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# **Watts Bar Nuclear Plant Unit 2 Completion Project**

## **Eighth Quarterly Update to the Estimate to Complete February - April 2014**

**Published August 2014**

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**Nuclear  
Construction**

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## **Section 1 - Executive Summary**

The eighth quarterly update of TVA's Estimate to Complete (ETC) for Watts Bar Nuclear Plant Unit 2 focuses primarily on the activities between February and April 2014.

Performance during the quarter continued to be consistent with the ETC, and project targets continued to be met for safety, quality, cost, and schedule.

During the course of the quarter, System 68 - Reactor Coolant was completed and released for pre-operational startup testing, bringing the number of major systems released for pre-operational testing to nine.

This allowed for an early start to Open Vessel Testing (OVT), which is the first in a series of major project milestones. OVT was initiated by emptying pressurized water from Cold Leg Accumulators into the Unit 2 reactor vessel.

System-specific construction work continued to support testing for future milestones. Those milestones include cold hydrostatic testing, hot functional testing, integrated leak rate testing, and fuel load. The schedule is organized to complete construction work to enable system testing in a logical sequence that supports each milestone.

The Unit 2 team recognizes there will be challenges as the project moves forward. These challenges include:

- Completing the release of plant systems for pre-operational startup testing during a compressed time period while maintaining safety and quality standards;
- Testing Unit 2 systems that share components with Unit 1 without jeopardizing the safe and reliable operations of Unit 1;
- Constructing and testing systems in shared spaces, higher than expected equipment failures and repairs, and productivity issues during start up testing;
- Preparing for and transitioning to dual-unit operations;
- Addressing regulatory and licensing issues, including waste confidence.

The Unit 2 organization will adjust as necessary to facilitate the resolution of challenges and risks. The organization also will align itself to support the continued reliable operation of Unit 1 while delivering the safe and high quality completion of Unit 2 within budget and on time — and to transition Watts Bar successfully to dual-unit operations.

### **Quarterly Summary Points**

**Safely worked nearly 27 million work hours without a lost-time incident**

**Performed activities in a manner that resulted in a Quality Control (QC) acceptance rate of 97 percent**

**Met cost and schedule expectations**

**Continued to track to a most likely target of December 2015 for commercial operation**

**Released one more plant system for pre-operational testing**

**Turned three systems over to Operations -- turbine extraction traps and drains, turbine building supply fans, and generator bus cooling**

**Identified no new risks that would affect project completion**

## Watts Bar Unit 2 Completion Project Quarterly Update to the Estimate to Complete, February - April 2014

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### Section 2 - Background

In August 2007, TVA's Board of Directors approved resuming construction to complete Watts Bar Unit 2. However, the project did not fully meet expectations for schedule or budget.

In August 2011, a new management team performed a root cause analysis of the issues responsible for the schedule and budget problems and developed a revised ETC for the project.

The revised ETC is based on a range of values for both schedule and budget. As part of its effort to develop the ranges, the team considered risks and obstacles that could hinder meeting project expectations.

On April 26, 2012, the TVA Board of Directors approved the budget and schedule shown below to complete Unit 2.

Watts Bar 2	Aggressive	Most Likely	Upper Range
Completion Cost	\$4.0 Billion	\$4.2 Billion	\$4.5 Billion
Commercial Operation	September 2015	December 2015	June 2016

*Note: More information and additional details about the cause analysis, as well as the process that was used to develop the new ETC, can be found in the Executive Final Report on the Estimate to Complete posted on this link: [http://www.tva.com/power/nuclear/pdf/wattsbar2\\_executive\\_etc.pdf](http://www.tva.com/power/nuclear/pdf/wattsbar2_executive_etc.pdf)*

### Section 3 - Quarterly Performance

The project continued to meet overall targets for safety, quality, cost, and schedule in the three months from February to April 2014.

During the quarter, major construction was completed on System 68 - Reactor Coolant. The system was released for pre-operational startup testing, bringing the number of major safety related systems in pre-operational testing to nine.

Pre-operational startup testing includes cleaning and flushing pipes and components, component tests, such as running motors, pumps, and valves, and acceptance tests on overall systems. The successful completion of these tests is crucial for being ready to load fuel in 2015.

The project took a start for OVT, which is the first in a series of major project milestones.

As systems are released for pre-operational startup testing, the next steps are to clean, flush with water, inspect, and prepare the pipes, structures, and components that make up the system and to prepare them for various tests.

Major components, such as motors and power operated valves, are tested individually prior to testing the overall system. Temporary test fixtures are installed to conduct pressure boundary integrity testing (hydrostatic testing) on systems that will contain pressurized fluids. Temporary test instrumentation is installed and fluid flow balance measurements are made. Upon successful completion of the system acceptance tests, the system is released for subsequent control by the Unit 2 Operations staff.

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Some of the additional project accomplishments for the quarter were:

- Verified the completion of seven previously released systems for pre-operational testing;
- Turned three systems over to Operations -- turbine extraction traps and drains, Turbine Building supply fans, and generator bus cooling;
- Successfully completed the piping tie-ins and system connections, and made significant progress in completing other Fukushima response modifications;
- Completed a Nuclear Regulatory Commission (NRC) Problem Identification and Resolution Inspection of Unit 2 with no significant findings;
- Had 27 Inspection Planning and Scheduling (IP&S) items closed by NRC;
- Safely installed 20 large restraints associated with the steam generators;
- Successfully flowed water through all emergency core cooling pumps and operated the containment air recirculation fans;
- Started work to enable the running and testing of emergency core cooling system pumps in advance of OVT.

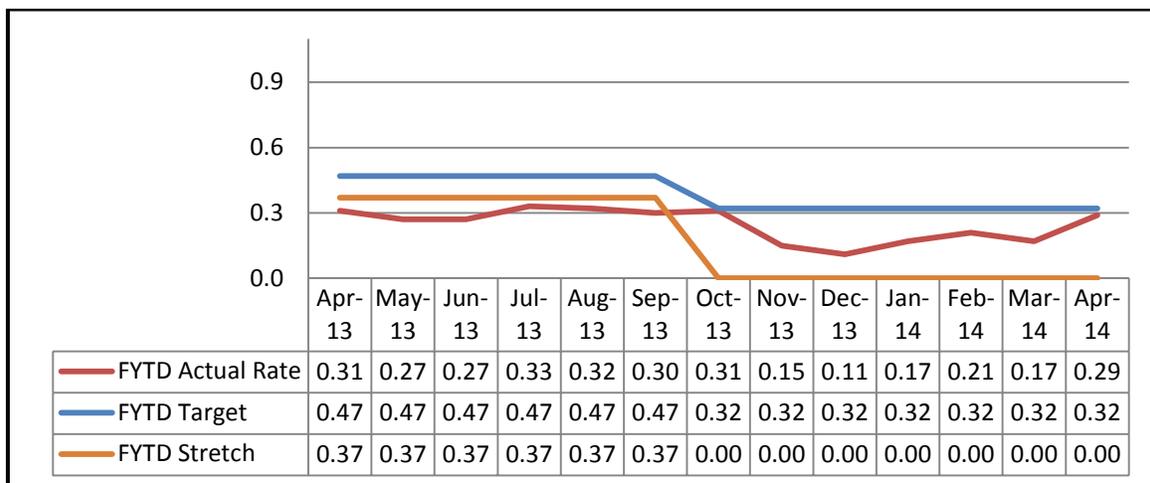
As the project moves forward, it also continued to strengthen its organizational response to emergent issues. Through the judicious use of daily structured review meetings in close coordination with a dedicated response team, new issues are being assessed promptly, and corrective actions are planned and executed.

More information illustrating project performance is provided in the sections below.

### Safety

During the quarter, Unit 2 personnel worked nearly 27 million work hours without a lost-time incident, a significant accomplishment. And, as the chart below shows, the Recordable Injury Rate<sup>1</sup> continued to be better than the target.

**Watts Bar 2 Recordable Injury Rate**



<sup>1</sup> Recordable Injury Rate is a measure of employee safety. It tracks the number and types of work-related injuries reported by TVA employees and contractors through TVA's record keeping system for safety statistics.

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There were many reasons why Unit 2 workers continue to meet industrial safety goals, including:

- Adherence to changing plant conditions as systems are turned over to the operating unit;
- Almost 1,000 constructive interventions were performed by craft safety teams and the Tri-lateral Safety Alliance made up of TVA, represented crafts, and contract partners;
- Over 4,000 management observations of which about 1,800 focused on human performance.

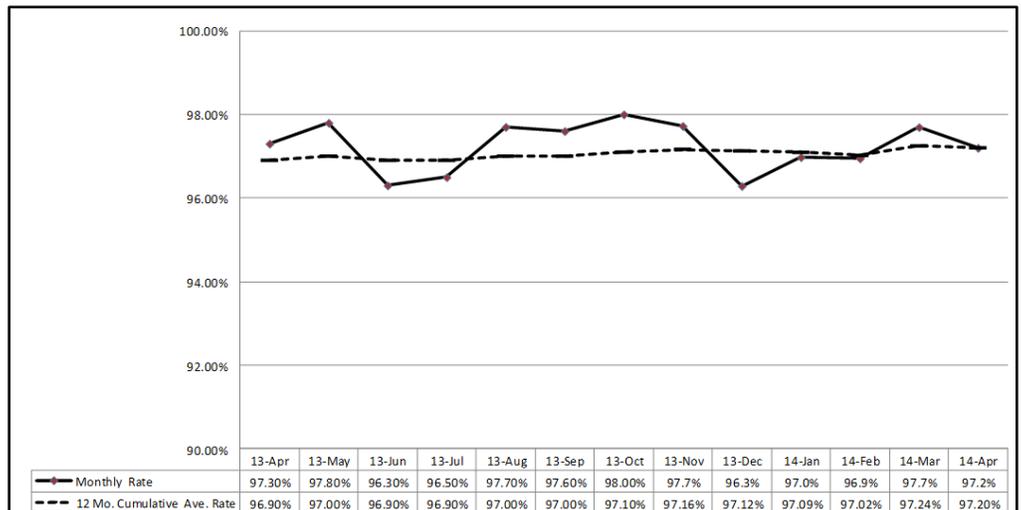
A key emphasis of the Unit 2 completion project is to intervene at any time to ensure safety. The Unit 2 team closely monitors low-level safety incidents and communicates those among project personnel, along with safety experiences across TVA and the industry. This helps workers identify potential risks so they can take actions to keep themselves safe.

### Quality

The quality of Unit 2 work remains high as measured by the Quality Control (QC) acceptance rate (see the chart below). This rate measures the percentage of work that has passed the QC inspection process for each month. For the quarter the acceptance rate exceeded 97 percent.

Quality Assurance (QA) groups for both TVA and Bechtel continued to provide oversight of the system turnover process, the testing program, and

**Watts Bar 2 Quality Control Acceptance Rate**



engineering and construction document closure. Quality Assurance observed the following activities and provided feedback to the appropriate line organization:

- Implementation of initial electrical scheme checks as part of component testing;
- Review of the pre-startup engineering work control (WO) process and WO closure;
- Review of TVA's required American Society of Mechanical Engineers documentation prior to the application of the code data plate;
- Evaluations of a sample of pipe supports for compliance with NRC Bulletin 79-14 governing seismic qualifications.

In addition, QA completed programmatic audits of the quality assurance manual activities conducted by Bechtel Power Corp. The audit teams concluded that personnel satisfactorily implemented program requirements and Bechtel was meeting QA and regulatory requirements.

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## Cost

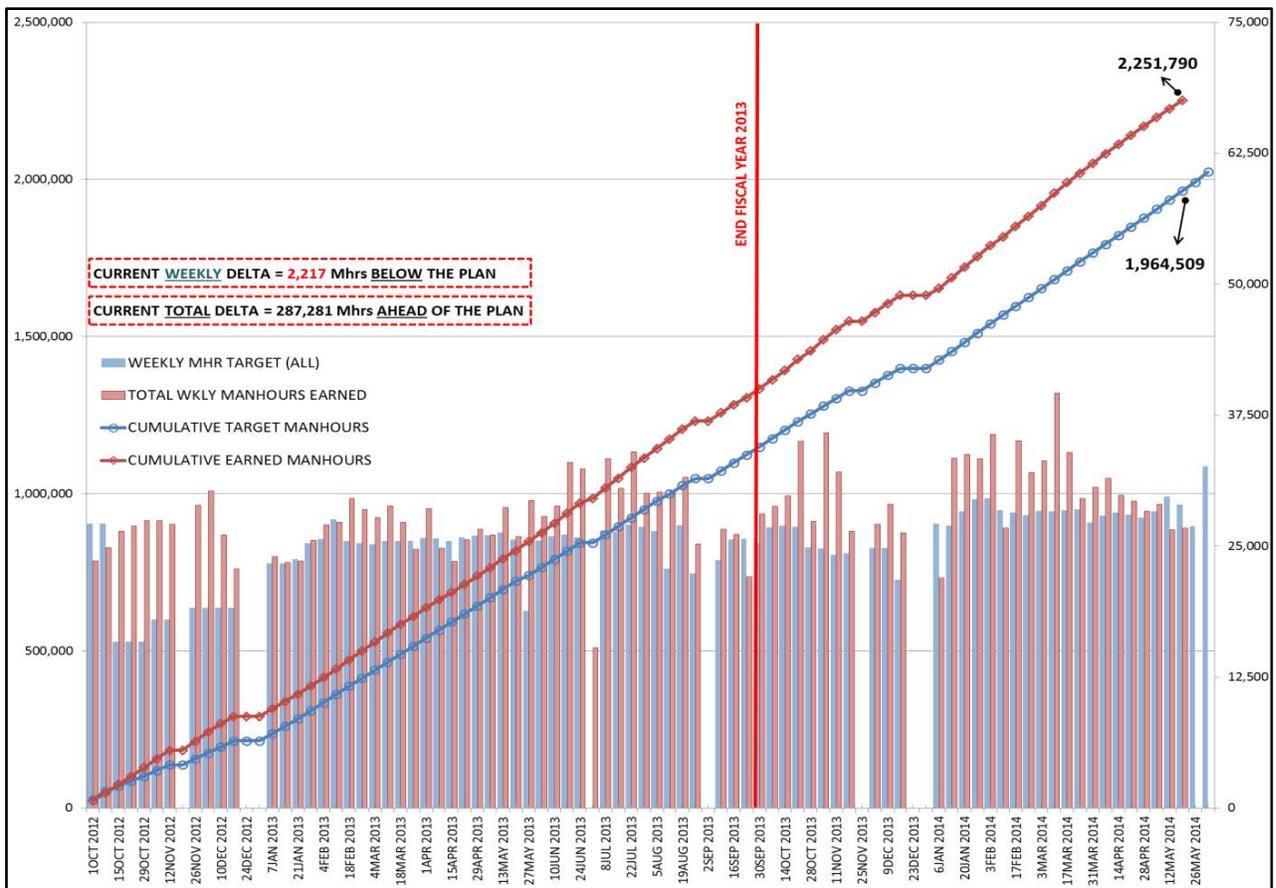
During the quarter, the project continued to trend to a completion cost of between \$4.0 billion and \$4.2 billion, which is on target and within the most likely range estimate included in the ETC. This is consistent with meeting the most likely commercial operation date of December 2015.

With the organization preparing to transition from construction to operations, a de-staffing plan has been developed to methodically reduce the project workforce. This is part of the project plan and is needed to ensure budget and schedule adherence.

## Schedule

During the quarter, the Unit 2 team was focused on system completion and release to testing of systems needed to support the early target for OVT. Overall, the project continued to earn more hours than targeted. This is shown on the chart below which compares actual earned hours per week to the number of hours targeted to be earned.

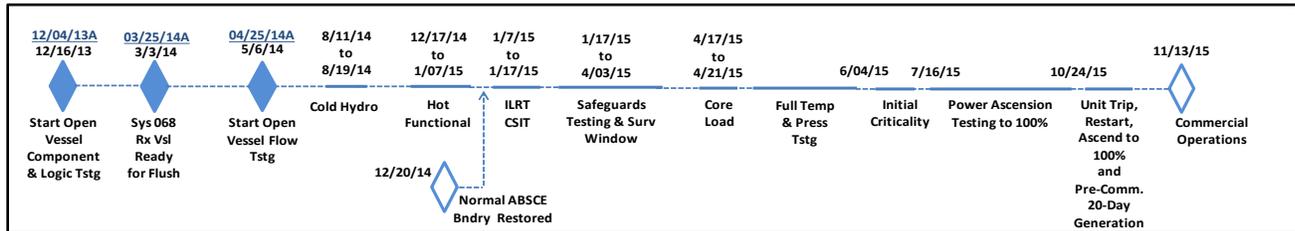
### Watts Bar 2 Fiscal Year 2013 Target Versus Actual Earned Manhours



## Watts Bar Unit 2 Completion Project Quarterly Update to the Estimate to Complete, February - April 2014

The major milestones for project completion are shown below. Based on current and targeted schedule performance, the project continues to track earlier than the most likely fuel load date of June 2015 and commercial operation in December 2015.

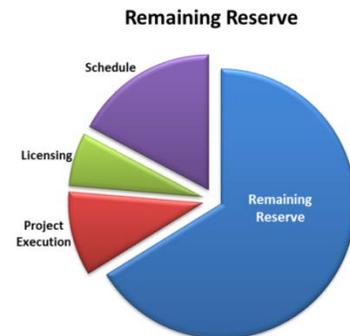
### Major Project Milestones



### Section 4 - Reserve Management

Project reserve money is available to fund risk management and risk occurrence, as well as unforeseen expenditures.

The chart to the right shows that the project continues to expend only a moderate portion of the established reserve. The relative sizes of the total allocations from the reserve through the end of this quarter are shown as extracted portions in the chart.



### Section 5 - Known Risks

In order to ensure a realistic perspective of risk, the project has emphasized risk identification and analysis during the critical transition to system testing.

There were no new significant risks identified during the quarter that might compromise project completion. A summary of notable risks is shown in the table to the right. Additional information on the risks follows.

#### Waste Confidence

The NRC is in the process of revising its “Waste Confidence Rule,” which is a generic determination that spent nuclear fuel can be safely managed on site after a plant is shut down and until a permanent repository is established. The revised Waste Confidence Rule is scheduled to be issued and approved by October 2014.

A significant challenge related to the Waste Confidence Rule is a set of contentions raised by external stakeholders. These contentions will not be addressed until the final rule is published.

<u>Risk</u>	<u>Risk Trend</u>
Waste Confidence	Stable
Dual-Unit Operational Readiness	Stable
Closure of Licensing Issues	Stable
Documenting Completion of Work	Stable
Construction Completion	Stable
Cyber-Security	Stable
Emergent Work and Verification	Stable
Startup Testing Delays	Increasing
Fukushima	Decreasing

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If the contentions are not resolved quickly by the NRC at the time the Waste Confidence Rule is “effective,” then delays will be experienced in the issuance of the Unit 2 operating license 2. The Unit 2 team has addressed its concerns with NRC senior management and the NRC Commissioners.

TVA and Unit 2 senior managers have also met with Congressional staff to communicate concerns. Additional actions are being developed to make use of other avenues that can help assure the appropriate and timely disposition of the contentions. Because the regulatory entities are not under the control of the project team, a project delay remains a strong risk.

### **Dual-Unit Operational Readiness**

The upcoming transition has been led by the Dual-Unit Operational Readiness Team. Key activities this team has supported and coordinated include staffing, training, and development of procedures and preventive maintenance (PM) instructions. A significant focus for this team is supporting the station in being ready for the upcoming World Association of Nuclear Operators Pre-startup Review scheduled for August of this year and the NRC Operational Readiness Assessment Team inspection planned for three months prior to fuel load.

Power Ascension Testing preparations are making good progress. All of the required procedures are drafted and are going through reviews prior to being sent to the NRC. In addition, a detailed schedule has been developed that will take the project from fuel load to commercial operations. Other areas that are making steady progress include procedure development, facilities completion, and materials acquisition.

Additional management focus is being applied to ensure that backlogs of maintenance and corrective actions for the operating unit are reduced and that the development of PM instructions will be ready to support upcoming system turnovers.

A significant challenge to support dual-unit readiness is related to a two-part submittal of the Dual-Unit Fire Protection report to the NRC. The effort to get ready for this includes procedure development and validation of timed operator actions. An integrated team is focused on this effort to make sure that it stays on track.

### **Closure of Licensing Issues**

A critical area requiring focused attention is resolving IP&S items with the NRC. The IP&S items must be resolved before fuel may be loaded in Unit 2. The project has developed a concentrated approach to prioritize and streamline IP&S item closure activities and has made progress toward closure of the items. To date, approximately 75 percent of the items have been completed.

### **Documenting Completion of Work**

The quantity and complexity of required documentation represents a challenge to productivity. The project has made many positive changes to ensure both quality and ease of completion of the required construction documentation. Changes included unbundling complex or multi-system design or construction work packages to simplify the verification of the documentation; performing earlier quality checks of documentation during the work; and inspecting for specific, critical attributes of the documentation after the work is completed. Assessments and weekly metrics continue to demonstrate quality closure and closure rates sufficient to support the project schedule.

As the project moves further into the startup and testing phase, documentation closure of startup and testing activities will receive a comparable level of scrutiny and effort to ensure similar positive results.

## **Construction Completion**

The Construction organization continues to focus on the completion of plant systems for turn-over to startup testing. Previously implemented action plans to improve schedule adherence are being closely monitored by the Construction Management Oversight team. There remains room for improvement; therefore, the project will continue to make changes designed to achieve targeted improvement.

## **Cyber Security Requirement Implementation**

Requirements by NRC relating to cyber-security were established to help protect important information technology assets from damage perpetrated by malevolent entities. The requirements for cyber security at Unit 2 are in the final stages of planning and are being implemented. The NRC is scheduled to conduct a Cyber Security Inspection in July 2014.

## **Fukushima**

As a result of the events at the Fukushima Daiichi Nuclear Plant in Japan during March 2011, the NRC now requires U.S. nuclear plants to upgrade their facilities to provide diverse and portable means of supplying cooling water and AC power during an extended period of loss of offsite power and loss of normal access to the ultimate heat sink.

The project, which has been designated as a pilot for the industry, has established a path forward that meets the NRC requirements to date, resulting in a lower risk. As a result, Unit 2 will be much more resilient to a broader range of unexpected environmental events.

The Watts Bar site has made significant progress in completing the required additions for both units. Specific accomplishments during the quarter include:

- Completed exterior/interior walls and roof of the Flexible Equipment Storage Building
- Completed micro-piles and foundation for the new auxiliary feed water storage tank
- Completed all Unit 1 modifications required for Unit 1 refueling outage
- Made significant progress on Unit 1 and Unit 2 pipe taps and 225 kVA diesel generator installation

## **Startup Testing Delays**

The project is beginning to experience schedule delays from startup testing activities. These delays are related to equipment failures and the time needed to make repairs, longer times required for system flushing and cleaning, construction and startup personnel working in the same congested areas, and complications when testing systems common to Unit 1 and Unit 2.

Watts Bar personnel successfully conducted crucial testing of shared systems and other construction activities during the most recent Unit 1 refueling and maintenance outage. This was the last practical opportunity to accomplish those activities that must be performed while the operating unit is shut down.

## **Emergent Work and Verification of Released Systems**

Levels of emergent work added into the schedule continue to be higher than desired. Analysis indicated that only a small percentage of new WOs initiated this quarter represented new scope. Of the approximately 2,200 new WOs written during this quarter, less than 2.5 percent were for new scope, the remaining WOs addressed timing, support or breakage.

To expedite the identification of known scope getting accurately into the schedule, the project continued to utilize dedicated resources to focus on the proactive initiation of known scope for systems required for cold hydro and hot functional testing.

In addition, the WOs are being estimated and material needs identified so that the schedule is more accurate. The project is closely monitoring the system release process for the next key systems required for the cold hydrostatic and the hot functional testing milestones and is ready to make further improvements as needed.

Incomplete work and incomplete documentation were discovered on some previously released systems. More than 120,000 additional construction hours were needed to complete the remaining work and 40,000 additional work-hours were needed for closure. This delayed both the testing and release of the systems to the Operations staff. A revised turnover process was developed and implemented that provided comprehensive scrubs and coding to ensure all construction work is complete or specific known exceptions are approved prior to turnover. These efforts are progressing well, as evidenced by the number of systems that were re-verified for turnover during this period.

## **Section 6 - Project Oversight**

### **Project Assurance**

The Project Assurance group is independent of the Unit 2 organization and is responsible for assessing various facets of project performance and reporting its findings to the Senior Vice President of Watts Bar Operations and Construction.

Observations provided to Unit 2 management during the quarter included:

- The project continues to track toward the ETC most likely dates for fuel load of June 2015 and for commercial operation of December 2015.
- Common themes were identified in scheduled component tests that may lead to low throughput.
- Summaries were developed of several challenges that the project may encounter associated with the current process for turning over completed systems to Operations.
- Overly optimistic schedule durations were identified for some testing activities based on recent test performance.
- A trend was identified of scope increases associated with Engineering scoping and construction WO reviews.

## **Nuclear Construction Review Board**

The Nuclear Construction Review Board's (NCRB) most recent report in April recognized several project accomplishments, such as continued good industrial safety performance, successfully turning over several safety related systems in support of OVT and completing necessary actions to support fuel load and obtaining an operating license.

The NCRB also provided a number of recommendations, including:

- Ensuring resource demands on management and engineers are considered for aggregate adverse impact;
- Completing evaluation and finalizing simplification of the system turnover process;
- Reviewing assumptions to identify schedule adjustments and/or process improvements to support successful milestone achievement;
- Developing an integrated, completion verification plan that identifies the programs and documents needed to validate the plant is designed, constructed, and tested in accordance with the licensing basis.

**The NCRB is an independent oversight panel made up of industry experts from outside TVA who provide external, independent insight to TVA.**

**The NCRB is charged with independently reviewing TVA's nuclear construction completion and startup testing performance for safety, quality, and efficiency until fuel load. Then activities will be transitioned to the Nuclear Safety Review Board.**

## **McKinsey and Associates**

McKinsey and Associates, a management consulting firm, spent several weeks at the Unit 2 project in February and March to independently review project progress and recommend improvements based on the assessment.

The company recognized improvements in the project accomplishments and execution and provided the following recommendations to reduce risk for the remaining project phase:

- Accelerate project cash flow to support staffing levels required in construction and engineering to achieve critical FY14 milestones;
- Revise the project performance indicator to increase effectiveness;
- Enhance the risk management program.

## Section 7 - Project Organizational Health

### Nuclear Safety Culture

The number of concerns expressed during this quarter was higher than the previous reporting period. While the Employee Concerns Program (ECP) experienced an increase in concern traffic this reporting period, no significant increase was noted in anonymous problem evaluation reports (PER) received.

Three NRC allegations also were received during this reporting period. None of the allegations were referred to TVA for further investigation.

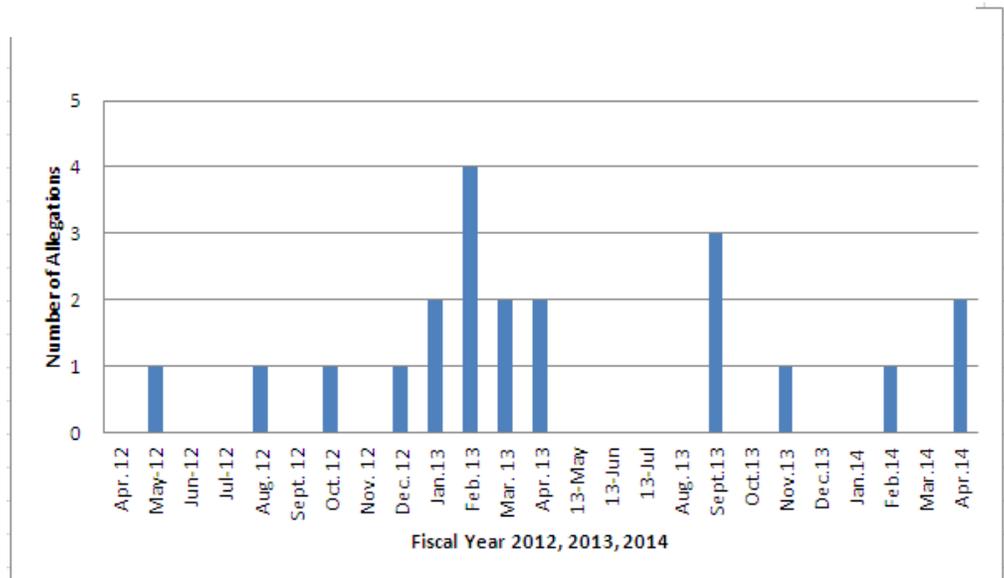
The NRC concern traffic for the period is slightly higher than the previous reporting period in which Unit 2

received only one allegation. The ECP surmises that the increase in concerns is in part due to the commencement of demobilization (increased lay off of contractor personnel) during the reporting period.

Surveys of employees completed by ECP this quarter indicated 98 percent of all personnel would raise a nuclear safety or quality issue if one was identified. Technical issues accounted for 25 percent of the concerns received. Concerns related to management and personnel type of issues continue to be the highest contributor to the concerns received in both the Bechtel and TVA ECP at 67 percent. This is slightly higher than the previous reporting period and indicates that continued diligence is needed in addressing manager/worker relationships.

Through case investigations and pulsing surveys of employees, ECP did not identify a systemic problem with supervision but highlighted isolated issues. Unit 2 management has addressed these issues when ECP has substantiated them.

In summary, ECP continues to see positive results related to concern traffic, anonymous PERs and NRC allegations counts due to the ongoing actions by Unit 2 management to address communication with employees and the implementation of improvement initiatives. These initiatives include monthly employee discussions with management, an emphasis on Safety Culture Work Environment through weekly messages, personnel realignments to strengthen knowledge base, and meetings with workers to address emergent issues.



## **Project Completion Incentive Program**

Approximately 3,100 workers have met the 1,000 work-hours requirement to be eligible for the Unit 2 Project Completion Incentive Program. These individuals have been assigned and dedicated to the project, and provided they remain with the project until their work is completed, could receive an incentive payout proportional to the hours they have worked. For any incentive payout to be made to eligible participants, commercial operation must be certified by TVA by December 31, 2015, and the project must be completed at or below \$4.4 billion.

The incentive program was implemented in October 2012 to help ensure safety and achieve the construction timeline and budget of the ETC. The incentive program will be funded by savings realized by the project if it is completed in a safe, quality, cost-effective, and timely manner.

## **Section 8 - Going Forward**

During the next quarter, work will continue to release plant systems for cleaning and testing. The primary focus of testing will be on the subsystems, structures, and components required to support OVT. These are important steps in the pre-operational startup tests that will verify the full systems meet regulatory requirements before their control is turned over to the site Operations staff.

Once OVT has been completed, the project will focus on preparations for cold hydrostatic testing, which will verify that welds, joints, pipes, and components in the Reactor Coolant System and associated high-pressure systems hold pressure and do not leak.

Conditions in the field will continue to change as systems are released for pre-operational testing and as tests are set up and conducted. Multiple methods will be used to communicate to workers to work safely by looking out for each other, staying aware of changing plant conditions, and stopping when something unexpected is encountered.

Another area of focus for the project will be completing construction activities and the continued implementation of a project demobilization plan. The plan will help make sure that as the project is completed, construction support structures and materials are removed and permanent structures and site grounds are restored. As part of the demobilization efforts, a de-staffing plan will be implemented to ensure effective project completion and that outplacement services are made available to help those leaving the project navigate the transition process.