Office of Enterprise Assessments
Review of the Hanford Site
Waste Treatment and Immobilization Plant
Construction Quality

January 2015

Office of Nuclear Safety and Environmental Assessments
Office of Environment, Safety and Health Assessments
Office of Enterprise Assessments
U.S. Department of Energy

Table of Contents

Acronyms

ASME	American Society of Mechanical Engineers
BNI	Bechtel National, Inc.
BOF	Balance of Facilities
CDR	Construction Deficiency Report
CM	Commercial Grade
CRAD	Criteria, Review and Approach Document
CTL	Critical Weld
DOE	U.S. Department of Energy
EA	Office of Enterprise Assessments
HLW	High-Level Waste
kV	Kilovolts (1000 volts)
LAB	Analytical Laboratory
LAW	Low-Activity Waste
MCC	Motor Control Center
MSOW	Management Suspension of Work
NCR	Nonconformance Report
NEC	National Electric Code
NQA	Nuclear Quality Assurance
OFI	Opportunity for Improvement
ORP	Office of River Protection
P&ID	Piping and Instrumentation Diagram
PDSA	Preliminary Documented Safety Analysis
PICA	Post Installed Concrete Anchor
PIER	Project Issues Evaluation Report
psi	Pounds per Square Inch
PTF	Pretreatment Facility
Q	Quality Related
QA	Quality Assurance
QAM	Quality Assurance Manual
QC	Quality Control
ORP	Office of River Protection
SDJ	Stack Discharge Monitoring
SSC	Structure, System, and Component
W	Watts
WCD	WTP Construction Oversight and Assurance Division
WTP	Waste Treatment and Immobilization Plant
V	Volts

Office of Enterprise Assessments Review of the Hanford Site
Waste Treatment and Immobilization Plant
Construction Quality

EXECUTIVE SUMMARY

The U.S. Department of Energy Office of Enterprise Assessments (EA) conducted an assessment of construction quality at the Hanford Site Waste Treatment and Immobilization Plant (WTP) during September 8-12, 2014. This EA assessment was performed in the broader context of an ongoing program of quarterly assessments of construction quality at the WTP construction site.

The scope of this assessment included observations of ongoing work activities, review of the Bechtel National, Inc. (BNI) program for control of nonconforming conditions, examination of implementation of selected requirements in the BNI quality assurance program, and follow-up on issues identified during previous assessments.

EA determined that construction quality, including pressure testing of piping electrical cable pulling and installation of electrical equipment at WTP is generally satisfactory in the areas that were reviewed. BNI has also developed appropriate corrective actions to resolve specific deficiencies for closed nonconformance reports and construction deficiency reports reviewed by EA. BNI has also responded appropriately to previous EA concerns about the lack of performance based self-assessments by revising their self-assessment program priorities and conducting and planning more performance based self-assessments.

However, progress has been slow in addressing identified deficiencies in two areas. First, BNI's approach to determining the extent of condition was adequate for errors in installation of certain important structural components (i.e., called Post Installed Concrete Anchors). However, BNI's corrective actions have not been timely to resolve the installation errors. Because of BNI's delay in developing installation criteria for these components, a large number of components had to be re-inspected and re-evaluated a second time after they had been previously inspected and found to be acceptable. BNI expects to complete the remaining corrective actions for the Post Installed Concrete Anchors by December 2015. Second, deficiencies continue to be evident in certain aspects of electrical construction (the labeling on some electrical cabinets, the sizing of breakers, and the adequacy of cable support between the cable trays and the entrance into cabinets); similar deficiencies had been previously identified but efforts to resolve them have been progressing slowly.

Because of the safety significance of WTP facilities, EA will continue to conduct quarterly reviews to assess the quality of ongoing construction. EA will continue to focus on unresolved issues and ongoing BNI initiatives, including corrective actions to address identified discrepancies in the Post Installed Concrete Anchors installation process, BNI's performance based self-assessments, and actions taken by BNI to resolve ongoing issues with electrical construction.

Office of Enterprise Assessments Review of the Hanford Site
Waste Treatment and Immobilization Plant
Construction Quality

1.0 PURPOSE

The U.S. Department of Energy (DOE) Office of Enterprise Assessments (EA) conducted an assessment of construction quality at the Hanford Site Waste Treatment and Immobilization Plant (WTP). The assessment was conducted by EA's Office of Environment, Safety and Health Assessments during September 8-12, 2014.

This EA assessment was performed in the broader context of an ongoing program of quarterly assessments of construction quality at the WTP construction site. Because of the safety significance of WTP facilities, EA will continue to conduct quarterly reviews to assess the quality of ongoing construction.

2.0 SCOPE

The scope of this quarterly assessment of construction quality included observations of ongoing work activities, review of the Bechtel National, Inc. (BNI) program for control of nonconforming conditions, examination of implementation of selected requirements in the BNI quality assurance (QA) program, and follow-up on issues identified during previous assessments. Design and procurement programs are not included in the scope of these reviews. Ongoing work activities have been affected by reductions in construction craft staffing and unresolved technical and design issues that may result in the redesign of some systems and/or structures.

Work activities observed during EA's September 2014 review included one pneumatic pressure test, electrical cable installation, and installed electrical equipment. EA examined nonconformance reports (NCRs) and construction deficiency reports (CDRs) identified by BNI under its corrective action program, as well as ongoing corrective actions to address deficiencies identified in the installation of post installed concrete anchors (PICAs). EA also reviewed the results of quality control (QC) tests performed on samples of concrete placed in the High-Level Waste (HLW) Facility, the BNI construction organization's self-assessment program, and BNI QC surveillance reports.

EA reviewed various construction quality documents and conducted several construction site walkthroughs, concurrent with WTP Construction Oversight and Assurance Division (WCD) staff. During the walkthroughs, EA observed pressure testing of a section of the instrument air system distribution piping on elevation 48 in the Low-Activity Waste (LAW) Facility and examined electrical equipment, cable tray and cable installation, and preservation of electrical equipment. EA also examined drawings, specifications, and procedures that control installation of PICAs, pressure testing of piping and instrument tubing, mixing and placement of concrete, structural steel welding, and installation of electrical cables and equipment.

3.0 BACKGROUND

The Office of River Protection (ORP) was established in 1998 to manage the 56 million gallons of liquid or semi-solid radioactive and chemical waste stored in 177 underground tanks at the Hanford Site. ORP provides DOE line management for the Tank Farms (which maintain the 177 underground storage tanks)

and the WTP, an industrial complex for separating and vitrifying the radioactive and chemical waste in the underground tanks. The WTP complex consists of five major components, including the Pretreatment Facility (PTF) for separating the waste, the HLW and LAW Facilities where the waste will be immobilized in glass, the Analytical Laboratory (LAB) for sample testing, and the balance of facilities (BOF) that will house support functions. WTP is currently in the design and construction phase.

Design and construction activities at WTP are managed by BNI under contract to ORP. BNI prepared a preliminary documented safety analysis (PDSA) for the WTP, describing the facility design codes, safety systems, design basis accident analysis, pre-operational testing program, operational safety, and the QA program. The QA program requirements for design, construction, and operation of the WTP, referenced in the PDSA and cited in the BNI contract, are specified in American Society of Mechanical Engineers (ASME) Nuclear QA (NQA) -1-2000, *Quality Assurance Requirements for Nuclear Facility Applications,* and DOE Order 414.1C, *Quality Assurance*. Construction work is classified as essentially complete for the LAB and the majority of the BOF buildings. ORP staff, primarily the ORP WTP Construction Oversight and Assurance Division (WCD), provides oversight of construction activities at WTP.

The estimated date for essential completion of the LAW Facility is the third or fourth quarter of 2015. All construction work activities have been deferred in the PTF because of questions regarding separation and processing of the waste and the design life of equipment. Pending resolution of technical issues for some aspects of the waste treatment processes in the HLW Facility, construction craft staffing for the HLW Facility was reduced, although construction continued at a slow pace in areas of the HLW Facility not impacted by the unresolved technical issues. In a September 2014 letter, DOE authorized BNI to proceed with design engineering work on the HLW Facility since considerable progress has been completed to resolve the HLW Facility technical issues.

4.0 METHODOLOGY

EA conducted this assessment of WTP construction quality processes in accordance with the *Plan for the Independent Oversight Review of the Hanford Site Waste Treatment and Immobilization Plant Construction Quality*, dated September 2014. The review included examining documents (e.g., work instructions, procedures, specifications, drawings, and records), interviewing key personnel responsible for construction and inspection work activities, and site walkdowns to observe work activities and inspect WTP components. The review considered the requirements of 10 CFR 830, Subpart A, *Quality Assurance Requirement*, and DOE Order 414.1C, *Quality Assurance*. Title 10 CFR 830 and DOE Order 414.1C require the contractor to use appropriate national consensus standards to implement DOE QA requirements. The PDSA references ASME NQA-1-2000, *Quality Assurance Requirements for Nuclear Facility Applications*, as the national consensus standard for BNI to follow as the basis for the WTP QA program. The QA requirements in ASME NQA-1 are specified in 18 basic and supplemental criteria. BNI Document 245909-WTP-QAM-QA-06-001, *Quality Assurance Manual*, provides a detailed description of the application of the 18 NQA-1 requirements to the WTP. The QA Manual (QAM) establishes the planned and systematic actions necessary to provide adequate confidence that structures, systems, and components (SSCs) perform satisfactorily in service. The WTP QAM incorporates the basic and amplified requirements of the supplemental criteria from NQA-1.

This EA assessment focused on electrical cable installation, installed electrical equipment, and certain portions of the following criteria, review and approach documents (CRADs):

- CRAD 64-15, *Construction – Structural Concrete*
- CRAD 45-52, *Construction – Piping and Pipe Supports*

- CRAD 64-20, *Feedback and Continuous Improvement Inspection Criteria and Approach – Contractor*.

Supplemental information, including the members of the EA team, the Quality Review Board, and EA management, is provided in Appendix A. Listings of key documents reviewed, interviews conducted, and evolutions observed are provided in Appendix B.

5.0 RESULTS

This section includes a brief description of activities reviewed by EA during the assessment and the results of that review. Conclusions are summarized in Section 6, opportunities for improvement (OFIs) are included in Section 7, and items for follow-up are discussed in Section 8.

5.1 Corrective Action Program

Criteria: A process shall be established to identify, control, document, evaluate, and correct conditions adverse to quality. Records shall be maintained documenting the corrective action program, including documentation of objective evidence of satisfactory implementation of corrective actions. (NQA-1, Requirement 16; Policy Q-16.1 of the WTP QAM; and DOE Order 414.1C)

BNI Procedure 24590-WTP-GPP-MGT-044, *Nonconformance Reporting and Control*, defines the requirements for identifying, documenting, reporting, controlling, and dispositioning nonconforming conditions at the WTP associated with quality related (Q) and commercial grade (CM) SSCs. NCRs are issued to document and disposition Q nonconforming conditions, while CDRs are used to document and disposition CM nonconforming conditions. SSCs designated as Q (previously classified as Quality-List or QL) in the design documents must be constructed or manufactured in accordance with the WTP QA program and the ASME NQA-1 standard. SSCs designated in the design documents as non-Q (i.e., CM) are constructed in accordance with CM standards, such as the Uniform Building Code, or are purchased as CM items from vendors who are qualified CM suppliers.

EA reviewed the 75 NCRs issued by BNI between May 12 and September 5, 2014, and the 98 CDRs issued by BNI between May 12 and July 3, 2014, to evaluate the types of nonconforming issues that were identified, their apparent causes, and subsequent corrective actions. The categories of the NCRs were as follows: 19 NCRs related to construction or installation errors, including damage to installed components resulting from construction activities; 41NCRs for procurement and supplier deficiencies; 10 NCRs for engineering issues; 2 for sub-contractor errors; and 3 NCRs for Q materials handling issues. The procurement problems included hardware/components that were delivered to the site without the required supporting documentation demonstrating compliance with purchase specifications, improperly labeled hardware, hardware/equipment that did not comply with project specification requirements, and missing parts or damage that occurred during shipping. The engineering issues include drawing or design errors or failure of engineering to perform independent quality verifications for equipment delivered to the WTP project.

The 98 CDRs reviewed by EA included 44 for deficiencies in the installation of PICAs, 16 CDRs related to other construction or installation errors; 22 CDRs for procurement and supplier deficiencies; 6 CDRs for sub-contractor errors; and 10 CDRs for other deficiencies such as engineering or materials handling issues. The types of procurement and supply problems were similar to those documented on NCRs.

With the exception of CDR 24590-CDR-CON-14-0359 (discussed in the next paragraph), the BNI engineering organizations have developed appropriate corrective actions to disposition the specific

problems identified in the completed NCRs and CDRs that EA reviewed. The corrective action program and implementation appears adequate to address and resolve specific construction quality deficiencies.

In May 2014, the main power supply cables for the LAB were pulled from BOF Building 87. During the pull, BNI personnel noted that cable MVESW60001A01, a 15 kilovolts (kV) shielded power cable, had a damaged outer jacket. The damaged area was approximately a 1.5 inch circular area. The shielding was not damaged, and the jacket was repaired using electrical tape rated for 600 Volts (V). BNI initiated CDR 24590-CDR-CON-14-0359 to document use of the electrical tape with an inadequate rating, i.e., a tape rated for 600 V to repair the outer jacket of the 15 kV power cable. BNI Engineering concluded that BNI Specification Number 24590-WTP-3PS-E000X-T0003, *Engineering Specification for Cable Terminations*, permitted use of the 600 V tape to repair the 15 kV cable. BNI then closed this CDR with a disposition of "use-as-is." WCD issued finding S-14-WCD-RPPWTP-005-F02 to address the inadequacies of this Specification that permit use of a tape rated at 600 V to repair a 15 kV cable. BNI opened Project Issues Evaluation Report (PIER) 24590-WTP-PIER-MGT-14-0724-C to evaluate this issue. The BNI site construction manager committed to modify the cable repair by replacing the electrical tape with a repair kit rated for 15 kV cable.

5.2 Deficiencies in Installation of PICAs

Criteria: A process shall be established to identify, control, document, evaluate, and correct conditions adverse to quality. Management shall determine the extent of the adverse condition and complete corrective action, including assigning responsibilities and establishing milestones to ensure timely completion of corrective actions. Records shall be maintained documenting the corrective action prog ram, including documentation of objective evidence of satisfactory implementation of corrective actions. (NQA-1, Requirement 16; Policy Q-16.1 of the WTP QAM; and DOE Order 414.1C)

PICAs are installed in the concrete structure after the concrete has hardened and attained its design strength to provide anchorage for equipment in locations where embedded plates and cast in-place anchor bolts are unavailable. The types of hardware and components supported by PICAs include structural steel platforms, pipe supports, instrument racks, transformers, electrical components, and conduit and instrument supports. During a review of CM pipe support installation records in September 2011, DOE WCD personnel identified incorrect or missing data in the documentation of installation of CM PICAs. On September 21, 2011, BNI issued PIER 24590-WTP-PIER-MGT-11-0918-C, *Post Installed Concrete Anchor (PICA) Documentation*, to follow up on concerns identified by WCD. The action items for this PIER required review of the PICA records for all anchors installed between July 19, 2010, and May 2012. After completing this review, BNI Construction Field Engineering determined that actual physical inspections of PICA installations were needed to resolve the questions regarding PICA documentation deficiencies and possible installation errors. BNI issued PIER 24590-WTP-PIER-MGT-12-1246-B, Rev. 0, *Post Installed Anchor Bolt Installation and Documentation*, to perform additional actions, including reviewing installation documentation and re-inspecting all CM PICAs installed on the WTP project. A management suspension of work (MSOW) was issued by BNI to control installation of new PICAs pending completion of the corrective actions. Under the MSOW, installers and field engineers received additional instructions to ensure the PICAs installed while the MSOW was in effect complied with the current installation criteria.

As of April 30, 2014, BNI Field Engineering identified 2024 records for CM PICAs in the LAW Facility (1234), the LAB (310), and BOF (480) that required re-inspection. An additional 177 records for CM PICAs installed in the HLW Facility will be inspected at a later date. The number of PICAs represented by each record varies, typically between 4 and 10. Re-inspections of the PICA installations documented on 1954 records were completed as of April 30, 2014. These re-inspections included 1178 records in the LAW Facility, 305 records in the LAB, and 471 records in the BOF. BNI identified installation errors

with one or more PICAs documented on 778 of these records. The majority of these errors consisted of either PICAs that were inadequately embedded or installed too close to other embedded items. Since September 2011, BNI has initiated 778 CDRs (one for each record that contained an installation error) related to PICA deficiencies to disposition the discrepancies. BNI Design Engineering has completed evaluating over half the CDRs. In most cases, BNI Design Engineering determined that the installed PICAs could support the applied loads (use-as-is), but some additional rework has been required to restore the design margin and required safety factors for PICA deficiencies documented in some (less than 5 percent) of the CDRs. PICAs used in Q applications were not included in the re-inspection program because the location and anchor type (diameter and length) are shown on the design drawings, so the spacing between Q PICAs is controlled, and QC inspectors perform independent inspections of all Q PICAs to verify the location, correct anchor type, and appropriate installation method. QC inspectors do not inspect CM PICAs. Field engineers perform the acceptance inspections for CM PICAs.

BNI Specification 24590-WTP-3PS-FA02-T0004, *Engineering Specification for Installation and Testing Post Installed Concrete Anchors and Drilling/Coring of Concrete*, establishes the technical requirements for installing, inspecting, and testing PICAs. Revision 6 of the BNI specification, issued on October 7, 2013, incorporated the lessons learned from the walkdown inspections and the corrective actions to close out PIER 24590-WTP-PIER-MGT-12-1246-B and 24590-WTP-PIER-MGT-11-0918-C. Revision 7 of BNI Specification 24590-WTP-3PS-FA02-T0004, issued on April 29, 2014, contained more conservative criteria for the minimum spacing between adjacent PICAs included additional details on spacing and edge distance. It also added a series of sketches with examples of how to determine the correct spacing and edge distance for PICAs. Because of the changes to the PICA spacing criteria in Revision 7 of the Engineering Specification, many of the PICAs that were previously inspected and found acceptable had to be re-inspected to verify that the installed PICAs complied with the new, more conservative spacing criteria. Furthermore, PICAs installed in 2013 and 2014 under the MSOW had to be inspected to determine whether they complied with the revised spacing criteria.

BNI's approach to determine the extent of condition and the corrective actions necessary to correct the PICA installation deficiencies was adequate. However, corrective actions have not been timely. Because of BNI's delays in developing PICA installation criteria, BNI had to perform significant rework, including a large number of PICAs that had to be re-inspected and re-evaluated a second time after they had been previously inspected and found to be acceptable. BNI expects that corrective actions for the PICAs will be completed by December 2015.

5.3 Pressure Testing of Piping

Criteria: Construction and pre-operational tests, such as pressure testing operations for piping systems, shall be conducted in accordance with methods approved by the design organization. Test procedures shall include test requirements, acceptance criteria, test prerequisites, inspection hold points, and instructions for recording data. Testing shall be observed by qualified inspection personnel. Test results shall be recorded and evaluated by qualified personnel. (NQA-1, Requirement 11; Policy Q-11.1 of the WTP QAM; and DOE Order 414.1C)

EA observed a pneumatic pressure test performed on a section of the instrument air system distribution piping on elevation 48 in the LAW Facility. The WTP site work process for conducting leak testing is specified in Construction Procedure 24590-WTP-GPP-CON-3504, *Pressure Testing of Piping, Tubing and Components*. The requirements for pneumatic pressure testing are specified in ASME Code B31.3, Paragraph 345.5, *Pneumatic Testing*.

EA attended the pre-test briefings, reviewed drawings and test data sheets, observed pressurization of the systems to the specified test pressure, observed the minimum hold times, and witnessed the system

walkdown and inspection of the piping within the test boundary. The requirements for the pneumatic pressure test were specified in System Pressure Test Package 24590-LAW-PPTR-CON-14-0162, which included the test data sheets, test information, test requirements, valve lineup sheets, and marked-up piping and instrumentation diagrams (P&IDs) for the pneumatic test. The pressure test and inspection boundaries were shown on the marked-up P&IDs, and the attached valve lineup sheets listed the test valve position and listed test plug or blind flange locations. The piping within the pressure test boundaries is classified as CM. Before the pressure tests, EA walked down the piping system and examined the valve lineup and pressure test tags attached to the valves. The tags are placed on components to caution that a pressure test is in progress, indicate the test position of the component (open, closed, or N/A), and state that only authorized test personnel may operate the component. No discrepancies were identified.

The minimum test pressure was specified to be 148.5 pounds per square inch (psi), 110 percent of the piping design pressure. The BNI construction procedure specifies a minimum hold time of 10 minutes at the test pressure. EA verified that the calibration stickers on the test pressure gauges were current and that whip restraints were installed on pressure hoses. EA witnessed the pressurization sequence and verified that the system tested was pressurized to the designated test pressure and held for a minimum of 10 minutes before initiating the system walkdown to inspect the piping for leakage. BNI Field Engineering personnel performed walkdowns and inspections of the piping and other components. EA observed the walkdowns and inspections. No leaks were identified, and the test was declared successful. The pressure testing program was found to be satisfactory for the sample reviewed by EA.

5.4 Inspection of Critical Welds

Criteria: Special processes that control or verify quality, such as those used in welding, shall be performed by qualified personnel using qualified procedures in accordance with specified requirements. (NQA-1, Requirement 9; Policy Q-9.1 of the WTP QAM; and DOE Order 414.1C)

EA reviewed the nondestructive examination requirements for welds classified as critical welds (CTLs) in steel structures. The CTLs are indicated on the design drawings. BNI Specification 24590-WTP-3PS-SS00-T0001, *Welding of Structural Carbon Steel*, requires the following inspections for CTLs: (1) visual inspection of 100 percent of all CTLs; (2) inspection of 10 percent of full-penetration CTLs, using either ultrasonic examination or radiographic examination methods; and (3) inspection of 10 percent of partial-penetration CTLs, using either liquid penetrant examination or magnetic particle examination methods. EA reviewed the field welding checklist record No. 24590-HLW-FWCL-CON-13-00196, for the HLW canister import bay monorail rails. Welds designated as FW-13 and FW-14 were classified as CTLs. Inspection records documented on the field welding checklist include results of visual inspections of FW-13 and FW-14 and an ultrasonic examination performed on FW-14. The welds were acceptable. EA concluded the inspection program for CTLs was acceptable.

5.5 Concrete Placement Records

Criteria: Work, such as concrete construction, shall be performed in accordance with approved procedures, design drawings, and other design basis documents, including applicable codes and standards. The procedures, instructions, and drawings shall include or reference appropriate quantitative or qualitative acceptance criteria for determining that prescribed results have been satisfactorily attained (NQA-1, Criterion 5; Policy Q-5.1 of the WTP QAM; and DOE Order 414.1C). Records shall furnish documentary evidence that items or activities meet specified quality requirements (NQA-1, Requirement 17; Policy Q-17.1 of the WTP QAM; and DOE Order 414.1C).

EA reviewed the results of QC tests performed on concrete samples from the four Q concrete placements in the HLW Facility between May and August 2014. Three of the placements were in the HLW Facility walls and one in an interior floor slab. The tests included slump, temperature, and unit weight testing performed on the freshly mixed concrete and unconfined compression tests performed on concrete cylinders cured in the concrete laboratory. The unconfined compression test results are used to verify the concrete quality and demonstrate that the concrete meets the design strength requirements based on the unconfined compression strength test results. The design strength of concrete is determined by casting samples of concrete in cylindrical molds, moist curing them in a field laboratory for a specified period, and then subjecting them to an unconfined compression test. At WTP, the design strength of concrete is based on the results of the unconfined compression tests performed on concrete test cylinders that were moist cured in the concrete field laboratory for 28 days. One concrete cylinder is tested at 7 days and a set of two at 28 days. The 7 day test result provides an early indication of the 28 day concrete strength and shows that the concrete that was placed can be expected to meet design requirements. The unconfined compression strength of concrete increases approximately 20 to 25 percent between the ages of 7 days and 28 days. The methods for sampling the concrete, casting and curing the cylinders, and performing the unconfined compression tests are specified in American Society for Testing and Materials International standards.

The unconfined compression tests performed on nine sets of concrete cylinders from the three HLW Facility wall pours placed in May, June, and July 2014 showed that the concrete strength at an age of 28 days in these placements ranged between 5630 and 6520 psi. The average strength for the nine sets of test cylinders was 6130 psi. The required (design) strength for the concrete is 5000 psi. For the HLW Facility concrete slab placed in August 2014, EA reviewed the results from concrete strength tests performed on two test cylinders that were tested at an age of 7 days. The concrete placed in August was not 28 days old at the time of the review so only the 7 day compression test results were available for review. The unconfined compressive strength for these two cylinders (tested at an age of 7 days) was 4460 and 4730 psi, an average of 4585 psi, which is 96 percent of the 28 day design strength.

The test results indicate the quality of concrete placed at the WTP plant is satisfactory. The results of the unconfined compression strength of the concrete at 28 days continues to exceed the specified design strength by at least 1000 psi for all classes of structural concrete placed at WTP.

5.6 Installation of Electrical Equipment

Criteria: Electrical equipment that performs a safety function shall be installed in accordance with approved procedures, design drawings, manufacturer's instructions, and other design basis documents, including applicable codes and standards. The procedures, instructions, and drawings shall include or reference appropriate quantitative or qualitative acceptance criteria for determining that prescribed results have been satisfactorily attained. (NQA-1, Requirement 5; Policy Q-5.1 of the WTP QAM; and DOE Order 414.1C)

EA examined construction activities in several of the WTP buildings (including the HLW, LAB, LAW, and several BOF buildings), inspecting ongoing cable pulling operations to verify that cable pulling was performed in accordance with design documents (i.e., specifications and drawings) as well as to verify that as-built configurations of installed electrical switchgear, electrical control panels, and cables were consistent with the design documents. EA's observations are discussed in more detail below.

Cable Pulling. In order to minimize interferences with other craft personnel, most cable pulling activities are performed on the night shift. EA and the WCD site electrical inspector discussed cable pulling operations with the supervisors and electrical craft and observed cable pulling activities performed during the night shift in the LAW Facility. The supervisors and electrical craft discussed different methods of

transitioning from the cable trays into the motor control center (MCC) cabinets and showed EA many cable installations that had been completed. The craftsmanship was adequate in many of the installations inspected. However, as discussed below, there is ambiguity regarding what an acceptable method of transitioning from cable trays to cabinets and equipment.

EA toured the cable storage area and discussed the procedures for package planning, inventory control, and cable cutting. Cables are stored in a controlled area. A work package comes to the inventory control specialist who cuts the cables and places them on smaller reels to be used in the field. Cable lengths are verified by comparing the design information (i.e., the numbers generated by the SETRoute cable routing computer program) with the as-built dimensions of the raceways before cutting the cables. EA concluded the process was efficient and effective.

Electricians were making a short cable pull (i.e., hand-pulling two cables between two cabinets within the same room) on the 28' level of the LAW Facility. The work was performed efficiently and in a good "workmanlike" manner. BNI was also preparing to pull cable from a utility owned feeder building to WTP Building 87. Scaffolding had been erected in the basement of the utility owned building. However, work was stopped because questions from BNI construction personnel disclosed that overhead cables in the utility building were energized, requiring the work plan to be reassessed. EA toured the utility building along with several representatives of the utility, BNI, and WCD and observed preparations for pulling the cables, noting that pulling sheaves, ropes, and pulleys were installed and ready to go.

Equipment Labeling. During the March 2014 quarterly WTP construction quality review, EA identified labeling inconsistencies on the domestic (potable) water system and process service water system panels in the Water Treatment Building. BNI has not yet corrected the labeling on these panels but is tracking the inconsistencies through by CDR-14-0123. During the March 2014 review, EA also identified labeling inconsistencies on the 10 Ton Monorail Rope Hoist panels LPH-PNL-0027 and LPH-PNL-00028 on the -21' elevation of the LAW Facility. Several lights and switches were out of place and have yet to be corrected. The location of the RSD (hoist raised) relay limit switch does not match the design drawing on similar panels in adjacent rooms. BNI is tracking this issue via CDR-14-0218. EA previously identified an OFI during the March 2014 review concerning the electrical panel labeling issues.

Equipment installation. EA inspected the stack discharge monitoring (SDJ) panels and associated equipment that had been recently installed in the LAB, discussing the installation methods with the electricians and field engineers who were involved with the installation. The SDJ cabinets were installed in accordance with manufacturer's instructions which included stopping the conduits short of the cabinets and routing the cables in free air between the conduits and the cabinets. The cables are run through conduit grounding bushings into the SDJ cabinets.

Several motor control switches are adjacent to the SDJ cabinets. These switches are located in non-metallic boxes with metallic conduit going to them. The National Electric Code (NEC) requires these conduits to be electrically bonded to one another. An electrician opened one of the switches and verified the installation of the bonding jumper between conduits. The NEC also requires metal raceways to be bonded to one another and to the metal enclosures that they service. Several of the conduits feeding the SDJ cabinets were not bonded together. The craft stated that they believed the conduits were bonded through the conduit straps attached to the unistrut conduit supports. The straps were not listed as bonding fittings; therefore the electricians agreed to add bonding wires to the conduit bushings. WCD initiated finding S-14-WCD-RPPWTP-009-F02 to document the inadequate bonding.

EA inspected the following SDJ cabinets and panels:

- SDJ-PNL-00001 – Record Sampler Cabinet

- SDJ-PNL-00002 – Record Sampler Cabinet
- SDJ-PNL-00003 – Record Sampler Electrical Cabinet
- SDJ-PNL-00004 – Record Sampler Cabinet
- SDJ-PNL-00063 – Record Sampler Electrical Cabinet
- SDJ-PNL-00064 – Record Sampler Electrical Cabinet
- SDJ-PNL-00094 – Heat Trace Remote Monitoring Controller
- SDJ-PNL-00095 – Heat Trace Remote Monitoring Controller
- SDL-PNL-00096 – Heat Trace Remote Monitoring Controller

The heat trace monitor controller cabinets (SDJ-PNL-00094, -00095, and -00096) are vendor supplied packages with a nameplate that specifies the power supply voltage at 120 Voltage Alternating Current and a maximum power of 1200 Watts (W), the equivalent of 10 Amps. According to drawing 24590-LAB-E8-LVE-00011, power for these cabinets is supplied by panel LVE-PNL-60011 and each SDJ cabinet is supplied by a 30 amp breaker. Good NEC practice would dictate that breaker to be sized at 15 amps.

The record sampler electrical cabinets (SDJ-PNL-00003, -00063, and -00064) are vendor supplied packages with a nameplate that specifies the power supply voltage at 120 Voltage Alternating Current and a maximum power of 1120 W, the equivalent of9.3 Amps. Power for these cabinets is normally supplied by panel LVE-PNL-60033, with each cabinet connected to a 70 amp breaker, which is excessively oversized. These electrical cabinets are also connected to the uninterruptable power supply panel UPE-PNL-60042 and supplied by a 50 amp breaker. Good NEC practice would dictate that breaker also be sized at 15 amps.

WCD initiated finding S-14-WCD-RPPWTP-009-F03 to document the failure to properly size the over current protection for these cabinets. WCD also initiated OFI S-14-WCD-RPPWTP-009-O01 to encourage BNI to expand its inspection process to identify these deficiencies earlier and reduce the amount of required rework.

EA identified an OFI during the May 2014 quarterly WTP construction quality review regarding the use of non-sequential labeling (identifiers) for some exhaust fans in the LAB and their respective controllers and motors. The SDJ cabinets are similarly numbered. For example the record sampler cabinets are panels -0001, -0002, and -0004, the electrical cabinets are -0003, -0063 and -0064, and the heat trace controller cabinets are -0094, -0095, and -0096. EA will continue to track the labeling on these SDJ components in subsequent EA reviews of WTP construction quality.

Routing of Cables between Cable Trays and Electrical Cabinets. The terms of the WTP design and construction contract with ORP specifies that BNI is the Authority Having Jurisdiction for interpretation and enforcement of the NEC for code compliance at WTP. During the May 2014 quarterly WTP construction quality review, documented in a September 2014 EA Report, EA questioned the method of routing electrical cables between cable trays and the top of electrical cabinets such as MCCs. The cables are not routed in conduit or vertical cable trays, but rather drop unprotected in the open air. The WCD site electrical inspector also questioned this practice before the May 2014 review. BNI has issued a formal interpretation of the NEC, stating that cables can be run in free air, up to 6' between cable trays and/or between cable tray and equipment, and that multiple cables can be bundled together up to 6' in length without derating their ampacity. This is not a proper interpretation of the NEC. The BNI interpretation of the Code also discusses whether MCCs are classified as equipment or cabinets. Currently, electricians are pulling the cables and leaving them coiled above the cabinets. At a later date the electricians will install the cables into the cabinets and make the terminations, which is inefficient and delaying completion of cable installations. Some cables are currently not installed in a workmanlike

manner. The ORP staff is still discussing these cable installation issues and view them as unresolved. (See **OFI-WTP-1**.)

5.7 Maintenance, Preservation, and Protection of Stored and Installed Equipment

Criteria: Equipment that performs a safety function shall be sufficiently maintained before, during, and following installation to ensure it provides the necessary reliability and availability to perform its intended safety function, and to prevent damage, loss, or deterioration. Handling, storage, cleaning, packaging, shipping, housekeeping, and preservation of items shall be controlled to prevent damage or loss and to minimize deterioration. (NQA-1 Requirement 13; Policy Q-13.1 of the WTP QAM; and DOE Order 414.1C)

EA observed electricians performing biennial cleaning and maintenance on the MCCs in the LAB main switchgear room, which is a good preventive maintenance practice. EA toured the LAB and examined the preservation and maintenance of permanent plant equipment. EA observed that the building is essentially complete except for cable pulling and terminations. The permanent plant equipment is covered and adequately protected from ongoing construction activities.

5.8 Self-Assessment Program

Criteria: Line and support organizations shall perform self assessments of their performance and the adequacy of their processes. Self-assessments shall be used to evaluate performance at all levels periodically and to determine the effectiveness of policies, requirements, and standards and implementation status. Self-assessment results must be documented in sufficient detail to identify the activity covered, identify the individuals performing the surveillance, and document results and any necessary corrective actions. (Policy Q-02.2 of the WTP QAM; DOE Order 226.1A; DOE Order 226.1B; and DOE Order 414.1C) Note: DOE Order 226.1A was superseded by DOE Order 2261B by Contract Modification 310, dated January 28, 2014.

According to BNI definitions, self-assessments are self-critical evaluations of work processes and activities to ensure that work is performed as expected, to monitor work results to ensure that completed work meets project requirements, and to evaluate performance at all levels to identify problems with work processes and completed work activities. In the construction quality quarterly report issued on May 22, 2013, EA identified an OFI specifying that the self-assessment process within the BNI Construction Field Engineering organization should include more performance-based assessments. BNI Procedure 24590-WTP-GPP-MGT-036, *WTP Self-assessment*, the implementing procedure for performing the self-assessments necessary to comply with the BNI QA program and DOE QA requirements, described a self-assessment process that includes both compliance-based and performance-based self-assessments. BNI defined a compliance-based assessment as one that focuses primarily on determining whether work items were completed in accordance with a procedure, requirement, standard, or other implementing document. A compliance-based assessment typically included a review of documentation to measure whether those performing the task are following the prescribed method or rule, with only minimal observations of work. A performance-based assessment evaluates work as it is performed. In addition to ensuring that work items are completed in accordance with a procedure, requirement, standard, or other implementing document, a key objective of a performance-based assessment is actual observation of ongoing work activities, followed by an evaluation focused on improving the performance of that activity.

In 2013, the BNI Field Engineering organization performed 21 compliance-based self-assessments that determined whether completed construction records were complete and accurate. None of the self-assessments performed in 2013 by BNI Field Engineering were performance-based self-assessments that included observations of ongoing work activities and/or evaluations of performance of construction

activities. With the exception of a self-assessment to review the construction turnover process, the performance-based self-assessments performed in 2011 and 2012 to review field engineering activities were reactive (i.e., in response to issues identified by the BNI QA organization or WCD). The majority of the field engineering self-assessments performed in 2011 and 2012 were compliance-based assessments.

In the fourth quarter of 2013, the schedule for the 2014 self-assessment program in the BNI Construction Field Engineering organization was revised to include more performance-based assessments. EA reviewed the schedule for BNI Field Engineering self-assessments that are currently planned for 2014. Three performance based self assessments have been completed in 2014 and, during the current review; two were in progress to assess pump alignments and field engineering surveys. Three other performance based self-assessments are scheduled for 2014 to assess cable terminations, structural steel erection, and pressure testing of piping.

EA reviewed the WTP self-assessment report titled *Pre-Test Requirements for Leak Tests*, dated March 13, 2014, during the EA's May 2014 review. During the current review, EA reviewed the results of the performance based self-assessments performed by BNI Field Engineering to assess magnetic particle testing of field welds between June 11 and 30, 2014, and electrical cable installation between June 2 and July 15, 2014. BNI Field Engineering concluded that magnetic particle testing activities were being performed correctly by a qualified magnetic particle testing examiner using a qualified procedure. The electrical cable self-assessment team identified OFIs regarding the need for additional training of craft and field engineering involved in cable pulling activities and apparent inadequate cable support after the cables exit the cable trays. EA previously identified the same issue with cable support. EA will continue to evaluate the implementation of the self-assessment program by the BNI Field Engineering organization in subsequent quarterly construction quality reviews.

5.9 Quality Assurance Surveillance Activities

Criteria: Quality Assurance surveillances shall be performed by knowledgeable personnel and shall be scheduled in a manner to provide coverage, consistency and co-ordination of ongoing work. Surveillance results shall be documented in sufficient detail to identify the activity covered, identify the individuals performing the surveillance, and document results and any necessary corrective actions. (NQA-1 Criterion 18; Policy Q-02.3 of the WTP QAM; and DOE Order 414.1C)

BNI Procedure 24590-WTP-GPP-QA-601, *Quality Assurance Surveillance*, describes the process used to plan, conduct, and document surveillances of work activities at WTP. The surveillances focus on observations of work activities to determine whether procedures are followed and to provide feedback to management on organizational performance. The onsite QA and QC staffs perform these surveillances, which supplement QA audits that are conducted by the offsite QA staff. Surveillances performed by the QA staff are titled QA Surveillances, while those performed by the QC staff are titled QC Surveillances.

EA reviewed ten QC surveillances that were completed in April through August 2014 to verify that the supplier of concrete for the WTP project, Central Pre-Mix, complied with the BNI WTP concrete supply specification and the approved Central Pre-Mix QC and QA programs. These surveillances included observations of a cross section of the concrete supply work activities, including receipt inspection, storage, and testing of concrete ingredients, calibration of batch plant equipment, concrete batch plant operations, QA records, control of procedures, and hot weather concrete operations. No deficiencies were identified by EA. The BNI QC surveillance program was found to be satisfactory for the sample reviewed by EA.

6.0 CONCLUSIONS

EA determined that construction quality at WTP is adequate in the areas that were reviewed (design and procurement programs were not included in the scope of this quarterly construction quality review). BNI has developed appropriate corrective actions to resolve specific deficiencies for construction quality NCRs and CDRs reviewed by EA. BNI continues to implement corrective actions that are necessary to address errors in the installation of PICAs. BNI's approach to determining the extent of condition was adequate. However, corrective actions have not been timely to resolve the PICA installation errors that were initially disclosed in September 2011. Because of delays by BNI to develop PICA installation criteria, many of the PICAs that were previously inspected and found acceptable had to be re-inspected. Corrective actions are expected to be completed by December 2015.

Electrical cable pulling and installation of electrical equipment was satisfactory. However, deficiencies were evident in other aspects of electrical construction. Labeling on the compartments of some MCCs in the LAB is inconsistent. In addition, sizing of some breakers is incorrect; this issue is being tracked via an ORP WCD finding. Further, cable support between the cable trays and cabinets appears inadequate; ORP WCD inspectors are tracking this issue to resolution.

In response to previous EA concerns regarding the lack of performance based self-assessments, BNI Construction Field Engineering is adjusting the focus its self-assessment program to include more performance based self-assessments. Three performance based self-assessment have been completed in 2014, two others were in progress during the review, and three others are scheduled to be performed in calendar year 2014.

7.0 OPPORTUNITIES FOR IMPROVEMENT

EA identified one OFI. This potential enhancement is not intended to be prescriptive or mandatory. Rather, it is a suggestion offered by the EA assessment team that may assist site management in implementing best practices, or provide potential solutions to minor issues identified during the review. In some cases, OFIs address areas where program or process improvements can be achieved through minimal effort. This OFI should be evaluated by the responsible line management organizations and either accepted, rejected, or modified as appropriate, in accordance with site-specific program objectives and priorities.

OFI-WTP-1: Re-evaluate the adequacy of cable support between the cable trays and entrance into equipment cabinets and the effect of bundled cables on the ampacity of the cables and resolve questions to ensure compliance with code requirements and to ensure that work can be completed efficiently and without a need for rework.

8.0 ITEMS FOR FOLLOW-UP

EA will continue to follow up on inspection of welding activities, piping and pipe supports, pressure testing of piping, cable pulling, cable terminations, and installation of electrical equipment. EA will also continue to review corrective actions to address identified discrepancies in the PICA installation process and will perform additional reviews of self-assessments conducted by BNI Field Engineering. Additionally, EA will review actions taken by BNI to resolve issues identified by EA during the 2014 quarterly reviews involving equipment labeling inconsistencies, support of electrical cables from the point the cables exit cable trays to where they enter cabinets, and breaker sizing in the SDJ system.

Appendix A
Supplemental Information

Review Dates

September 8-12, 2014

Office of Independent Enterprise Assessments Management

Glenn S. Podonsky, Director, Office of Enterprise Assessments
William A. Eckroade, Deputy Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
William E. Miller, Director, Office of Nuclear Safety and Environmental Assessments

Quality Review Board

William A. Eckroade
Thomas R. Staker
William E. Miller
Karen L. Boardman
Michael A. Kilpatrick

EA Site Lead for Hanford Site

Robert Farrell

EA Team Composition

Joseph Lenahan
James Boyd

Appendix B
Documents Reviewed, Interviews, and Observations

Documents Reviewed

- Construction Procedure 24590-WTP-GPP-CON-3504, Rev. 10A, Pressure Testing of Piping, Tubing and Components, August 26, 2014
- Construction Procedure 24590-WTP-GPP-CON-3205, Rev. 4B, Post Installed Concrete Anchors, April 30, 2014
- Specification 24590-WTP-3PS-DB01-T0001, Rev. 8, Engineering Specification for Furnishing and Delivering Ready-Mix Concrete, March 26, 2007
- Specification No. 24590-WTP-3PS-FA02-T0004, Rev. 7, Engineering Specification for Installation and Testing of Post Installed Concrete Anchors and Drilling/Coring of Concrete, April 29, 2014
- Specification No. 24590-WTP-3PS-SS00-T0001, Rev. 7, Engineering Specification for Welding of Structural Carbon Steel, January 30, 2008
- Procedure 24590-WTP-GPP-MGT-043, Rev. 5E, Corrective Action Management, August 7, 2014
- Procedure 24590-WTP-GPP-MGT-044, Rev. 2, Nonconformance Reporting and Control, December 4, 2013
- Procedure 24590-WTP-GPP-MGT-036, Rev. 3A, WTP Self Assessment and Line Surveillance, February 26, 2014
- Procedure 24590-WTP-GPP-QA-601, Rev. 6C, Quality Assurance Surveillance, May 1, 2013
- Document N o. 24590-WTP-MN-CON-01-001-10-10, Rev. 6, Bechtel Nondestructive Examination Standard, Visual Examination VT-AWS D1.1, August 15, 2006
- Document No. 24590-WTP-MN-CON-01-001-10-09, Rev. 8, Bechtel Nondestructive Examination Standard, Visual Examination VT-ASME, August 8, 2013
- Document No. 24590-WTP-QAM-QA-06-001, Rev. 15, Quality Assurance Manual, September 9, 2015
- Construction Deficiency Report numbers 24590-WTP-CDR-CON-14-0329 through -0394, 24590-WTP-NCR-CON-14-0396, and 24590-WTP-NCR-CON-14-0398 through -0428. Note: Numbers 24590-WTP-CDR-CON-14-0395 and -0397 were not issued.
- Nonconformance Report numbers 24590-WTP-NCR-CON-14-0064 through -0090 and 24590-WTP-NCR-CON-14-0092 through -0139. Note: Number 24590-WTP-NCR-CON-14-0091 was not issued.
- WTP Self Assessment Report 24590-WTP-SAR-CON-14-0009, Electrical/Instrument Cable Pull Knowledge and Installation, July 29, 2014
- WTP Self Assessment Report 24590-WTP-SAR-CON-14-0017, Assessment of Field Welding Magnetic Particle Testing (MT), July 2, 2014
- WTP Self Assessment Report 24590-WTP-SAR-CON-14-0018, Setroute Record Assessment for PIER 24590-WTP-MGT-13-0343-B, June 9, 2014
- Quality Control Surveillance Report number 24590-WTP-SV-QC-14-048, Central Pre-Mix Gradation Testing of Materials (CPM #10)
- Quality Control surveillance Report number 24590-WTP-SV-QC-14-059, Central Pre-Mix Material Testing and Equipment Calibration
- Quality Control Surveillance Report number 24590-WTP-SV-QC-14-060, Central Pre-Mix Batch Plant Operations
- Quality Control Surveillance Report number 24590-WTP-SV-QC-14-072, Central Pre-Mix Controlled Documents (CPM #15)
- Quality Control Surveillance Report number 24590-WTP-SV-QC-14-073, Central Pre-Mix Quality Assurance Records (CPM #22)

- Quality Control Surveillance Report number 24590-WTP-SV-QC-14-074, Central Pre-Mix Hot Weather Concrete (CPM #14)
- Quality Control Surveillance Report number 24590-WTP-SV-QC-14-086, Central Pre-Mix Receipt, Storing Admixtures (CPM #4)
- Quality Control Surveillance Report number 24590-WTP-SV-QC-14-087, Central Pre-Mix Gradation Unloading, Receipt, Storing Aggregates (CPM #5)
- Quality Control surveillance Report number 24590-WTP-SV-QC-14-088, Central Pre-Mix Unloading, Receing Cement/Fly Ash (CPM #7)
- Quality Control surveillance Report number 24590-WTP-SV-QC-14-096, Central Pre-Mix Concrete Company Procurement Procedures (CPM #1)
- System Pressure Test Document Number 24590-BOF-PPTR-CON-14-0162
- Drawing Number 24590-LAW-M6-ISA-00002001, Rev. 0, P&ID – LAW Instrument Service Air System Distribution, Elevation 48 Feet, 0 IN
- Drawing Number 24590-LAW-M6-PSA-00002001, Rev. 0, P&ID – LAW Plant Service Air System Distribution, Elevation 48 Feet, 0 IN
- Specification No. 24590-WTP-3PS-E00X-T0004 Rev. 8, Engineering Specification for Installation of Cables, September 17, 2013
- Specification No. 24590-WTP-3PS-E00X-T0005 Rev. 5, Engineering Specification for Electrical Raceway and Cable Identification, October 27, 2011
- Specification No. 24590-WTP-3PS-EW00-T0001 Rev. 3, Engineering Specification for Power, Control, and Instrumentation Cable, Medium Voltage Power Cable and Fiber Optic Cable (Safety), July 1, 2011
- Construction Procedure 24950-WTP-GPP-CON-3304 Rev. 2D, Electrical Cable Installation, September 23, 2013
- National Electric Code – 1999
- Drawing Number 24590-LAB-E8-UPE-60042, Rev. 5, Analytical Laboratory Non-SS UPS 208/120V Panel Schedule
- Drawing Number 24590-LAB-E8-LVE-00033, Rev. 1, Analytical Laboratory 120/208V Distribution Panel Schedule
- Drawing Number 24590-LAB-E8-LVE-00011, Rev. 5, Analytical Laboratory 208/120V Distribution Panel Schedule
- Drawing Number 24590-LAB-E22-GRE-00001, Rev. 3, Analytical Laboratory Grounding Plan
- Document Number 24590-WTP-AHJ-E-14-0003, Rev. 0, Request for Authority Having Jurisdiction (AHJ) Approval
- Document Number S-14-WCD-RPPWTP-009-O01, Draft, Opportunity for Improvement
- S-14-WCD-RPPWTP-009-F02, Finding on Grounding/Bonding in the LAB
- S-14-WCD-RPPWTP-009-F03, Finding on Overcurrent Protection for SDJ cabinets
- PIER 24590-WTP-PIER-MGT-14-0724-C, BNI's Engineering Specification Failed to Adequately Define the Requirements
- CDR 24590-WTP-CDR-CON-14-0359, BOF Tape Used for Repair is Not Rated for Cable
- S-14-WCD-RPPWTP-005-12, Assessment Report on MVE Cable Pull from Switchgear 87 to the LAB

Interviews:

- Field Engineering Manager
- Field Engineers
- QC Manager
- QC Inspectors

- Electricians

Observations:

- Preumatic pressure test
- Installation of Electrical Cables
- Installed electrical equipment and control panels