 5, 2007, the NRC issued a report to Congress that addressed existing and alternative programs for improving quality and QA in the design and construction of commercial nuclear power plants.[9] The NRC report concluded that the root causes for major quality-related problems included the following:

- Utility management's inability to adequately control all aspects of the construction project, including planning, scheduling, procurement, and oversight of contractors.

[9] *Improving Quality and the Assurance of Quality in the Design and Construction of Nuclear Power Plants: A Report to Congress* (NUREG-1055), NRC, February 5, 2007.

- Inexperience with nuclear plant construction, resulting in utilities and their contractors not fully appreciating the complexity and difficulty associated with building a nuclear power plant and therefore the importance of nuclear-related standards.
- A false sense of security growing out of prior successes.

The report also noted that the failure of management to control certain conditions, such as the amount of rework because of excessive design changes, the failure to complete designs sufficiently ahead of construction, uninformed supervision, and a project environment that emphasizes production to the detriment of quality, can defeat quality craftsmanship.

As noted on the following page, many of the issues identified by the NRC report occurred on this project. The project suffered from several management and oversight weaknesses that contributed to the schedule delays and cost overruns. As a result, key improvements that could have had a significant impact on the project did not occur.

Project Oversight Was Not Performed as Intended

The intent was for Bechtel to manage the project and TVA to provide oversight. The contract was written for the contractor to have primary responsibility for the work performed. Specifically, the contractor was to ". . . provide professional engineering, procurement, construction and related services (such as QA, Quality Control [QC], and maintenance and modifications work)." The contract also called for the contractor to ". . . manage the project control function for the completion of WBNII and supply project control personnel." TVA would provide project control personnel to oversee the contractor and to help integrate WBN Unit 2 with Unit 1.

However, instead of providing oversight, WBN Unit 2 management became involved in day-to-day project management and decision-making. Specifically, the original Site VP, WBN Unit 2, made virtually every decision down to reviewing résumés for noncraft positions, reviewing most purchase orders, and controlling information. The OIG personnel assigned to the project noted that it was obvious the original Site VP, WBN Unit 2, was in charge, regardless of what the intended structure might have been.

An outside consultant hired by TVA to conduct assessments at WBN Unit 2 even stated they had never seen one individual (i.e., the original Site VP, WBN Unit 2) have so much control over a project this size. The concern about TVA site management's role in the project was also raised in a February 2010 NGDC internal assessment that was drafted but never finalized at the former SVP, NGDC's, direction. The assessment team found that "TVA management is directly involved in the day-to-day management and decision-making of the project with respect to production, budget, and cost. This heavy managerial involvement resulted in little to no effective oversight of the EPC and major contractors involved."

When conflict arose between TVA and Bechtel over performance issues, Bechtel asserted that the level of TVA site management involvement in daily management was a contributing factor. In a December 22, 2010, letter to TVA, Bechtel stated:

> We note that your referenced letters fail to recognize TVA Management's involvement on this project and the impacts that they have contributed and continue to contribute towards Bechtel's performance. If TVA believes that the project is staffed with people who have inadequate expertise and experience, TVA must also share the responsibility for this condition. Essentially, all construction nonmanual staffing assignments are vetted and pre-approved by TVA. The hiring policies imposed on Bechtel by TVA have resulted in a construction team made up of 52% agency employees. For senior level staff (Grade 25 and above), the percentage of agency employees increases to 56%. Approximately 50% of our agency employees are TVA retirees or have worked for TVA in the past and WBN Unit 2 TVA Management was influential in their hire. Otherwise stated, our experience and expertise in the construction staff is as allowed by TVA.

Since TVA was only to provide oversight as called for in the contract, the team established for WBN Unit 2 was small. From the start of the project, about 15 TVA employees were tasked with oversight. In early January 2011, nearly 3,500 employees and contractors were on the project, making it difficult for the 15 TVA individuals to provide effective oversight and nearly impossible for them to make quality day-to-day management decisions. Instead, the project team was forced to "run from one fire to the next" and never provided effective oversight.

Lack of oversight did not stop at the site level. It is incumbent on senior management to be knowledgeable of large projects like WBN Unit 2 and make any changes they deem necessary to keep the project on track. As the head of NGDC, the SVP was responsible for monitoring the progress of nuclear construction projects, with an attitude of "trust but verify." However, according to TVA personnel, the former SVP, NGDC, ignored data and opinions of the oversight team and others in favor of what the original Site VP, WBN Unit 2, told him. The General Manager, NGDC Oversight, noted in an e-mail to the former SVP, NGDC, "We have two standards for oversight on NGDC projects – one for WBN2 and one for all other projects."

Certain Warning Signs Were Not Adequately Addressed

There were indications of problems in the project's early stages. A time line of key project events makes it hard to reconcile the continued problems with the continued message of on time and on budget. Also, assessments that documented problems were not addressed. Although it is not clear how high up in the organization problems were being communicated, the following time line documents problems with the project dating back to January 2008.

- In January 2008, 3 months into the project, TVA and Bechtel held a meeting to discuss performance issues.

- In June 2008, TVA wrote in a letter to Bechtel that Bechtel's compliance with key contract requirements was not meeting TVA's expectations.
- On June 22, 2009, Bechtel submitted a recovery plan for the project schedule.
- The February 2010 NGDC draft internal assessment found the project was 3 to 5 months behind the internal 54-month schedule.
- The March 2010 NGDC internal assessment stated the 54-month schedule was being challenged by poor EPC coordination of the project from engineering to work planning to construction activity, as well as insufficient resources.
- In a July 2010 letter to Bechtel, TVA stated that without substantial performance improvement, even a 60-month schedule would be at risk.
- The July 29, 2010, WBN Unit 2 weekly status report stated the internal 54-month schedule might be at risk by 60 days.
- On December 9, 2010, TVA issued a letter to Bechtel stating that despite multiple letters, Bechtel's performance continued to be unsatisfactory to TVA.
- In the February 4, 2011, WBN Unit 2 executive meeting, the new Bechtel project manager reported the project did not have a schedule.
- The March 4, 2011, WBN Unit 2 Executive Package stated that without change, the project would be $97 million over budget, and using current methodology, the 60-month schedule was in jeopardy.
- On May 20, 2011, the former Senior Manager, WBN Unit 2, Project Control, estimated the project to be $200 million over budget.

Despite all these indications of schedule and cost performance problems, project and NGDC management continued to characterize the project as on time and on budget. It was not until June 2011 that it was acknowledged the project would not be completed on schedule and within budget. These acknowledgments, which occurred after the OIG briefed executives on its concerns, were made at an NRC public meeting on June 20, 2011, and at the Nuclear Oversight Committee on June 23, 2011.

Internal Assessments Indicating Performance Problems Were Not Addressed

To help monitor and assess the project's progress, the NGDC Project Assurance Process was put in place. The procedure states, "This process provides for an independent overall assessment of approved NGDC projects during construction and transition to operation phases to assure that specific and programmatic processes are reviewed, deficiencies are identified and addressed and NGDC Project goals are achieved."

In October 2009, Bechtel issued a revised schedule (Revision [Rev] 1) for the WBN Unit 2 project. The Rev 1 schedule was intended to provide an updated schedule based on work completed, performance to date, and scope changes. In early 2010, an internal team, led by NGDC's QA team, completed a Rev 1

schedule assessment. The report, done in accordance with procedure NGDC SPP-33.05, *Project Assurance Process*,[10] offered a number of criticisms, concerns, and risks about the project. Specifically, the report stated (1) the project was at considerable risk of not meeting the 54-month target schedule and (2) overall risk factors without mitigating efforts could adversely impact fuel load by 3 to 5 months. Moreover, the report noted the following:

- Current productivity had not kept pace with the Rev 1 schedule requirements since its initiation nearly 4 months before.
- Production of actual versus planned work had improved but consistently had not met the goal. Concerns existed over obtaining the resources and productivity to reach the greater than 30,000 man-hours/week goals in the near future.
- Based on late completion of engineering design, work planning problems, not meeting targeted craft resources, procurement risks, and the like, the current schedule to support fuel loading by October 2011 was at major risk.

According to NGDC personnel who prepared the report, the assessment by the oversight team was presented to the original Site VP, WBN Unit 2, in February 2010. Before even seeing the report, the former SVP, NGDC, informed the oversight team presenter that this report was not the way to perform oversight. The former SVP, NGDC, was later presented a copy of the report but subsequently ordered the team to change the approach and perform a different type of review. In spite of credible evidence to the contrary, the former SVP, NGDC, believed only the original Site VP, WBN Unit 2, when the original Site VP continued to say he could make the internal 54-month schedule.

In March 2010, the internal NGDC team completed a data review of the Rev 1 WBN Unit 2 schedule, work-off curves, procurement, planning, engineering, and construction work data. The report identified three areas for improvement:

- The 54-month completion schedule is being challenged by poor EPC coordination of the project from engineering to work planning to construction activity, as well as insufficient resources.
- The WBN Unit 2 completion project appears to have shifted from an EPC-directed project to a TVA-managed project.
- The alignment between WBN Unit 1 and NGDC does not appear robust enough to effectively support WBN Unit 1 outage requirements and the WBN Unit 2 construction schedule.

[10] At the time of the assessment, SPP-33.05 was in draft. The SPP (Standard Programs and Processes) was finalized in February 2010 but was canceled and superseded by SPP 34.05 in July 2010.

In response to the report, the former SVP, NGDC, sent an e-mail to the author criticizing the report for being too broad in scope and not in line with what he wanted. The e-mail stated, "Had a chance to review. Not what we discussed. I asked us to focus on hanger work to give us insights into a larger issue. We are again focused on broad themes. This will not help the site. Right now the only scope I want is AFI number 1 with a focus on hangers. If there is value we will move to AFIs 2/3." This report, like the February 2010 report, was never finalized or formally published. In March 2010, a report was generated and later issued addressing only the hangers. In addition, at the direction of the former SVP, NGDC, it was addressed to Bechtel and not to the project.

Neither the February nor March 2010 reports, each of which contained credible evidence of schedule and cost performance problems at WBN Unit 2, was used by project or NGDC management as a basis for responding to issues. Moreover, some team members who drafted the reports and disagreed with management's message believe their careers were adversely affected. Further, on February 15, 2011, the OIG's Assistant Inspector General, Audits and Inspections, requested from the former SVP, NGDC, copies of all draft and final (1) internal assessments of WBN Unit 2 conducted by NGDC and (2) external assessments of WBN Unit 2 conducted by third parties or other TVA organizations. The OIG was not provided either the February or March 2010 internal assessments, which the former SVP, NGDC, later attributed to an "oversight."

At this point an appropriate question might be, "Why were the problems not more obvious?" As discussed in the next section of this report, several things helped mask the issues with the project.

Documentation Obscured Project Performance

Looking back at the history of the project, project data made it possible to believe the project was performing better than it actually was. This ranged from increasing resource levels in updated schedules to make up for past delays, to excluding historical data from progress charts, to paying the EPC contractor for meeting multiple milestones. A cursory review of project data matched up with the on-budget and on-schedule message that was communicated, but a detailed look at the data should have raised questions, such as the following:

- Is historical data being ignored?
- Is a craft level of 2,500 feasible?
- Were the milestones chosen appropriate and indicative of overall project performance?

Each time a new schedule was issued, everything appeared to be on track, regardless of how poorly the project had performed or what problems were unresolved. In essence, with each new schedule the project was reforecasted to achieve the target completion, even though time had passed and significant amounts of work were pushed forward. The following details show how changes

to the schedule obscured project performance each time the project was reforecast.

- In June 2008, the first schedule (Rev 0) was published. By September 2009, the project was 1.29 million hours behind the Rev 0 schedule.
- In October 2009, a revised schedule (Rev 1) was approved. By October 2010, the project was approximately 286,000 hours behind the Rev 1 schedule. However, the October 28, 2010, WBN Unit 2 weekly status report stated the ". . . overall project is on schedule to complete in 54 months . . .," 6 months ahead of the Board-approved schedule.
- In November 2010, the Rev 1 Estimate at Completion was issued. By February 2011, the project was approximately 273,000 hours behind the Rev 1 Estimate at Completion. However, the February 24, 2011, WBN Unit 2 weekly status report stated the ". . . overall project is three months behind the 54-month schedule . . .," which was 3 months ahead of the Board-approved schedule.

As noted above, the project was behind at each forecast. Each time a schedule revision was issued, hours not completed from the prior schedule were included in the new forecast. This resulted in more work to be done in a shorter period of time in order to meet the target completion. This also made the project's historical performance easier to overlook.

There was also a trend of changes in the packages during the WBN Unit 2 meetings. Once again, history had a way of changing or being ignored in favor of looking forward. For example:

- A chart from the Monthly Management Review package issued May 1, 2009, showed the project was not meeting the planned schedule. However, the Monthly Management Review package issued November 6, 2009, showed the updated Rev 1 chart did not include the project's history. Without the schedule history, continued poor performance could take longer to identify.
- A chart from the Monthly Management Review package issued October 8, 2010, showed the project was not meeting the planned hours. However, the Monthly Management Review package issued December 3, 2010, showed the updated chart represented only the actual hours completed and did not include the planned hours. This made it difficult for anyone to identify past trends.

Another way the project continued to show on track, even while not meeting the schedule, was with resource levels. According to Bechtel personnel, the original craft staffing peak was determined to be between 1,600 and 1,800 during DSEP. TVA said this level was too high, so changes were made, and the number was reduced to 1,200. However, by Rev 0, the estimated peak craft had increased to about 1,500; by Rev 1, the estimated peak had reached almost 2,500.

Finally, meeting milestones painted a picture that the schedule was being met. The justification for a milestone measure was to support the goal of meeting or exceeding the work schedule goals for the FY based on work planned to achieve the schedule plan or to better the scheduled plan (compared to DSEP). Each year, TVA and Bechtel worked to set goals for the upcoming year. The goals were to represent completion of major pieces of work that indicated the project was on schedule. Not only did Bechtel have incentives tied to the milestones, but NGDC personnel had a portion of their Winning Performance bonus money tied to the same milestones. In addition, NGDC normally had a limited number of milestones tied to other projects. Table 1 lays out the milestone information for Bechtel for FYs 2008 to 2010.

Bechtel Milestone Data, FYs 2008-2010

Year	Number of Milestones	Number Achieved
FY 2008	20	18
FY 2009	18	17
FY 2010	28	21

Table 1

If the milestones had been a good barometer of the project schedule, it would have been easy to develop the impression that the project was progressing well; however, that was not the case. As indicated above, during essentially the first 2 years of the project, the project was 1.29 million hours behind schedule but completed 35 of 38 milestones. The next year, the project was approximately 286,000 hours behind schedule, but Bechtel met 21 of 28 milestones. Over the first 3 years of the project, Bechtel was behind the craft work-off curves but was paid more than $8.5 million in milestone performance fees. In looking back, it is obvious the milestones did not represent the full body of work that needed to be completed to remain on schedule.

Review Done by an External Party Had the Scope Limited

In August 2010, the former SVP, NGDC, hired an outside consultant to perform a risk assessment of the WBN Unit 2 project. During the consultant's first trip to WBN, the team met with the original Site VP, WBN Unit 2, to explain their approach and scope of work. According to one of the team members, the original Site VP, WBN Unit 2, basically told the team to get off the site. The original Site VP, WBN Unit 2, wanted the scope limited to six specific systems, although the consultant's intent was to look at the entire project.

The consulting team discussed the issue with the former SVP, NGDC, and reluctantly agreed to a reduced scope that included only the primary systems. Even with the limited scope, the consultants had problems getting access to information. As part of their work on primary systems, they wanted to test work order packages but were not given permission to do so. According to consulting personnel, the original Site VP, WBN Unit 2, limited their access to the site, people, and data during the review. In fact, the consulting report was based on November project data, which was not the most recent data. The original Site VP, WBN Unit 2, would not give the consulting team access to the information in order

for them to report on the latest data. The consultant notified the former SVP, NGDC, of this problem, but he did nothing to address the situation. Instead, the former SVP, NGDC, told the consultant to come back in April 2011 and perform a quarterly update.

Known Problems Were Not Adequately Mitigated

Throughout the project, problems that were identified were not successfully mitigated. These unresolved problems ranged from staffing issues to work order problems. Recently, there has been a concerted effort to resolve these legacy problems and improve performance. For example, WBN Unit 2 has conducted more than 2,000 walkdowns in order to verify the work that was completed and determine what work needs to be done.

Staffing Shortages

Even under normal conditions, finding qualified personnel can be difficult. However, because no nuclear construction had taken place for almost 3 decades, many experienced people were no longer available. The project experienced shortages of certain positions, such as welders, the Procurement Engineering Group (PEG), field engineering, and QC personnel. Inadequate experience and expertise on the project caused work delays, unnecessary rework, and additional training.

Although the 2007 Bechtel proposal stated Bechtel had adequate experience and expertise, TVA conveyed its concerns about the experience and expertise to Bechtel. In a letter to Bechtel on December 9, 2010, TVA stated, “Bechtel’s provision of inadequate staff expertise/experience, overstaffing of jobs, and failure to ensure those who are supposed to be working actually are doing the work requested by TVA under the Contract represent systematic performance deficiencies.” Bechtel’s response, as previously noted in this report, identified joint TVA and Bechtel accountability on the staffing issues.

Insufficient staffing was identified in the February 2010 NGDC draft internal assessment but was not given adequate attention until after the second Site VP, WBN Unit 2, identified the problem in February 2011.

Excessive Project Management Turnover

Since the project began, the WBN Unit 2 Bechtel management team has been a revolving team. The WBN Unit 2 project has had five different Bechtel project directors. Table 2 shows the number of people who have filled Bechtel’s key project management roles through January 25, 2012.

Bechtel Project Management Turnover as of January 25, 2012

Position	Number of People
Project Director	5
Construction Manager	6
Engineering Manager	4
Procurement Manager	1
QA/QC Manager	3

Table 2

In a March 2011 interview with the OIG, the second Site VP, WBN Unit 2, stated that the high level of contractor management turnover was a "red flag."

As Bechtel pointed out in its response to the request for proposal for WBN Unit 2, a project of this size is too much for one company. They had a hard time bringing the right people to the project. The high management turnover makes it difficult to develop consistency and a sense of unity on the project.

Even TVA oversight personnel have seen turnover. The second Site VP was hired on February 16, 2011, and led the project until a General Manager, WBN Unit 2, Technical Services, and a General Manager, WBN Unit 2, Engineering and Construction, were named on February 10, 2012. In fact, the most recent management change at WBN Unit 2 involved bringing back a former President and Chief Operating Officer to run Engineering and Construction. The November 2007 organizational chart for WBN Unit 2 shows 15 individuals who had a direct oversight role for the project, all of whom were long-term TVA employees with considerable experience. Several employees of the WBN Unit 2 TVA team were provided incentives to stay and assist with the project, due to their past experience. Best practice fully utilizes management personnel in developing mentoring, identifying high-potential employees, and establishing a succession planning process. With TVA's emphasis on more nuclear construction, it is important to build a staff that can carry on that direction into the next 20-plus years.

The book *Industrial Megaprojects*[11] discusses the importance of continuity in team leadership. The author states, "Most damaging is the departure of the project director anytime between FEL-2 and project completion." The author adds that, with project leadership turnover, there seems to be ". . . a loss of memory among some functions and organizations that borders on total amnesia. Agreements between operations/manufacturing and the project about design features come unstuck." Ultimately, management turnover brings its own problems to the table.

Problems With Work Order Package Quantity and Quality

As previously discussed, at the beginning of the project the decision was made to begin engineering and construction at essentially the same time. Construction personnel needed detailed instructions or work order packages to be able to work. These work order packages were developed by work planners based on design engineering packages, and walkdowns were not performed prior to completing the work package. Because 25 years had passed since work had begun on WBN Unit 2, it was difficult to determine what components needed to be replaced or installed. However, with construction personnel on site, they needed planned packages as soon as possible. Work order packages were not being planned fast enough to keep up with the pace of construction.

[11] Edward W. Merrow, "Industrial Megaprojects: Concepts, Practices, and Strategies for Success," *Hoboken: John Wiley & Sons, Inc.*, 2011, pp.180-182.

To be able to get work into the field faster, changes were made in how the work was packaged. Instead of developing smaller packages, bulk commodities, such as hangers, cable, or piping, were grouped into large packages in order to get more work into the field for construction. The bulk commodity packages had a very large scope and contained work on multiple systems. Work on these systems required multiple work order packages. Once the work was complete, the systems were to be turned over to the start-up group for testing. However, before the systems can be turned over, the physical work must be essentially complete, and the work order packages must be closed. Since the system completion schedules varied greatly, not all the work in the bulk commodity packages was completed, resulting in systems that could not be turned over because work order packages for bulk commodities were involved and could not be closed until the work was verified.

In the rush to get work to construction personnel, the quality of work order packages suffered as well. Work order packages would often contain revisions or had missing instructions, causing workers in the field to have a hard time identifying what steps were required. Craft workers often required assistance from field engineers to understand the work needed. With a limited number of field engineers, craft workers often found themselves waiting, negatively impacting the productivity of the craft.

In May 2011, Bechtel and TVA prepared an ETC that showed TVA had identified inaccuracies with the data in the scheduling system. The schedule showed there were (1) quantities, or scope, unidentified in the schedule; (2) work order packages in fieldwork-complete status[12] without the work being complete; and (3) other issues with data in the Bechtel scheduling system. TVA reviewed a sample of planned work order packages and found that only 10 percent of the packages were actually workable in the schedule. In addition, TVA identified approximately 900 work orders in complete status in the schedule but not shown as complete in Maximo,[13] meaning the paperwork was not complete or closed. As mentioned earlier in this report, to fully understand the scope of work remaining, more than 2,000 walkdowns have been conducted to verify the number of components to be added or modified, if the amount of time for the allotted activities is reasonable, and if the percent of work completed status is accurate.

NRC Characterized Information Submitted by TVA as Lacking Quality and Timeliness

On January 27, 2011, the NRC sent a letter to the former SVP, NGDC, on the status of WBN Unit 2's operating license application review. In that letter, the NRC reiterated concerns over the timeliness and quality of the documentation

[12] The fieldwork complete status designates that all the "wrench turning" has been completed.

[13] Maximo is the IBM software TVA uses to manage the Enterprise Asset Management, which is a single application for work management, corrective action, and supply chain business functions for the entire TVA fleet.

submitted that had previously been raised to TVA in another letter dated July 28, 2010. The letter went on to:

> . . . re-emphasize . . . that issues with the timeliness and quality of submittals continue to arise, and these issues are impacting the schedule for completing the licensing review. As a consequence, the duration of review activities to achieve the schedule milestones needed for licensing WBN Unit 2 will be extended because of TVA's difficulty in providing the necessary and sufficient supporting information in response to staff request for additional information.

The letter stated specific issues with submittals including:

- The final "as-designed" Fire Protection report submitted on December 18, 2010, found placeholders for future design information, as well as errors and omissions, and therefore did not fully meet the NRC's informational needs. Further, "The fire protection review schedule has already been impacted by previous delays, and further delays can only worsen the schedule."
- Regarding the final Safety Analysis report, the NRC stated that ". . . late receipt of TVA responses to request for additional information affected the NRC staff's progress." The letter cited three examples of late submittals and partial responses, stating that "TVA has not yet been able to fully address these issues."
- The NRC's review of TVA's supplement to the environmental impact statement for operation of WBN Unit 2 was extended due to delays in submitting revised analyses related to severe accident mitigation alternatives and other supporting studies.

The letter closed by stating that action is ". . . imperative for the NRC staff to complete all of its licensing reviews and inspections consistent with your schedule to commence operation in fiscal year 2012." Since the NRC controls the operating license and the plant cannot operate until that license is obtained, it is imperative to provide high-quality and timely information to the NRC.

Long Lead Materials Were Not Identified and Ordered Timely

Engineering generates material requests for the major components needed to complete the work. Procurement uses the engineering specifications to order the components. If those components cannot be obtained, Procurement relies on the PEG to identify appropriate substitutions.

As previously stated, engineering must be complete before accurate work order packages can be issued. Because of the inadequate backlog of work order packages, construction laborers were relied upon to perform walkdowns and identify materials needed. This resulted in the late identification of material, and subsequently, the late ordering of long lead material.

The November 9, 2007, monthly review status meeting asserted that long lead items (greater than 20 months) had been identified and procurement was underway. However, time and again, we noted reports and presentations discussing the challenges of procuring certain items, such as the following:

- July 11, 2008 – The Rev 0 Project Schedule challenges include "long lead time procurement items."
- September 25, 2008 – Project Schedule risks include long lead materials.
- October/November 2008 – "Identification of critical and long lead materials to support construction and the Rev 0 Schedule . . ." is listed as an issue/ challenge.
- Week of November 24, 2008 – In a project meeting, the former Site VP, WBN Unit 2, stated that with the current process for identifying missing valves, it would take 10 years to identify them all. He further stated that the project could not continue to operate this way.
- December 2008/January 2009 – The monthly progress report described ". . . continued focus on identification of critical and long lead materials to support Construction and the Rev. 0 . . ." as an issue/challenge.
- May 1, 2009 – The Monthly Management Review status report showed a "continued focus on long lead procurements."
- November 6, 2009 – The Monthly Management Review status report showed a focus area to ". . . continue to identify remaining long lead procurements with Engineering."
- Week of November 16, 2009 – In a project meeting, management stated that valves had been identified that needed to be ordered. The lead time was unknown until the packages could be completed and submitted to vendors for bids.
- February 2010 – The NGDC draft internal assessment stated, "Procurements for engineered materials continue to threaten the schedule e.g. ERCW and CCS ASME Valves. Until Engineering is completed, the full extent of schedule impact from delayed material delivery cannot be fully determined and remains a risk."

Even with continual focus, by March 10, 2010, 213 ASME valves, 57 safety-related valves, and 163 quality-related valves had not been ordered. During the following week, the project identified an additional 122 quality-related valves that had not been ordered, indicating that the project still did not have a good grasp on the material needed to complete the project.

A December 2010 WBN Unit 2 *Threats to Schedule* presentation showed that Bechtel was "behind in identifying and ordering parts." The presentation also showed "1088 valves that have not been delivered" with a mitigation plan for expediters to work with Engineering to look at Bellefonte valves and be in contact

with the vendors to make sure delivery dates are on track. A February 2011 presentation by the original Site VP, WBN Unit 2, showed that procurement of safety-related ASME valves could challenge the project's critical path. In fact, Bechtel hired six to eight expediters in order to get the materials on site faster with minimal additional charge.

TVA'S ACTIONS TO ADDRESS IDENTIFIED PROBLEMS

TVA recognizes and acknowledges the problems with the WBN Unit 2 project and has taken a number of steps to make improvements not only for WBN Unit 2 but also future nuclear construction projects.

On April 5, 2012, the Chief Executive Officer and SVP, Nuclear Construction, held a public meeting at WBN Unit 2 in which they discussed the revised schedule and budget and factors that caused the cost and schedule slippage. TVA now estimates the cost of completion to be between $4 billion and $4.5 billion with an estimated time of completion between September and December 2015. The factors discussed were:

- Leadership – A failure to verify the rigor in the cost and schedule targets.
- Estimating – Using BFN productivity rates even though the situation at WBN Unit 2 was vastly different.
- Executing – Work orders that were too complex and cumbersome and contained insufficient detail because all walkdowns were not performed.
- Overseeing – A lack of early, straightforward metrics to highlight problems.

With respect to management actions to address the problems, one major action was to develop a comprehensive ETC for the WBN Unit 2 project. The ETC is the forecasted scope, budget, and schedule to complete the project. The ETC included the following:

- Walkdowns to determine and validate quantities and verify accuracy.
- Estimating resource needs for subcontractors, support organizations, and nonmanual personnel.
- Developing risk ranges.
- Extensive management review.
- Independent assessment.

This ETC was approved by TVA's Board of Directors during the April 2012 Board meeting.

Additionally, an internally led team performed an extensive root cause analysis to understand the underlying issues that resulted in the cost overruns and schedule delays. The team identified ineffective leadership, inaccurate estimates,

ineffective execution, and inadequate NGDC/TVA oversight and assurance as primary root causes. External consultants from McKinsey and Company reviewed this analysis to identify any gaps or weaknesses.

Corrective actions have been taken related to planning documents, field engineering, schedule and cost monitoring tools, and the change control process. Specifically,

- To offer an accurate status of the project, weekly project and abbreviated management reports are being prepared. These differ from status reports earlier in the project because of the level of detail and data provided. Some of the key indicators include Cost Performance Index, Schedule Performance Index, and scope growth. Not only is this information included for the project as a whole, but also by individual commodity type.
- An alignment and engagement strategy was developed to address cultural issues that existed with the workforce.
- A communication plan was developed to document how information and updates will be given to stakeholders.
- Team rules have been prepared to communicate the behaviors that are acceptable on the project.
- Other corrective actions related to improved productivity are planned or in process.

In addition, Nuclear Construction and TVA Corporate's corrective actions, including a planned review of the accuracy of the Bellefonte estimate, restructuring the independent Project Assurance Organization, and developing a contracting strategy for various project classifications are planned or in progress. TVA's actions are positive and should help to improve the process for WBN Unit 2 and future projects.

RECOMMENDATIONS

As a result of set-up flaws and oversight that was too narrowly focused and managed by too few, the project has paid a high cost. With TVA entering into another nuclear construction project in the near future, there are multiple opportunities to learn from this project's mistakes. To improve the schedule and cost performance of nuclear construction projects, we recommend TVA's Nuclear Construction organization:

- Develop a consistent and thorough approach for planning and estimating nuclear construction projects including, but not limited to, a range of estimates with probabilities, key risk assumptions, and contingency amounts.
- Develop contingencies for supplementing contractors' expertise in case they are unable to provide qualified resources.

- Develop contingencies for obtaining the ASME certifications for future projects as applicable.
- Require design engineering be substantially complete before starting construction on nuclear projects.
- Establish controls over the development and reporting of project performance data and provide for independent verification of the data.
- Assess the cultural climate to determine if the actions of certain, former key management have affected the organizational culture. Additionally, provide an opportunity for WBN Unit 2 personnel to voice their concerns about the culture that exists currently and views about what should be done to create a more transparent culture.
- Evaluate project incentives to ensure they will deliver desired results.
- Address aging nuclear workforce issues by developing a program for transferring knowledge.
- Work collaboratively with TVA's Board of Directors to evaluate the benefits of retaining the services of nuclear construction experts to monitor large nuclear construction projects' progress and report results directly to the Board.

BECHTEL'S RESPONSE

On May 7, 2012, Bechtel management responded in writing to a draft of this report. Bechtel disagreed with ". . . several of the Draft Report's implications and have identified conclusions that we believe are not supported by the project record." We carefully reviewed Bechtel's comment letter and reevaluated the report and supporting documentation, and remain confident in the report's information and conclusions; therefore, we made no changes to the report based on Bechtel's comment letter. Below, we discuss certain key points in Bechtel's response and our evaluation of them.

Bechtel's first concern was the report could be interpreted that Bechtel's project data ". . . attempted to cloud rather than draw attention to problems and challenges the project faced." Specifically, Bechtel focused on the feasibility of craft resource levels; whether reforecasting of the schedule "set aside or ignored historical data;" and whether milestone payments were related to the project schedule.

Bechtel provided multiple examples from Rev 1, which expressed its concerns regarding craft resource levels. According to Bechtel, Rev 1 ". . . acknowledged our judgment that the resource levels to achieve TVA's direction were impractical, and identified other risks confronting the project at that point." Bechtel further states, ". . . our forecasts clearly documented the project's performance at each stage and provided sufficient information for TVA to understand the challenges and risks associated with each forecast."

We agree Bechtel raised concerns in Rev 1 related to achieving peak-craft levels. However, as noted on page 15 of this report, our point related to staffing levels is that while risks may have been pointed out in detailed 80 page reports, that information was not included in certain other project reports at key points when project performance was reviewed, thus obscuring the project's performance and concerns about achieving the stated performance targets. For example, the first joint TVA/Bechtel monthly management package following the issuance of the Rev 1 schedule, dated November 6, 2009, concluded ". . . the schedule remains 48 months to ready for fuel load." This monthly management package was reviewed at the site by key TVA and Bechtel managers and, in our opinion, the conclusion that the schedule remained achievable could have masked the concerns Bechtel raised in the Rev 1 schedule. Moreover, even later in the project, Bechtel documented staffing levels as a challenge in the October 2010 Estimate at Completion but in the same document concluded the project was on schedule for the 48 months ready for fuel load.

Similarly, Bechtel contends they do not understand the conclusion reached that the December 3, 2010, chart made it harder to identify past trends. In the chart dated October 8, 2010, Bechtel included the planned number of hours completed as well as the actual hours for each week. This made it easy for the reader to determine if the project was getting the work done each week. However, the December 3, 2010, chart only shows the actual hours and does not include the planned hours for each week. Those who were not on the project site on a daily basis might not have known that some of the weekly planned hours were not being completed.

Bechtel also disagrees that ". . . the milestone tasks and activities that TVA and Bechtel used to set goals for the upcoming year were unrelated to the project schedule". As pointed out in the report, the justification for having milestone measures was to support the goal of meeting or exceeding the work schedule based on work planned to achieve, or to better, the schedule plan. Since Bechtel was able to achieve 35 of 38 milestone tasks during the first 2 years of the project, while being 1.29 million hours behind schedule, the milestones were clearly not a good indication the project was meeting the schedule.

Lastly, Bechtel said they believed ". . . the approach taken with the DSEP in 2007 was consistent with what all concerned then viewed as reasonable practices to conduct an assessment of the cost and schedule to complete construction of WBN Unit 2." We find this assertion quite concerning. TVA recently reported that $800 million of the $1.7 billion project overrun (most likely estimate within the estimate range) was tied to errors in the estimation process. These errors were related to unit rates, walkdowns being stopped too early, and lack of contingency. In our opinion, for the global engineering and construction company hired to perform the estimate to say the approach was reasonable when current estimates show that, at best, the estimate was off by $800 million is unconvincing.

Bechtel management also separately provided technical and clarifying comments that we evaluated and incorporated into the final report, as appropriate.

See Appendix A for Bechtel's complete response.

TVA'S RESPONSE

On May 15, 2012, TVA management responded in writing to a draft of this report. TVA agreed with the fundamental findings and recommendations in the report. TVA also suggested a wording change for clarity and consistency that has been incorporated into the final report. Further, TVA's comments included the opinion that Bechtel's response to the draft report ignored Bechtel's contributions to the project's problems. However, TVA determined it was not constructive to respond to Bechtel on a point-by-point basis, choosing instead to focus on moving forward.

In response to our recommendations, TVA management has completed or plans to complete the following actions:

- TVA has included a range of estimates and contingencies based on identified risks within its new estimate for WBN Unit 2.
- TVA has revised the contract with Bechtel to give TVA the authority to assign tasks to other contractors as appropriate and has contracts with other construction and engineering firms in place to supplement resources as needed.
- While it is not feasible to revisit the ASME process for the WBN Unit 2 project, TVA stated it will determine appropriate contingencies to ensure a single ASME stamp holder does not impede project progress prior to beginning full construction at Bellefonte.
- TVA identified outstanding engineering work for WBN Unit 2 and has developed a work-off indicator to ensure engineering work is completed as needed.
- TVA has developed a set of standard metrics that will be reviewed by Senior Project management weekly and an executive management package that will be issued monthly. Additionally, TVA has begun implementation of a Project Assurance group that will perform independent assessments of project status reporting and provide the results of these assessments to executive management.
- Nuclear Construction management will continue to employ the Organizational Health Index to give independent and confidential assessment of employee attitudes. Additionally, Nuclear Construction is developing the Alignment and Engagement Strategy to improve the culture of the workforce. Interim measures, such as a detailed communication plan and Employee Advisory Group, have been instituted to improve alignment and engagement.

- TVA has revised the Bechtel contract to establish a more performance-based incentive program.
- Nuclear Construction management has instituted a formal succession planning activity. In addition, TVA and Bechtel management have agreed to open dialog concerning employee performance.
- TVA has reinstated the Construction Safety Review Board to review construction activities and provide an assessment from a safety perspective and look into project performance issues. The Construction Safety Review Board will provide their results to the Nuclear Oversight Committee, chartered by the Board of Directors.

Additionally, TVA management plans to incorporate these actions, as applicable, on the Bellefonte completion project. The OIG concurs with TVA's planned and completed actions. However, we encourage Nuclear Construction management to take additional actions to assess the culture at WBN Unit 2 by seeking input from both TVA employees and contractors working on the project.

See Appendix B for TVA's complete response.

May 7, 2012

25402-OIG-BM-TVAU2CC-2012-0002

Mr. Robert E. Martin
Assistant Inspector General
(Audits and Evaluations)
Tennessee Valley Authority
400 West Summit Hill Drive
ET 3C-K
Knoxville, TN 37902

Subject: Watts Bar Unit 2 Construction Completion Project – Bechtel Job No. 25402
TVA Contract No.: 65419 (the "Contract")
Subject: Draft Inspection Report 2010-13088 – Watts Bar Nuclear Plant Unit 2 Project Set-Up and Management Issues Affected Cost and Schedule (the "Draft Report")

Dear Mr. Martin:

Bechtel Power Corporation provides the following comments to the Office of Inspector General's above-referenced Draft Report at the invitation of Robert E. Martin, TVA's Assistant Inspector General. The Draft Report indicates it is part of and results from the OIG's engagement in the Watts Bar Nuclear Plant Unit 2 Project from October 2007 to date. More specifically, the report states its purpose has been to assess project set-up and management issues to assess TVA's schedule and cost performance on the Project. As the Draft Report discussed, a number of issues adversely affected the project's performance, but the primary contributors to schedule and cost overruns were TVA's control and direction in project set-up and in day-to-day operations. Although we support TVA and the OIG in working to improve its nuclear program, and appreciate the opportunity to participate in that process through our comments, we disagree with several of the Draft Report's implications and have identified conclusions that we believe are not supported by the project record.

Bechtel Project Documentation Did Not Obscure Performance

We are concerned that a possible interpretation of the Draft Report is that the project data Bechtel provided attempted to cloud rather than draw attention to problems and challenges the project faced. Thus, to the extent this interpretation is possible, we want to clearly underline that Bechtel does not agree that is the case, and we have first addressed our comments to that section of the Draft Report that discussed project data and documentation.

The Draft Report sets out the OIG's view that "project data made it possible to believe the project was performing better than it actually was."[1] The Draft Report focused on three things about which it asserts a "detailed look . . . should have raised questions . . :"[2] 1) the feasibility of craft levels in Bechtel's September 2009 schedule reforecast; 2) each schedule reforecast set aside or ignored historical data and management review package contents were changed to change or ignore project

[1] Draft Report, p. 14.
[2] Draft Report, pp. 14, 16.

history; and 3) milestone payments to Bechtel the Draft Report views as unrelated to performance in relation to the project schedule.

1. Craft Resource Levels

The facts are that Bechtel clearly stated in its September 2009 Rev. 1 schedule submission to TVA that the peak of 2,000+ craft workers was not practical. Specifically, Bechtel's submission provided: "Engineering and construction durations (and resource requirements) have been forced to support the test occurring during the RF10 outage as well as the balance of demand dates established in the system turn-over waterfall schedule. The resulting peak craft resources are considered not practical."[3] In the Rev. 1 Summary Report Bechtel provided TVA additional detail that included the following:

> "Achieving the required peak craft levels is a concern. To date, craft levels have been restrained pending the development of a substantial backlog of construction work orders. This restraint has caused the remaining time to complete the work to decrease, and thereby will raise the peak level to perform the same number of hours in a shorter period. This backlog is now building and increases in craft levels will be required quickly to have the highest probability of achieving the 54 month schedule. Present indications are that a peak above 2,000 will be required for 6-8 months working 50 hours per week. The planned Rev. 0 staffing levels peaked at approximately 1,550 and that was considered an achievable level."[4]

At the time of the Rev. 1 submission, TVA had directed the Integrated Safeguards Test (IST) noted above must be conducted during the RF10 outage, which would occur in April 2011. This requirement was not known and therefore not planned in Rev. 0 in which these activities were planned to be performed post-RF10. This direction in turn 'forced' earlier completion of predecessor IST-related work activities than otherwise was planned in Rev.0. It is this factor, together with an effective loss of 20% of available work hours caused by TVA's restraint of the work week to 4x10s that was the primary driver of the schedule reforecast in Rev. 1 that yielded such a high level of craft resources. Bechtel discussed in Rev. 1 that the IST Test specifically drove the reforecast to be a "'what it will take' analysis to achieve the 54 month target schedule" and stated clearly its judgment that "[t]he resulting peak craft resources are considered not practical."[5] Bechtel identified "peak resource requirements (engineering and construction manual labor)" as the second of six listed "Risk Issues" at page 4 of Rev.1 and specifically noted that "no limits were placed on craft staffing levels" in the Basis and Assumptions of the Rev. 1 reforecast.[6]

Moreover, Bechtel urged in this reforecast that "the project must undertake an accelerated joint review of the two primary external forces that directly affect the pace and structure for the remaining work scope—available funds and available craft resources."[7] Among the measures Bechtel advocated in Rev 1. in September 2009 to address these risks and challenges was "delinking the Integrated Safeguards Test and RF10," a recommendation TVA did not adopt until Fall 2010. Bechtel also pushed to implement a 5x10 workweek, which had been our foundation assumption of the DSEP, but which TVA had not permitted since project start. Bechtel's development of this reforecast clearly

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[3] September 2009 Forecast (REV 1), p. 3 of 6 (hereafter "Rev. 1).
[4] Rev. 1, p. 11 of 80.
[5] Rev. 1, pp. 3, 5 of 6.
[6] Rev. 1, p. 30 of 80.
[7] Rev. 1, p. 5 of 6.

acknowledged our judgment that the resource levels to achieve TVA's direction were impractical, and identified other risks confronting the project at that point. We believe our forecasts clearly documented the project's performance at each stage and provided sufficient information for TVA to understand the challenges and risks associated with each forecast.

2. Bechtel's Forecasts and Presentations Incorporated Historical Data

With regard to the Draft Report's conclusions that historical data was ignored, the Rev. 1 forecast and the October 2010 Estimate At Completion, as discussed in the OIG's interviews of Bechtel personnel, were primarily based on historical performance. Each schedule analysis assessed the work that the project had completed and tackled the job of defining potential measures that could be taken to complete the remaining work to attempt to achieve the desired target completion date. As Bechtel stated in the Rev. 1 Executive Summary:

> "The project completed a total project forecast (REV 1) in September 2009, reflecting current status of designed and to-go quantities, engineering, construction and other non-manual resources, manual labor installation unit rates and manual labor hours, labor cost rates, material costs and the total project schedule."[8]

In the Rev. 1 scheduling submission, Bechtel described in detail the nature and extent of the efforts involved, which were primarily based on the project's history to that point in time:

> "The Rev. 1 Forecast effort constituted a bottom-up estimate of the project scope and execution approach. Quantification basis included physical work completed to date, design packages completed and available for planning, and task lists and system scoping documents provided by engineering. Analysis of installation unit rates indicated the standard unit rates for electrical commodities for cable, conduit and conduit support installation were low and were increased."[9]

The October 2010 EAC similarly reflected and incorporated project history:

> "The EAC is largely an update of the Rev. 1 Forecast completed in October 2009 while reflecting the change in assumptions and the additional experience gained. At the time of Rev. 1, engineering was 42% complete and construction was under 7% complete—engineering is now over 80% complete and construction is over 50% complete. We examined the total to-date experience and to-go work regarding engineering, field non-manual work, quantities, commodity installation unit rates, indirect labor, subcontracts and wage rates. We have incorporated all known and outstanding trends. The resulting quantities and man-hours then are key inputs to the schedule assessment."[10]

As discussed above in reference to Rev. 1, and as also discussed in the EAC schedule submission, TVA had changed a significant schedule requirement; first, at the time of Rev. 1, directing that the Unit 2 Integrated Safeguards Test had to be conducted during the Unit 1 RFO10 outage (March-April 2011); then at the time of the EAC, shifting the IST to be performed in September 2011.[11] The EAC incorporated this historical data. Bechtel's schedule submissions explicitly accounted for the project's

[8] Rev. 1, p. 1 of 6 (Emphasis added).
[9] Rev. 1, p. 4 of 6 (Emphasis added).
[10] Estimate at Completion—October 2010/Transmittal Letter, November 3, 2010, p. 4 (hereafter "EAC Transmittal").
[11] EAC Transmittal, p. 4.

history to the point in time the analyses were conducted. Therefore, we do not believe the schedules and forecasts we developed resulted in "changes to the schedule [that] obscured project performance each time the project was reforecast."[12]

In fact, Bechtel accounted for project history in each of its schedule submissions—openly and with explanatory data—identifying manhour adjustments and the bases for them. For example, although the Draft Report accurately summarized the purpose of Rev. 1, it did not take into account specific statements in Rev. 1 that provided the basis of changes in manhours and project status:

- Engineering hours increased (primarily due to design evolution and trends).
- Field Nonmanual hours increased (primarily due to the execution change from free release construction processes to detailed work order modifications processes).
- Craft hours have decreased due to reductions in quantities and the incorporation of more aggressive unit rates than were utilized in the DSEP.
- Results of the schedule review indicate the existing target milestones [associated with the 54 month schedule] are under threat due to numerous impacts.
- Additional pressure will be applied to meeting the target schedule dates due to FY2010 funding limitations which limit the amount of work that can be accomplished in 2010.[13]

Rev. 0, the baseline schedule in September 2008, stated the basis of manhour adjustments as well:

> "The scope utilized for development of the schedule is based on the Detailed Scoping Estimating and Planning (DSEP) study adjusted to account for the project knowledge gained to date relevant to the scope development. An overall 20% reduction in bulk quantities has been assumed based on a preliminary analysis and evaluation performed on major commodities, such as hangers and cables. Engineering assessment of the Unit 1 DCNs for applicability to Unit 2 has also been incorporated into the scope and Schedule which resulted in a 12% reduction in engineering scope.
>
> The reductions in scope effected corresponding jobhour budget reductions in engineering of approximately 0.4 million non-manual jobhours and in construction of 1.7 million manual jobhours. Preliminary manpower projection indicates an average of 625 full time equivalent persons for engineering, and 1,500 manual full time equivalents for construction craft."[14]

Although subsequent project experience established the project's craft hour assumptions were not borne out, there is no basis to conclude Bechtel made such adjustments to obscure project status. If that were the case, there would have been no reason to identify, as Bechtel did on multiple occasions, specific threats to completion by the targeted date.

As for the October 2010 and February 2011Weekly Status reports the Draft Report cites, all Weekly Status reports were prepared and issued by TVA site management without Bechtel's involvement and thus Bechtel is unable to comment on these materials.

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[12] Draft Report, pp. 14-15.

[13] Rev. 1, p. 1 of 6.

[14] Project Schedule (Revision 0) June 2008, p. 4.

The Draft Report also raises a question whether historical information was obscured through "a trend of changes in the packages during the WBN Unit 2 meetings."[15] The Draft Report says the presentation in the packages hindered the ability to identify "continued poor performance" and "past trends."[16] Although the Draft Report may have accurately noted the use of different charts or exhibits in information packages between specific monthly packages, it does not follow that the two referenced charts reflect an effort to create different impressions of the project. The May 1, 2009 chart is a depiction of overall project percent complete. At the direction of the original Site VP, the November 6, 2009 chart reflects only the Rev. 1 forecast work-off plan for Direct Craft Jobhours. It is our understanding that this concept was utilized on the BFN Unit 1 Restart and that TVA intended to use the same concept on WBN Unit 2. We do not understand how the conclusion was reached that the December 3, 2010 updated chart made it harder to identify past trends. The chart showed the actual earned direct hours for the past year relative to the projected to-go plan. The past trend was clearly visible and the point and conclusion that the project needed to significantly increase its rate of earnings could easily be seen on the chart. The lack of the past "planned" hours did nothing to dilute the message being presented in the chart. Thus, we take exception to any implication or interpretation that Bechtel prepared and/or revised any materials for the purpose of "changing or . . . ignor[ing history] in favor of looking forward."[17]

3. Performance Fee Incentives Were Tied to Substantive Performance Goals

The Draft Report addresses so-called "milestone performance fees" and states that Bechtel was paid more than $8.5 million in such "fees".[18] We respectfully disagree with the implication that the milestone tasks and activities that TVA and Bechtel used to set goals for the upcoming year were unrelated to the project schedule, particularly as 2010 indicated a decreasing level of achievement of the goals, and FY 2011 resulted in Bechtel achieving only four of 61 milestones.

As executed, the fee and incentive program under the Contract consisted of two separate and distinct parts: (1) a Completion Incentive based on achievement of the long-term goals related to the overall project cost and schedule performance; and (2) an Annual Performance Fee based on achieving agreed-to performance goals during a given TVA fiscal year.

The Completion Incentive was based on overall project cost and schedule criteria. Bechtel had the opportunity to earn the cost component of the Completion Incentive based on the project's overall total installed cost (TIC) performance and the schedule component based on Bechtel's schedule performance against a certain "ready for fuel load" date. Bechtel would not earn any of the TIC Completion Incentive if the project's overall TIC exceeded $2.44 billion and would not earn any of the Schedule Completion Incentive if Bechtel's scope did not achieve the "final ready for fuel load" milestone by 57 months after the Contract execution date.

The Annual Performance Fee was based on Bechtel's performance during a particular TVA fiscal year. This Fee was totally at-risk based on Bechtel's performance to agreed-to specific goals for the fiscal year in question. Performance was measured against agreed-to project specific goals for Bechtel's scope including goals related to schedule milestones, budget management, safety performance (e.g. no work-related fatalities), no tripping of Watts Bar Unit 1, and other project specific activities.

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[15] Draft Report, p. 15.
[16] Id.
[17] Id.
[18] Draft Report, p. 16.

Schedule milestones identified for each year were typically proposed by TVA and agreed-to by Bechtel. In accordance with the Contract, if we achieved the milestones, we received the agreed-to weighted fee assigned to the milestone components of the Annual Performance Fee. Each year TVA audited a detailed package of information related to each of the milestones. The agreed-to schedule milestones did in fact involve "completion of major pieces of work" that were necessary to be completed by the agreed upon milestone dates to enable Bechtel or other project participants to perform follow-on tasks. For example, in 2009 Milestone #4 established "Complete the issuance of all initial approved U1 RFO-9 related DCN scope" as one of the goals. This predecessor task was necessary to Milestone #7 "Complete the work package planning of maintenance and modifications approved scope related to U1 RFO-9."

Although the majority of the milestone tasks were not necessarily items on the schedule critical path, they were meaningful and substantive tasks that had to be completed at the target dates set as goals in order for subsequent work to proceed. For example and by way of overview:

- In FY08, the schedule milestones focused on project infrastructure and other prerequisite activities required to support the subsequent construction completion activities. In addition, milestones related to the Essential Raw Cooling Water (ECRW) critical path and long lead procurement activities (potential critical path) were also included in the milestones.

- In FY09, the schedule milestones focused on the completion of design activities and work needed to support Unit 2 activities needed to be completed during the Unit 1 RF09. In addition, the milestones included the issuance of the DCN for the ERCW Pump Replacement (critical path).

- In FY10, the focus shifted to activities associated with bulk construction work and initial system turnovers to Startup. Included in the system turnover milestones were Component Cooling (070), Safety Injection (063), and Residual Heat Removal (074), all associated with the project's ability to conduct the IST.

Project Performance Issues the Draft Report Raised

1. Prime Subcontractor Agreements

The Draft Report suggests that Bechtel failed to implement prime subcontractor agreements as promised in our proposal and that this contributed to project delays. The implication that Bechtel promised something that it chose not to deliver to TVA is unfounded. The facts are that Bechtel made attempts to secure agreements with two of the three prime subcontractors identified in the proposal. No workscope was ever identified by Bechtel and TVA for Areva. Temporary Seconding Agreements with WGI and S&L were put in place by Bechtel to expedite the work while subcontract negotiations were underway. As accurately stated in the Draft Report, WGI and S&L would not accept required TVA flowdowns from Bechtel's Prime Contract and TVA was unwilling to waive these terms and conditions. Subsequently, TVA decided to use its existing contract for S&L's services. As the need arose for Bechtel to obtain personnel with key specialty skills, we brought people to the project, either in full time assignments or through short term support from our Frederick office to meet these needs. The absence of these prime subcontractor agreements, as discussed in the next paragraph, did not impact Bechtel's ability to perform and did not deny Bechtel needed specialty skills.

2. Design Work by Others was Not Related to Bechtel's Performance

The Draft Report implies that issues with Bechtel's performance of design engineering work necessitated TVA's action to enlist the aid of three other engineering firms. However, these firms prepared only a limited number of the design packages. The project has issued a total of 935 design packages (DCNs/EDCRs) with less than a dozen such packages having been prepared by these firms. Bechtel believes it is critical to understand that, contrary to the implication that Bechtel performed design engineering poorly, completion nine months later than the original DSEP plan must take into account the fact that the DSEP planned on performing design engineering at 50 hours per week (5x10s). As discussed above, TVA did not allow such efforts, and thereby restricted the opportunity to make better progress. Moreover, because newly identified work emerged through Bechtel's evaluations of the internal condition of existing equipment during design engineering the scope of our efforts increased over the planned level.

3. Other Criticisms of Bechtel's Performance are Unfounded

Bechtel noted that among the Draft Report's findings was that TVA's management approach to WBNU2 had a "corrosive effect" on WBNU2 project personnel.[19] That corrosive effect also contributed to many of Bechtel's management changes. The Draft Report states, "…[t]he WBN Unit 2 Bechtel management team has been a revolving team."[20] In fact, several specific management changes in the Bechtel project management team can be tracked directly to TVA's original Site VP, either through resignations or TVA-directed changes.

During the course of the project, Bechtel worked hard to identify and order long lead items, and takes exception to the assertion that long lead materials were not identified and ordered timely. Long lead components are always an issue on any construction project and even more so for a restrictive ASME code-driven nuclear project. Also, for a project such as WBNU2, these challenges are compounded further because many long lead items cannot be identified as being needed until internal work on the existing field component takes place to determine its condition. As such, long lead procurements were continuously reviewed throughout the lifetime of the project, as is accurately reflected in the Draft Report.

DSEP and Problems in "Project Set-Up"

At the outset of the Draft Report, the OIG concludes that factors related to project set-up and TVA's management approach adversely affected cost and schedule. Bechtel agrees. It should be noted that TVA established the DSEP scope. Although the benefit of hindsight makes appealing a conclusion that more could and/or should have been spent, more could and/or should have been done, and more intrusive measures could and/or should have been taken, the fact is that a similar level of estimate development and estimate basis had previously been used with the Browns Ferry restart. Thus, we believe the approach taken with the DSEP in 2007 was consistent with what all concerned then viewed as reasonable practices to conduct an assessment of the cost and schedule to complete construction of WBN Unit 2.

In addition to the consequences of cutting short the DSEP efforts and the likely adverse effect to the project's success as discussed in the Draft Report, we would add that Bechtel at the time of DSEP efforts recommended that TVA allow the Bechtel team to continue with the then-existing engineering

[19] Draft Report, p. 9.
[20] Draft Report, p. 17

resources. This would have allowed for development of procedures for the initial, more detailed engineering and design that otherwise would have to be developed by the construction contractor after award of the WBN U2 contract. As the organization to undertake this work and the available funding existed under the DSEP budget, our judgment was that whether Bechtel was awarded the construction contract or not, the project would benefit from such 'advance' work by getting a 'leg up' going into contract performance. At Browns Ferry, Bechtel was involved with such an approach and that project realized benefit. However, TVA's original Site VP reduced Bechtel's DSEP staff from its peak of 111 at the end of April 2007 to 43 by the end of May and to 11 by the end of July, after having directed that the DSEP would be completed one month earlier than the budgeted time period.

In summary and as previously stated, we disagree with several of the Draft Report's implications and conclusions that we believe are not supported by project records. Our most significant issues with the Draft Report have been addressed herein by stating the facts as we know them. Again, we appreciate the opportunity that you provided for us to respond with our comments.

If you have any questions regarding this response, please contact me at (423) 365-3581.

Sincerely,
BECHTEL POWER CORPORATION

J.M. McLemore
Project Director and Vice President

JMM:blj

Cc: Bechtel:
J. Atwell
B. Joyner
J. Karlinger
N. Taylor

TVA:
Tom Kilgore
Michael Skaggs
OIG File No. 2010-13088

May 14, 2012

Robert E. Martin, ET 3C-K

RESPONSE TO REQUEST FOR COMMENTS – DRAFT INSPECTION 2010-13088 – WATTS BAR NUCLEAR PLANT UNIT 2 PROJECT SET-UP AND MANAGEMENT ISSUES AFFECTED COST AND SCHEDULE

This responds to your April 16, 2012, memorandum requesting a review of the draft Inspection Report 2010-13088. The attached addresses each recommendation and describes the actions taken, being taken, and the associated schedule for completion when appropriate.

Without attempting to express agreement or disagreement with all the facts and conclusions stated in the draft report, in general, we agree with the report's fundamental findings and recommendations. We do suggest one specific change to the language of the Executive Summary in order to make it consistent with the body of the report. Specifically, page *ii* of the Executive Summary states that TVA did not "Adequately mitigate known problems related to . . . accuracy and timeliness of information provided to the Nuclear Regulatory Commission . . . ." The body of the report supporting this statement discusses past NRC concerns about the "timeliness and quality" of submittals (see page 20). We therefore ask that the term "accuracy" in the Executive Summary be replaced with the more precise term "quality" which was the subject of emphasis by the NRC.

We have also had the opportunity to review Bechtel's comments on the draft report as provided in its letter of May 7, 2012. Generally, we think many of Bechtel's comments ignore or obfuscate major issues the report raises, as well as Bechtel's own significant contributions to the project's problems.[1] When we report that "leadership" was a major part of the project's past problems, we certainly include Bechtel among those in that role. However, we do not believe it would be constructive to address Bechtel's response on a point-by-point basis at this juncture. As you know, in light of Bechtel's project performance, in October 2011 TVA renegotiated the EPC contract with Bechtel rather than terminate the contract for default and enter a period of substantial additional delay and project restructure. Given the totality of the circumstances, we decided to move forward with the project under a newly organized and aligned project structure giving TVA more day-to-day control. TVA is now focused on driving better performance by all project participants, including Bechtel and other contractors, in order to ensure project completion in accordance with the Watts Bar Unit 2 estimate to complete that was presented to the TVA Board on April 26 in connection with its decision to approve the continuation of the Watts Bar Unit 2 project.

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[1] For example, Bechtel repeatedly references its October 2010 Estimate to Completion, but fails to mention that at that time Bechtel was unrealistically maintaining that "it is still prudent to target a 48-month 'Ready for Fuel Load' schedule." Only 9 months later, project performance had deteriorated to an extent that TVA sought to terminate the Bechtel contract for default because the 60-month commercial operation date was unachievable. Another example is Bechtel's suggestion that "required TVA flowdowns" of contract provisions prevented Bechtel from putting in place the subcontracts required by its EPC contract with TVA. However, TVA contracted directly with the same entities promptly after Bechtel failed to meet this obligation, and TVA's direct contracts included the same allegedly preclusive "TVA flowdowns."

Based on corrective actions resulting from the Office of Inspector General's (OIG) inspection and a root-cause analysis conducted by TVA and two industry consultants, we have high confidence that the right leadership, project controls, and processes are in place that will lead to project success. Most significantly, TVA has instituted a comprehensive monitoring program so that actions can be taken to keep the project on course and within projected cost and schedule estimates. Specifically, Nuclear Construction has instituted a set of metrics to track project performance, provide for management review, and provide information externally to promote transparency and oversight. There is a Nuclear Construction dashboard that provides timely, summary level information on safety, cost, schedule, budget, human performance, environmental, and regulatory issues to TVA executives and the Board on a monthly basis. In addition, there is a more detailed on-site metric package that examines project status on a weekly basis that is reviewed by senior site management and supervisors from site departments. Nuclear Construction is also forming a new Project Assurance group to provide independent verification of the site project reports.

As TVA moves forward with the completion and testing of Watts Bar Unit 2, actions will continue to be identified and the effectiveness of actions taken will be assessed to ensure the organization and schedule in place support completion of the project and there is adequate oversight of schedule and costs. Better communication channels with key stakeholders also will occur, with periodic updates on the status of the project and how costs are being managed. Lessons learned at Watts Bar Unit 2 and the findings contained in the OIG report will be incorporated into the Bellefonte project, where a high-level estimate and schedule review is in progress.

We appreciate the professionalism of the staff involved in this assessment, the forthright assessment of issues, and the recommendations set forth to improve cost and schedule performance at Watts Bar Unit 2 and future projects.

If you have any questions or concerns with TVA's plan of action to address the documented recommendations and plans for moving forward at Watts Bar Unit 2, please contact Mike Skaggs at (423) 751-6506.

Tom Kilgore

Tom Kilgore
President and Chief Executive Officer
WT 7B-K

KWW:GWM:PCW
Attachment
cc: See page 3

cc (Attachment):
Michael B. Fussell, WT 9B-K
Joseph J. Hoagland, WT 7B-K
Raymond A. Hruby, EQB 1B-WBN
Ralph E. Rodgers, WT 6A-K
Michael D. Skaggs, LP 6A-C
Kelly D. Stinson, Jr., OSA 1A-BLN
Preston D. Swafford, LP 3R-C
John M. Thomas III, MR 6D-C
Robert B. Wells, WT 9B-K
Oswald J. Zeringue, EQB 1B-WBN
OIG File No. 2010-13088

ATTACHMENT

Recommendations and Actions Taken Regarding OIG Inspection Report Draft Inspection 2010-13088

Watts Bar Nuclear Plant Unit 2 Project Set-Up and Management Issues Affected Cost and Schedule

OIG Recommendation	Response
Develop a consistent and thorough approach for planning and estimating nuclear construction projects including, but not limited to, a range of estimates with probabilities, key risk assumptions, and contingency amounts.	Management agrees with this recommendation. A new cost estimate for Watts Bar Unit 2 ("WBN2") has been prepared as the basis for the TVA Board of Directors' approval of continuing the project. The new estimate has a range of estimates that include an "Aggressive" estimate that is approximately a 50-percent probability; a "Most Likely" that is approximately a 75-percent probability; and an "Upper Range" that is approximately an 85-percent probability. A formal project risk register has been established, and this register was used to develop project contingencies. Contingencies were applied to each estimate level appropriate to risk as well as the degree of development of the project. Project contingency levels were reviewed by two independent consultants and found to be within normal industry practice. **Status: Action complete for Watts Bar Unit 2** **See bottom of page 4 for implementing lesson learned at Bellefonte**
Develop contingencies for supplementing contractors' expertise in case they are unable to provide qualified resources.	Management agrees with this recommendation. The contract with the primary contractor, Bechtel, has been revised to give TVA the authority to assign tasks to other contractors as we deem appropriate. TVA has in place existing contracts with construction and engineering firms that can supply needed resources as required. To this end, supplemental contractors have been brought to WBN2 to provide additional resources and expertise in order to improve project performance. The use of the supplemental contractors is constantly monitored and scrutinized to ensure those services continue to be needed and to assess the ability of the Engineering, Procurement, and Construction contractor to absorb those tasks. **Status: Action complete for Watts Bar Unit 2** **See bottom of page 4 for implementing lesson learned at Bellefonte**

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Recommendations and Actions Taken Regarding OIG Inspection Report Draft Inspection 2010-13088

OIG Recommendation	Response
Develop contingencies for obtaining the ASME certifications for future projects as applicable.	Management agrees with this recommendation. At this point in the life cycle of the WBN2 project, it is not feasible to go through the entire ASME certification process and obtain a new stamp holder. Prior to beginning full construction at Bellefonte, management will review contracts for constructors and determine appropriate contingency measure to ensure a single ASME stamp holder does not impede project progress. **Action: A Problem Evaluation Report (PER) will be developed for Bellefonte to ensure adequate tracking and closure of this item as described. The PER number will be provided to the OIG.**
Require design engineering be substantially complete before starting construction on nuclear projects.	Management agrees with this recommendation. Outstanding engineering work was identified for WBN2 and included in the project's Estimate to Complete. Watts Bar Unit 2 Engineering developed a work-off indicator to ensure engineering work is completed as needed. The rate of craft work was slowed, resulting in some craft lay-off, to ensure work not related to craft makes adequate progress prior to resuming full construction staffing. **Status: Action complete for Watts Bar Unit 2** **See bottom of page 4 for implementing lesson learned at Bellefonte**
Establish controls over the development and reporting of project performance data and provide for independent verification of the data.	Management agrees with this recommendation. A set of standard project management metrics has been established for use on WBN2. Senior Project Management reviews the package of metrics with the staff once a week. This provides for transparency of performance as well as an opportunity for management to correct performance issues in a timely manner. Management has also developed an executive report using a subset of the project metrics. That report will be issued monthly and sent to company executives. The executive report provides executive management the opportunity to intervene if project performance does not meet expectations. Additionally, management has begun implementation of a Project Assurance (PA) group. The PA group will perform independent assessments of project status reporting and provide the results of these assessments to executive management. The charter for the group has been developed and processes are currently under development. **Action: Provide copy of the Nuclear Construction procedure for Project Assurance to the OIG office when completed.**

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Recommendations and Actions Taken Regarding OIG Inspection Report Draft Inspection 2010-13088

OIG Recommendation	Response
Assess the cultural climate to determine if the actions of certain, former key management have affected the organizational culture. Additionally, provide an opportunity for WBN Unit 2 employees to voice their concerns about the culture that exists currently and views about what should be done to create a more transparent culture.	Management agrees with this recommendation. As with other TVA organizations, Nuclear Construction employs the Organizational Health Index (OHI) to give an independent and confidential assessment of employee attitudes. OHI and the associated Pulse surveys have shown improvement and are achieving good results. The results indicate that employees have a good sense of trust in the new management team. Nuclear Construction is also undertaking a new program to improve the overall culture of the workforce. It is the Alignment and Engagement Strategy. The basis for this strategy is INPO 09-007, Principles for Excellence in Nuclear Project Construction. Using these principles, we will define our desired end state. We will assess our current state against the principles and develop gap plans where appropriate to close those gaps. The process outlined above is a deliberate process that will take some time to complete. Therefore, we have implemented measures in the interim to improve employee engagement and alignment. First, there is a detailed communication plan that includes using a variety of media to provide regular communication from the Senior Vice President of Nuclear Construction to employees. In those messages employees are invited to provide feedback. To date, we have received numerous incidents of employee feedback on the messages. A response is provided directly to each employee who provides input. Second, the Employee Advisory Group (EAG) has been reinstituted. There are new members, a new charter, and a new management representative on the team. The Senior Vice President of Nuclear Construction did the kick-off for the new team and has participated in EAG meetings to demonstrate his support for the group. The group has been effective in raising employee issues and providing input into solutions to problems. **Action: Complete development of gap plans for the Engagement and Alignment Strategy**
Evaluate project incentives to ensure they will deliver results.	Management agrees with this recommendation. The contract with the primary contractor for WBN2, Bechtel, has been revised to establish a more performance-based incentive program. **Status: Action complete for Watts Bar Unit 2** **See bottom of page 4 for implementing lesson learned at Bellefonte**

ATTACHMENT

Recommendations and Actions Taken Regarding OIG Inspection Report Draft Inspection 2010-13088

OIG Recommendation	Response
Address aging nuclear workforce issues by developing a program for transferring knowledge.	Management agrees with this recommendation. Nuclear Construction has instituted a formal succession planning activity using guidance from TVA Human Resources. Furthermore, TVA and Bechtel management have agreed to open dialog concerning performance of TVA and Bechtel employees. **Status: Action complete for Watts Bar Unit 2** **See below for implementing lesson learned at Bellefonte**
Work collaboratively with TVA's Board of Directors to evaluate the benefits of retaining the services of nuclear construction experts to monitor large nuclear construction projects' progress and report results directly to the Board.	Management agrees with this recommendation. TVA has reinstated the Construction Safety Review Board (CSRB). The CSRB performs detailed review of construction activities and provides an assessment from a safety perspective. It also is chartered with looking deep into project performance issues. The CSRB will provide the results of its assessment to the Nuclear Oversight Committee, chartered by the Board of Directors. **Status: Action complete for Watts Bar Unit 2** **See below for implementing lesson learned at Bellefonte**

Implementing Lessons Learned from Watts Bar Unit 2 to the Bellefonte Completion Project

The seven month long review performed at WBN2 by TVA, as well as the findings of the OIG report, will be incorporated into the Bellefonte project going forward. One interim action taken for Bellefonte has been to restructure the organization with an increased focus on engineering. This restructuring ensures that engineering work will proceed to support future construction activity. Focusing on engineering provides assurance that the OIG findings related to delays in the start of engineering will not be repeated at Bellefonte.

While engineering activity proceeds toward completion, Nuclear Construction management is assessing the current state of the Bellefonte Completion project. Currently underway is a high-level review of the project estimate and schedule. The purpose of performing this high-level review is to determine if there is evidence that the same problems that existed with the WBN2 project are indicated in the Bellefonte project. The high-level review of project status is expected to be completed by the end of Calendar Year 2012. Once the high-level review is completed, a more detailed improvement plan will be developed incorporating lessons learned from the WBN2 project. Until the high-level review is completed and a more detailed project improvement is developed, it is difficult to provide specific actions and due dates in support of this report. However, the high-level review is being conducted by the Bellefonte project senior staff with significant oversight by the Senior Vice President of Nuclear Construction. The report resulting from the high-level review will be provided to the Chief Executive Officer.