Independent Oversight Review of the Hanford Site Waste Treatment and Immobilization Plant Construction Quality

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Acronyms

AISC	American Institute of Steel Construction
ASME	American Society of Mechanical Engineers
ASTM	ASTM International
BOF	Balance of Facilities
BNI	Bechtel National, Inc.
CDR	Construction Deficiency Report
CFR	Code of Federal Regulations
CM	Commercial Grade
CRAD	Criteria, Review and Approach Document
DOE	U.S. Department of Energy
DOE-WTP	DOE-ORP WTP Project Office
FCN	Field Change Notice
HLW	High-Level Waste
kip	1000 pounds-force
LAB	Analytical Laboratory
LAW	Low-Activity Waste
NCR	Nonconformance Report
NQA	Nuclear Quality Assurance
ORP	Office of River Protection
PICA	Post Installed Concrete Anchor
P&ID	Piping and Instrumentation Diagram
PIER	Project Issues Evaluation Report
psi	Pounds per Square Inch
PTF	Pretreatment Facility
Q	Quality Related
QA	Quality Assurance
QC	Quality Control
SSC	Structures, Systems, and Components
TC	Tension Control
WTP	Waste Treatment and Immobilization Plant

Independent Oversight Review of the Hanford Site
Waste Treatment and Immobilization Plant
Construction Quality

1.0 PURPOSE

The U.S. Department of Energy (DOE) Office of Enforcement and Oversight (Independent Oversight), within the Office of Health, Safety and Security, conducted an independent review of selected aspects of construction quality at the Hanford Site Waste Treatment and Immobilization Plant (WTP). The review, which was performed November 26-30, 2012, was the latest in a series of ongoing quarterly assessments of construction quality performed by Independent Oversight at the WTP construction site.

2.0 SCOPE

The scope of this review encompassed various topics, including observation of one pneumatic and two hydrostatic pressure tests, review of material condition and protection of facilities and equipment in the High-Level Waste (HLW) facility, review of tensile tests on structural bolts, and review of the results of quality control (QC) tests on samples of concrete placed in the HLW facility and the Pretreatment Facility (PTF). Independent Oversight examined nonconformance reports (NCRs) and construction deficiency reports (CDRs) identified by Bechtel National, Inc. (BNI) under its corrective action program, as well as corrective actions to address deficiencies identified in installation of post installed (drilled-in) concrete anchors. Independent Oversight also reviewed the BNI management and independent assessment programs and quality assurance (QA) audits and surveillances.

In addition, Independent Oversight reviewed various construction quality documents and conducted several construction site walkthroughs, concurrent with DOE Office of River Protection (ORP) WTP Project Office (DOE-WTP) staff. During the walkthroughs, Independent Oversight observed pressure testing of piping and activities related to the protection of equipment and facilities in the HLW facility. Independent Oversight also examined specifications and procedures that control the installation of post installed (drilled-in) concrete anchors, structural steel erection, field changes, and pressure testing of piping systems. Independent Oversight also followed up on site activities to address previously-identified opportunities for improvement.

3.0 BACKGROUND

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 serves as DOE line management for two functions: the Tank Farms, which maintain the 177 underground storage tanks; and the WTP, which is responsible for retrieval, treatment, and disposal of the waste stored in the underground tanks. The WTP is an industrial complex for separating and vitrifying radioactive and chemical waste stored in the underground tanks. The WTP complex consists of five major components: the PTF for separating the waste; the HLW and Low-Activity Waste (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. The WTP is currently in the design and construction phase. Design and construction activities at WTP are managed by BNI under contract to ORP. Construction oversight is provided by the DOE-WTP staff, specifically by the DOE-WTP Construction Oversight and Assurance Division. Because of the safety significance of WTP facilities, Independent Oversight has scheduled quarterly reviews to assess the quality of ongoing construction.

4.0 METHODOLOGY

This independent review of the WTP construction project was conducted in accordance with applicable sections of Nuclear Facility Construction Criteria, Review and Approach Documents (CRADs) HSS-CRAD-64-15, Structural Concrete; HSS-CRAD-64-16, Structural Steel; HSS-CRAD-45-52, Piping and Pipe Supports; and HSS-CRAD-45-53, Mechanical Equipment Installation.

5.0 RESULTS

Activities examined by Independent Oversight during the review are discussed below. Each activity is briefly described, and Independent Oversight's observations and conclusions regarding that activity are discussed in detail. Conclusions are summarized in Section 6, and items for follow-up are discussed in Section 7.

NCRs and CDRs

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

Independent Oversight reviewed the 90 NCRs issued by BNI from August 13 through November 29, 2012, and approximately 90 CDRs issued by BNI in October and November 2012 to evaluate the type of nonconforming issues that were identified, subsequent corrective actions, and the apparent cause of the nonconforming conditions.

Approximately 70 percent of the NCRs were issued to resolve equipment and hardware procurement problems. More than half of these problems involved hardware/components that were delivered to the site without the required supporting documentation demonstrating compliance with purchase specifications; others involved improperly labeled hardware, hardware/equipment that did not comply with project specification requirements, and missing parts or damage that occurred during transit. Independent Oversight found that the BNI engineering organization developed appropriate corrective actions to disposition the identified problems. Corrective actions may only require obtaining the required documentation from the vendor or may require performing rework on site. Some examples of rework performed on site are repairing deficient welds, replacing damaged gaskets in valves, or replacing incorrect fastener assemblies (bolts, nuts, washers) in components. In cases when extensive rework is required, or the item delivered to the site does not comply with the purchase specifications, the hardware is rejected and returned to the vendor. The remaining NCRs (approximately 30% of the total) were initiated to address construction, installation, or design/engineering issues. Examples of the issues identified in these NCRs were damage caused by construction work to installed equipment, failure to follow construction procedures, personnel errors, installation errors, and engineering deficiencies.

Most of the CDRs that Independent Oversight reviewed were issued to document nonconforming conditions identified in the LAB as a result of reviews conducted by BNI and DOE in preparation for completion of civil and mechanical work activities in the LAB. The reviews did not include electrical work activities, such as electrical cable installation, termination of electrical connections, and completion of pre-operational electrical testing, since these work activities are incomplete. Approximately half of the CDRs associated with the LAB involved equipment documentation issues, while 43 CDRs were issued to disposition deficiencies in installation of various types of drilled-in concrete anchors in the LAB and BOF. At the WTP project, drilled-in concrete anchors are designated as post installed concrete anchors (PICAs). Corrective actions to address PICA deficiencies are discussed in the following section.

Independent Oversight determined that BNI developed appropriate corrective actions to disposition the identified problems. The NCR/CDR process and implementation are adequate to address and resolve procurement and construction quality deficiencies.

Post Installed Concrete Anchors

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 not available. Independent Oversight reviewed the following documents, which establish the technical requirements for installation, inspection, and testing of PICAs: Specification No. 24590-WTP-3PS-FA02-T0004, Rev. 5, *Engineering Specification for Installation and Testing Post Installed Concrete Anchors and Drilling/Coring of Concrete*; and Construction Procedure 24590-GPP-CON-3205, Rev. 3B, *Post Installed Concrete Anchors*. The construction procedure includes installation instructions, inspection requirements, and documentation requirements.

The only types of PICAs approved for use in Q applications are the undercut type (also used in some CM applications), which are installed by drilling a hole in the concrete using a special type of drill bit that flares out to form a cone shaped, or undercut, hole at the bottom of the drill hole. The undercut anchor is installed in the hole and expanded into the undercut area using a hydraulic jack, and it transfers the tensile load from the bolt into the concrete structure by bearing against the undercut hole at the base of the anchor. The design drawings show the locations of the Q undercut anchors and their embedment depth, spacing, and edge distance. Field engineers and QC inspectors perform quality verification for the installation of the Q undercut anchors. The installation and inspection details for Q anchors are documented on a Post Installed Concrete Anchor Inspection Record, as specified in Appendix 2 of Construction Procedure 24590-WTP-GPP-CON-3205.

Other types of PICAs used in CM applications on the WTP project include wedge, drop-in, powder actuated, concrete screw type, and adhesive/grouted (using either cement or epoxy grout). The most common type of CM PICA used at WTP is the wedge type, which is installed by drilling a cylindrical hole in the concrete using an ordinary masonry/concrete drill bit, inserting the anchor, and setting the anchor by using a calibrated torque wrench to mechanically expand the anchor into the side of the drilled hole. The specified torque values are listed in the installation procedure for each size (diameter) anchor. The application of the installation torque is required to be witnessed by personnel other than the installers. Section 5.2 of the Specification and Paragraph 3.3.5.5 of the Installation Procedure specify an alternate method of verifying that wedge anchors are properly installed if the torque value is not witnessed, by performance of a direct tension test. Performance of a direct tension test is a required inspection attribute for all drop-in and adhesive anchors. All direct tension tests must be witnessed by personnel other than the installers.

A series of tensile tests were performed under the supervision of BNI to establish the design capacity for each size and type of PICA listed in Specification No. 24590-WTP-3PS-FA02-T0004. The theoretical ultimate capacity of a wedge type PICA is based on three factors: (1) concrete design strength and anchor embedment depth; (2) anchor pullout; and (3) the ultimate anchor steel strength. The potential failure mechanism based on concrete design strength and anchor embedment depth is assumed to be a cone-shaped rupture of the concrete. To obtain the maximum anchor capacity, the anchors must be placed far enough apart to avoid overlapping of the potential failure cones, and far enough from the concrete edge so that the failure cone intersects the concrete surface and does not go through the edge (side wall) of the concrete structure. Anchor pullout failure occurs when the tensile load on the anchor exceeds the friction between the concrete and the anchor. Factors that affect anchor pullout are the diameter of the drilled hole relative to the anchor diameter, the inclination of the drill hole, and application of the correct torque to expand the anchor into the sides of the drill hole. Steel failure caused by an anchor loaded in excess of the ultimate shear or tensile strength of the steel is rarely the cause of a PICA failure. A factor of safety is applied to establish the safe working loads for the PICAs. The diameter of the drill bit, depth of the drill hole, setting torque, minimum embedment depth, and minimum anchor spacing are specified in Construction Procedure 24590-GPP-CON-3205 for each anchor size (length and diameter). The tension test load, if a tension test is required, is also specified in the procedure. The anchor installers' skills and their strict adherence to the anchor installation instructions are necessary if the anchors are to comply with design requirements and be capable of supporting the design loads.

Quality verification of CM structural anchors is performed by field engineers and documented on the same Post Installed Concrete Anchor Inspection Record used for Q anchors. Structural CM anchors are designed and specified by engineering; anchors that are not called out on engineering drawings as "nonstructural" or "by field" are considered structural. The procedure defines nonstructural anchors as those that attach equipment weighing less than 400 pounds to the floor or on a wall such that the center of gravity of the component is no more than 4 feet above the floor or platform level, or those that attach wall- or ceiling-mounted components weighing 20 pounds or less. The installation methods and specifications are the same for both structural and nonstructural CM anchors, but their inspection and documentation requirements differ. The procedure does not require field engineer involvement in installation of nonstructural anchors. It specifically states that inspection, test, and acceptance criteria apply only to structural CM anchors and requires craft supervision to monitor installation of nonstructural CM anchors to ensure compliance with design requirements. The procedure implies that nonstructural CM anchors do not require documentation of anchor size, location, and installation data.

When Revision 5 of Specification No. 24590-WTP-3PS-FA02-T0004, Installation and Testing of Post Installed Concrete Anchors and Drilling/Coring of Concrete, was issued on July 19, 2010, Appendices C and D, which contain the anchor installation and acceptance criteria, were inadvertently removed from the Specification. Design Engineering issued DCN 24590-WTP-3PN-FA02-00026 on October 12, 2010, to reinsert these two appendices. On September 21, 2011, BNI issued Project Issues Evaluation Report (PIER) number 24590-WTP-PIER-MGT-11-0918-C, Post Installed Concrete Anchor (PICA) Documentation, with an action item to review the PICA records to determine whether the missing Appendices C and D affected the PICA documentation and installation records. Independent Oversight noted that the data from Appendices C and D was still listed in Construction Procedure 24590-GPP-CON-3205, Post Installed Concrete Anchors. This procedure describes the process for PICA installation, contains the instructions that construction craft personnel use for installing PICAs, and specifies the inspection criteria utilized by field engineers and QC inspectors. Before PIER number 24590-WTP-PIER-MGT-11-0918-C was issued, the DOE-WTP staff observed, during review of records for CM pipe supports, that some data on the CM Post Installed Concrete Anchor Inspection Records was incomplete.

The action item for PIER number 24590-WTP-PIER-MGT-11-0918-C required review of the PICA records for all anchors installed between July 19, 2010 (the date when Revision 5 of Specification No. 24590-WTP-3PS-FA02-T0004 was issued) and May 2012. After completing this review, field engineering determined that additional actions were necessary to resolve PICA documentation and installation issues. The review of the PICA records identified one new concern, in that incorrect tension loads may have been applied when testing the completed installation of some PICAs. BNI also concluded that reviewing the PICA records was not sufficient to resolve the documentation issues, but actual physical inspections of PICA installations were required. BNI issued PIER Number 24590-WTP-PIER-MGT-12-1246-B, Rev. 0, Post Installed Anchor Bolt Installation and Documentation, to perform additional actions to resolve questions concerning installation of the CM PICAs and the PICA installation records. These actions included reviewing the construction installation procedure, performing walkdown inspections to examine installed PICAs, and reviewing PICA installation records. A causal analysis and extent-of-condition review are also being performed as required by the BNI Corrective Action Management procedure (Procedure number 24590-WTP-GPP-MGT-043) for "B" level PIERs. These actions are ongoing.

Independent Oversight reviewed 43 CDRs issued between October 24 and November 29, 2012, documenting and dispositioning deficiencies identified in installation of more than 300 CM PICAs in the LAB and BOF facilities. Of these 43 CDRs:

- 20 CDRs documented components supported by CM PICAs that did not meet the minimum embedment depth specified in Construction Procedure 24590-GPP-CON-3205.
- 8 CDRs documented components supported by CM PICAs with spacing violations in that the PICAs were installed too close together, too close to an embed plate, or too close to a conduit or other hardware item embedded in the concrete structure. The minimum spacing between adjacent PICAs or between a PICA and embedded hardware item or concrete edge is specified in Construction Procedure 24590-GPP-CON-3205.
- 3 CDRs documented components supported by PICAs whose diameter was smaller than shown on the design drawings.
- 3 CDRs documented cases where the head of the PICA had been cut to shorten the projection of the anchor, but the embedment was not recorded prior to cutting. Since cutting the head removes the anchor length identification code, the procedure requires the embedment length to be recorded prior to cutting. Ultrasonic tests had to be performed to determine the embedment of PICAs with the cutoff heads; these tests can accurately record the length of an installed anchor.
- 3 CDRs documented components supported by PICAs with a combination of minimum embedment and spacing violations.
- 2 CDRs documented cases where PICAs were installed using the incorrect torque.
- 4 CDRs documented PICAs with other installation errors.

Disposition of the CDRs was as follows: 7 CDRs were closed after the nonconforming PICAs were replaced/repaired; 5 CDRs were still being evaluated by Design Engineering; and the remaining 31 CDRs were evaluated and determined to be acceptable to "use-as-is." PICAs that were not installed in accordance with design requirements were evaluated by Design Engineering on a case by case basis. Design Engineering specified a reduced load-carrying capacity for nonconforming PICAs, taking into consideration the actual as-built condition of those anchors. When the actual loads acting on nonconforming PICAs were less than the reduced capacity of the PICAs, the disposition and closeout of the CDR was "use-as-is."

The types of hardware supported by the nonconforming PICAs addressed in the CDRs were pipe supports, instrument racks, transformers, electrical components, conduit and instrument supports, and miscellaneous components. Most of the nonconforming PICAs referenced in the CDRs were classified as structural and required inspection by field engineers. The installation details for these PICAs were shown on design drawings, and Post Installed Concrete Anchor Inspection Records existed to document the installation details. During the current Independent Oversight review, BNI was in the process of determining corrective actions to address the PICA installation errors, including the extent of condition and actions required to prevent recurrence. Independent Oversight concluded that the installation errors may have resulted from dependence on the skill of the craft for installation of nonstructural anchors, with little involvement of field engineering; confusing instructions on distinguishing structural from nonstructural anchors; errors by field engineering in inspection and documentation of CM PICA installations; inadequate training of field engineers and craft personnel; and/or lack of oversight of CM PICA installations by either QA or QC personnel.

Control of Field Changes

During the construction process, issues often arise that require changes to design documents – for example, interferences where hardware cannot be installed as shown on the design drawings, drawing errors, errors in specifications, fabrication errors, and changes to materials or hardware. All changes to design documents, including drawings, specifications, and procurement documents, require review and approval by the Design Engineering organization. The process for preparation, review, and approval of proposed changes to design documents is specified in Construction Procedure 24590-GPP-CON-3103, Rev. 11, *Field Changes*. Independent Oversight discussed the process for preparation and review of field changes with the Manager of Field Engineering. When the need for a field change is identified, a field engineer prepares a field change request, which is submitted to the lead discipline field engineer for review and concurrence. The field change is then transmitted to Design Engineering for review and approval. Field changes are subject to design control measures, including design verification, commensurate with those applied to the original design. All field changes except pre-approved Field Change Notices (FCNs) require approval by Design Engineering prior to implementation; pre-approved FCNs are listed in Appendix 3 of Procedure 24590-GPP-CON-3103.

Field engineers also review NCRs and CDRs and recommend the disposition and corrective actions to resolve the identified problem. A CDR or NCR dispositioned "use-as-is" or "repair" is considered a potential design change and requires the approval of Design Engineering. Independent Oversight reviewed a sample of NCRs and verified that those with the recommended disposition "use-as-is" or "repair" had been reviewed and approved by Design Engineering. Independent Oversight also determined that the CDRs discussed above, under Post Installed Concrete Anchors, had been transmitted to Design Engineering for resolution. Independent Oversight concluded that the process for control and approval of field changes was adequate.

Management and Independent Assessment Programs

Independent Oversight reviewed the BNI management assessment and independent assessment programs that are implemented to comply with the DOE QA program requirements specified in Criteria 9 and 10 of 10 CFR 830.122 and DOE Order 414.1C. The BNI Quality Assurance Manual describes the assessment processes for monitoring QA activities. These processes include management assessments, self-assessments, audits, and surveillances. Independent Oversight reviewed the BNI procedures that implement the management assessment and independent assessment programs, reviewed tables listing completed management and independent assessments, and reviewed a sample of completed independent and management assessments.

Review of Implementing Procedures. Independent Oversight reviewed the procedures that describe and implement the management and independent assessment programs. The procedures and the programs they address are:

- Construction Procedure 24590-GPP-MGT-036, Rev. 2, *WTP Self Assessment*, describes a process for managers and employees to use to perform self-critical evaluations of their work processes and activities. Managers and employees use this procedure to ensure that work is being performed as expected and to monitor work results to ensure that completed work meets project requirements.

Self-assessments can be conducted by individuals or teams who are assigned by the responsible manager to perform the self-assessment in a particular subject area. Lines of inquiry are developed to address the scope of the self-assessment, which is conducted by observing work in progress, conducting interviews and document reviews, and/or collecting and evaluating data.

- Construction Procedure 24590-GPP-MGT-38, Rev. 3, *WTP Project Manager Assessment*, describes a management-directed evaluation process with the goal of identifying barriers to successful completion of the WTP project. The Project Manager, with assistance from other responsible managers, conducts the management assessment in an effort to identify systemic conditions, organizational weaknesses, or error-contributing factors that need to be addressed.

- Construction Procedure 24590-GPP-QA-501, Rev. 10, *Audit (Independent Assessment)*, describes the methods for scheduling, planning, and performing audits. Audits are performed to determine compliance with procedures, determine the effectiveness of implementation of procedure requirements in performing work activities, and identify opportunities for improvement. Audits are independent assessments performed by individuals who do not have responsibility for the activities being audited. Audit personnel are required to have sufficient authority and organizational freedom to perform meaningful and effective audits. Technical specialists or subject matter experts are assigned to the audit teams when the scope or complexity of the work activity being audited warrants assistance from a technical standpoint.

- Construction Procedure 24590-GPP-QA-601, Rev. 6A, *Quality Assurance Surveillance*, describes the process used to plan, conduct, and document surveillances of activities. Surveillances are normally conducted by the site QA organization. They are generally limited in scope – for example, observation of a work activity, and/or document reviews. Surveillances are planned and scheduled to provide coverage of ongoing work activities at a frequency commensurate with the status and importance of the work.

Management and Independent Assessment Schedule. Independent Oversight reviewed tables listing reports documenting management assessments, self-assessments, audits, and surveillances completed since 2008, as well as selected various reports relating to construction activities. These included project management assessments, self-assessments performed by various organizations, QA surveillances, and QA audits/independent assessments.

The QA audits and surveillances covered in-progress work activities based on a graded approach to safety significance for ongoing work and disciplines performing work at the WTP site. The audits/independent assessments were performed by personnel not directly involved in the work activity being audited. Technical specialists or subject matter experts were used on audit teams when appropriate. Most members of the audit/independent assessment teams were from an offsite QA office. The QA audits performed by BNI were effective in identifying deficiencies in the area reviewed, and BNI QA was effective in performing follow-up audits to ensure implementation and completion of corrective actions. QA surveillances are normally performed by the onsite QA staff. After reviewing the completed surveillance reports listed in the BNI database, Independent Oversight determined that surveillances have been performed in numerous work areas, including those performed by subcontractors.

Self-assessments provide opportunities to identify problems with work processes and completed work activities. Independent Oversight reviewed the implementation of the self-assessment program in the QC and field engineering organizations. The QC organization has performed periodic self-assessments to review implementation of the QC program, and PIERs were initiated to document and disposition findings identified during QC self-assessments. Records documenting completed self-assessments suggest that the field engineering organization may not have performed any organizational self-assessments of implementation of their work processes (procedures) and completed work activities since at least 2008. Field engineering personnel conducted a limited self-assessment to review procedures controlling the construction turnover process in May 2012, and the field engineering organization performs a broad annual assessment of the construction quality program that addresses the program requirements for document control, material control, QC, nonconformance control, measuring and test equipment control, training, records retention, and subcontractor control. Several self-assessments were also performed on a quarterly basis to review completed records for pipe supports. However, no self-assessment has been performed to evaluate installation of PICAs, and there are no documented self-assessments that evaluate the implementation of the welding program, except in response to a DOE-WTP finding. Independent Oversight will perform additional review of self-assessment reports to determine whether BNI is implementing the self-assessment program in accordance with DOE QA program requirements.

Concrete Placement Activities

There were no Q concrete placements during the current review. Concrete placement activities have been deferred in the PTF, with the exception of basemat placements for the PTF Control Room, due to design and process questions. Concrete placement continues in the HLW facility, but at a slow pace due to reductions in construction craft staffing. Independent Oversight reviewed the results of QC tests performed on concrete samples from five Q concrete placements in the HLW facility and one PTF basemat placement completed between August 22 and November 1, 2012. These tests included slump, temperature, and unit weight testing of the freshly mixed concrete and unconfined compression tests on concrete cylinders cured in the concrete laboratory for 3 to 28 days. The concrete design strength is based on the unconfined compression strength of concrete cylinders. The cylinders are either 4 inches in diameter and 8 inches high or 6 inches in diameter and 12 inches high. The concrete strength is determined by casting samples of concrete in cylindrical molds, moist-curing the samples in a field laboratory for a specified period, and then subjecting them to an unconfined compression test. The design strength at WTP is typically based on concrete test cylinders cured in the laboratory for 28 days. The results of the unconfined compression tests are used to verify the concrete quality and demonstrate that the concrete meets the design strength requirements. The methods for sampling the concrete, casting and curing the cylinders, and performing the unconfined compression tests are specified in ASTM International (ASTM) standards. At WTP, the unconfined compression strength of the concrete at 28 days generally exceeds the specified design strength by 1000 psi or more for all classes of structural concrete. The quality of concrete for the WTP project has been good.

Pressure Testing of Piping

Independent Oversight observed one pneumatic pressure test and two hydrostatic pressure tests on piping. The pneumatic pressure test was performed on a section of the LAB Radioactive Liquid Waste Disposal System, which is classified as Q. The hydrostatic pressure tests were performed on CM piping in the cross-connection piping between the fire service water supply tanks and on a section of the LAB Radioactive Liquid Waste Disposal System. The WTP site work process for conducting leak testing is specified in Construction Procedure 24590-WTP-GPP-CON-3504, Rev. 8a, *Pressure Testing of Piping, Tubing and Components*.

Independent Oversight 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 piping within the test boundary. During the pre-job briefings, the following items were discussed: safety guidelines, emergency plan, the size and setting of the pressure relief valve, test sequence, test boundaries, test pressure, system pressurization and depressurization, inspection activities, and work completion. The pressure test and inspection boundaries were shown on marked-up piping and instrumentation diagrams (P&IDs), and the attached valve lineup sheets listed the test valve position and referenced test plug or blind flange locations. The locations of limited access/safety barriers were established in accordance with procedure requirements by calculating stored energy.

Pressure Test Package 24590-BOF-PUPIR-CON-12-0041 included the test data sheets, test information, test requirements, valve lineup sheets, and marked-up P&IDs for the hydrostatic pressure test performed on the cross-connection piping between the two fire service water tanks. The applicable code is the National Fire Protection Association (NFPA) Code. The required hold time was 2 hours at a pressure of 225 pounds per square inch (psi). Since the test pressure gauges were located at same level as the portion of piping being tested, it was not necessary to adjust the test pressures to compensate for the elevation (head) difference between the location of the pressure gauge and the highest elevation of the piping being tested. Independent Oversight verified that the calibration stickers on the test pressure gauges were current and that whip restraints were installed on pressure hoses. The walkdowns and inspections of the piping were performed only by field engineering personnel, since the tested piping was classified as CM. Independent Oversight witnessed the walkdown inspection and reviewed the test data sheets, which recorded the test information, test requirements, required signoffs for pre-test reviews, documentation of measuring and test equipment used, and test results. The few leaks that were detected in mechanical connections were repaired by tightening fittings and/or flanges. There were no leaks in welded joints. The test was declared acceptable.

Pressure Test Package 24590-LAB-PPTR-CON-12-0072 included the test data sheets, test information, test requirements, valve lineup sheets, and marked-up P&IDs for the hydrostatic pressure test performed on piping classified as CM in a portion of the LAB Radioactive Liquid Waste Disposal System piping. The applicable code is ASME Code B31.3, Paragraph 345.4, Hydrostatic Testing. The test pressure gauge was located above the portion of the piping being tested, so no adjustment was necessary to compensate for the elevation difference between the gauge and the high point on the piping being tested. The test pressure was 30 psi, with a specified hold time of 10 minutes. Independent Oversight verified that the calibration stickers on the test pressure gauges were current and that whip restraints were installed on pressure hoses. The walkdowns and inspections of the piping were performed by field engineering personnel. The test was declared acceptable.

Pressure Test Package 24590-LAB-PPTR-CON-12-0074 included the test data sheets, test information, test requirements, valve lineup sheets, and marked-up P&IDs for the pneumatic pressure test performed on piping in a portion of the LAB Radioactive Liquid Waste Disposal System piping. The applicable code is ASME Code B31.3, Paragraph 345.5, Pneumatic Testing. Piping within the test boundaries included both Q and CM piping. The pressure test and inspection boundaries were shown on marked-up P&IDs, and the attached valve lineup sheet listed the test valve position and referenced test plug or blind flange locations. The locations of limited access/safety barriers were established in accordance with procedure requirements by calculating stored energy. Independent Oversight verified that the calibration stickers on the two test pressure gauges were current and that whip restraints were installed on pressure hoses. Independent Oversight observed pressurization of the system to 10 percent above the 50 psi design pressure (55 psi), observed the minimum 10-minute hold time (an overpressure of 56 psi was actually held for 11 minutes), and witnessed the system walkdown and leak testing of pipe joints. The walkdowns and inspections of the joints and welds in the Q portions of the piping being tested were performed by both QC inspection and field engineering personnel, as required by the test procedure, while the leak checks in the CM piping were performed by field engineering. (WTP site procedures do not require QC inspectors to perform inspections of CM components.) No leaks were detected, and the test was declared acceptable. Independent Oversight reviewed the test data sheets, which recorded the test information, test requirements, required signoffs for pre-test reviews, documentation of measuring and test equipment used, test results, and test acceptance by field engineering and QC.

The pressure tests witnessed by Independent Oversight were completed in accordance with the requirements of Construction Procedure 24590-WTP-GPP-CON-3504, Rev. 8A.

Follow-up Review of the Structural Steel Installation Procedure

Procedure 24590-WTP-GPP-CON-3206, *Structural Steel Installation and On-Site Fabrication*, was revised and re-issued as Revision 4A, with an effective date of February 28, 2012. During a review of Revision 4A of this procedure in May 2012, Independent Oversight identified discrepancies in the instructions for completing several of the data sheets in the appendices of the procedure and noted correction of these discrepancies as an opportunity for improvement. During the current review, Independent Oversight examined Revision 5 of the procedure, which went into effect on September 27, 2012, and concluded that the discrepancies have been corrected.

Pre-Installation Verification Testing of Tension Control Structural Steel Bolts

Procedure 24590-WTP-GPP-CON-3206, *Structural Steel Installation and On-Site Fabrication*, requires bolts used in structural steel connections to undergo pre-installation verification testing per American Institute of Steel Construction (AISC) 348-00, *Specifications for Structural Joints Using ASTM A325 or A490 Bolts*. The verification tests are performed to demonstrate that fastener assemblies (bolts, nuts, and washers) and the installation method provide the minimum bolt pre-tension value specified in Table 8.1 of AISC 348-00. The testing also demonstrates that the fastener components comply with the requirements of applicable ASTM specifications and provides a practical method for ensuring that nonconforming fastener assemblies are not incorporated into the project. To allow for variations in fastener hardware and the cumulative effects of tolerances, the minimum verification test acceptance criterion is 1.05 times the pre-tension values specified in Table 8.1. AISC 348-00 requires that a minimum representative sample of three complete fastener assemblies of each diameter, length, grade, and lot be subjected to verification testing. Most of the bolts used in structural steel joints at WTP are twist-off type tension control (TC) bolts with splined ends. Proper bolt tension is achieved when the splined end is severed from the bolt when the bolt is tightened. The directions for performing pre-installation verification tests of TC bolts are specified in Section 2.2 of Appendix 8 of Procedure 24590-WTP-GPP-CON-3206.

Independent Oversight reviewed the results of pre-installation tests performed on four lots of 1-1/8 inch diameter ASTM Grade A490 TC bolts and five lots of 7/8 inch diameter ASTM Grade A325 TC bolts. The bolts were tested using a Skidmore Bolt Tension Calibrator, which measures the tension in a bolt when the nut on the bolt is tightened. For TC bolts, the tension is measured when the spline is severed. All the 7/8 inch diameter ASTM Grade A325 bolts that were tested exceeded the minimum test acceptance value of 41 kips (1.05 x 39 kips, from Table 8.1). (A kip is 1000 pounds-force.) The 1-1/8 inch diameter ASTM Grade A490 bolts from three of the lots exceeded the test acceptance criteria of 84 kips (1.05 x 80 kips, from Table 8.1). One of three bolts in the remaining lot of 1-1/8 inch diameter ASTM Grade ASTM A490 bolts did not meet the minimum acceptance value. In accordance with Section 2.1 of Appendix 8, Sample Failure Actions, which specifies the procedure to be followed when a bolt from the initial lot fails to meet the acceptance criteria, a sample of three additional fasteners was selected from this lot and tested. Two of the three additional bolts failed the test. Nonconformance Report 24590-WTP-NCR-CON-12-0185 was initiated to disposition the TC bolt tension test failures. None of the bolts from this lot had been installed. Corrective actions were to identify the kegs of nonconforming bolts and segregate them in the storage area to be scrapped or returned to the vendor.

Material Condition and Protection of Installed Equipment and Facilities

Independent Oversight, accompanied by DOE-WTP personnel, toured the HLW to examine ongoing construction activities and the protection provided for installed equipment. The overall material condition of installed equipment was good. Instrumentation and instrument panels were wrapped in protective covers, and the mechanical equipment, such as cranes and motors, was covered and protected from construction activities. During an August 2012 review, Independent Oversight identified that approximately a dozen stainless steel pipes that penetrate concrete walls were missing the protective covers on the pipe ends; the protective caps are intended to prevent internal contamination of the permanent piping. During the current review, Independent Oversight noted that the missing protective covers had been replaced. New TC bolts were stored in a dry, protected storage area in the HLW. The kegs of nonconforming bolts discussed above, under Pre-Installation Verification Testing of Tension Control Structural Steel Bolts, were identified and segregated in the storage area to prevent inadvertent installation.

6.0 CONCLUSIONS

Independent Oversight determined that construction quality at WTP is adequate in the areas that were reviewed. BNI Engineering has developed appropriate corrective actions to disposition the NCRs and CDRs that Independent Oversight reviewed. Changes to design documents are controlled as required by established design control measures and DOE QA regulations. Concrete quality is good. The program for pressure testing of installed piping is adequate. Verification testing of new structural steel bolts is performed in accordance with recommended AISC code practices. BNI is in the process of evaluating corrective actions necessary to address errors in installation of PICAs. Records of self-assessments performed by field engineering and other BNI construction organizations require additional review to determine whether the self-assessment program is being properly implemented in accordance with DOE QA program requirements.

7.0 ITEMS FOR FOLLOW-UP

Independent Oversight will continue to follow up on inspection of piping, pipe supports, installation of mechanical equipment, and activities related to pressure testing of piping. Independent Oversight will also review corrective actions to address discrepancies identified in the PICA installation process and will perform additional review of self-assessments.

Appendix A
Supplemental Information

Review Dates

November 26-30, 2012

Office of Health, Safety and Security Management

Glenn S. Podonsky, Chief Health, Safety and Security Officer
William A. Eckroade, Principal Deputy Chief for Mission Support Operations
John S. Boulden III, Director, Office of Enforcement and Oversight
Thomas R. Staker, Deputy Director for Oversight
William E. Miller, Deputy Director, Office of Safety and Emergency Management Evaluations

Quality Review Board

William Eckroade
John Boulden III
Thomas Staker
William Miller
Michael Kilpatrick
George Armstrong
Robert Nelson

Acting Independent Oversight Site Lead for Hanford Site

William Miller

Independent Oversight Team Composition

Joseph Lenahan

Appendix B
Documents Reviewed

- DOE-WTP Surveillance Reports for August and September 2012
- Construction Procedure 24590-WTP-GPP-CON-3503, Rev. 6A, Aboveground Piping Installation, November 20, 2012
- Construction Procedure 24590-WTP-GPP-CON-3509, Rev. 2C, Pipe Support Installation, July 11, 2012
- Construction Procedure 24590-WTP-GPP-CON-3504, Rev. 8A, Pressure Testing of Piping, Tubing and Components, September 6, 2012
- Construction Procedure 24590-WTP-GPP-CON-3206, Rev. 5,Structural Steel Installation and Onsite Fabrication, September 27, 2012
- Construction Procedure 24590-GPP-CON-3205, Rev. 3C, Post Installed Concrete Anchors, October 17, 2012
- Specification No. 24590-WTP-3PS-FA02-T0004, Rev. 5, Engineering Specification for Installation and Testing Post Installed Concrete Anchors and Drilling/Coring of Concrete, July 19, 2010
- Specification Change Notice, Document No. 24590-WTP-3PN-FA02-00026 dated October, 12, 2010, to Specification No. 24590-WTP-3PS-FA02-T0004, Rev. 5, to reinsert Appendices C and D, which had been deleted in error from Revision 5 of Specification No. 24590-WTP-3PS-FA02-T0004.
- Construction Procedure 24590-GPP-MGT-043, Rev. 4, Corrective Action Management, September 26, 2012
- Construction Procedure 24590-GPP-MGT-044, Rev. 1A, Nonconformance Reporting and Control, February 28 , 2012
- Construction Procedure 24590-GPP-CON-3103, Rev. 11, Field Changes, May 17, 2012
- Construction Procedure 24590-GPP-MGT-036, Rev. 2, WTP Self Assessment, October 8 , 2012
- Construction Procedure 24590-GPP-MGT-38, Rev. 3, WTP Project Manager Assessment, October 18, 2012
- Construction Procedure 24590-GPP-QA-501, Rev. 10, Audit (Independent Assessment), January 17 , 2012
- Construction Procedure 24590-GPP-QA-601, Rev. 6A, Quality Assurance Surveillance, May 14, 2012
- Design Guide 24590-WTP- GPG-M-017, Rev. 9C, Design Parameters & Test Pressures for Equipment & Piping, April 9, 2012
- Document No. 24590-WTP- QAM-QA-06-001, Rev. 11, Quality Assurance Manual, July 30, 2012
- Nonconformance Report 24590-WTP-NCR-CON-12-0185, Tension Control Bolts Failed the Pre-Installation Verification Process
- Construction Deficiency Reports for nonconforming Post Installed Concrete Anchors, numbers 24590-WTP-CDR-CON-12-0411, -0432, -0434, -0436 through -0438, -0443 through -0449, -0464, -0474, -0481,-0498, -0499, -0536,-537, -0540, -0558, -0560 through -0563, -0565 through -0567, -0574 through -0577, -0579, -0583, -0585, -0587, -0595, -0598, -0607, -0608, 0613, and -0615.
- PIER Number 24590-WTP-PIER-MGT-11-0918-C, Rev. 0, Post Installed Concrete Anchor (PICA) Documentation, identified September 21, 2011
- PIER Number 24590-WTP-PIER-MGT-12-1246-B, Rev. 0, Post Installed Anchor Bolt Installation and Documentation, identified October 16, 2012
- Construction Deficiency Reports numbers 24590-WTP-CDR-CON-12-0425 through -0449, and 24590-WTP-CDR-CON-12-0550 through -0614. Note: Some CDRs for PICAs listed above are also included.

- Nonconformance Report numbers 24590-WTP-NCR- CON-12-0139 through -0221, and 24590-WTP-NCR-CON-12-0223 through -0229. Note: Number 24590-WTP-NCR-CON-12-0222 was not issued.
- WTP Project Manager Assessment Report 24590-WTP-MAR-PM-10-0005, NCR/CDR Program Assessment
- WTP Management Assessment Report 24590-WTP-SAA-MGT-11-0004, NCR/CDR Program Assessment
- WTP Self Assessment Report 24590-WTP-SAR-CON-12-0007, Assessment of Construction Assessment Program
- WTP Self Assessment Report 24590-WTP-SAR-CON-12-0009, Self Sponsored Assessment in Quality Control
- WTP Self Assessment Report 24590-WTP-SAR-CON-12-0011, In-Process Welding Documentation Assessment
- WTP Self Assessment Report 24590-WTP-SAR-CON-12-0018, Quarterly Piping Record Review
- WTP Self Assessment Report 24590-WTP-SAR-CON-12-0021, Construction Turnover to Startup Readiness
- Quality Assurance Internal Audit Report 24590-WTP-IAR-QA-12-0009, Construction Quality Control
- Quality Assurance Internal Audit Report 24590-WTP-IAR-QA-10-0007, WTP Engineering Processes
- Quality Assurance Internal Audit Report 24590-WTP-IAR-QA-10-0004, Field Requisitions
- Quality Assurance Internal Audit Report 24590-WTP-IAR-QA-09-0013, Internal Audit of the Third Party Independent Inspection Program
- QA/QC Surveillance Report 24590-WTP-SV-QA-12-0085, Drillco Maxi-Bolt Installation for Electrical Panel Supports at the LAW +28 Foot Elevation
- Quality Assurance Internal Audit Report 24590-WTP-IAR-QA-08-0019, WTP Graded Approach
- Storage and Maintenance Surveillance 24590-WTP-SV-MATL-12-058, Verification Non-Q Temporary Erection Bolts Painted
- Storage and Maintenance Surveillance 24590-WTP-SV-MATL-12-062, Civil Structural Laydown Areas
- Drawing Number 24590-LAB-M6-RLD-00008001, Rev. 0, P&ID-LAB Radioactive Liquid Waste Disposal System C5 Leak Detection Boxes (Marked up for system pressure test, Document No. 24590-LAB-PPTR-CON-12-0074)
- Drawing Number 24590-LAB-M6-RLD-00008002, Rev. 0, P&ID-LAB Radioactive Liquid Waste Disposal System C5 Drain Collection System (Marked up for system pressure test, Document No. 24590-LAB-PPTR-CON-12-0074)
- Drawing Number 24590-LAB-M6-RLD-00006001, Rev. 1, P&ID-LAB Radioactive Liquid Waste Disposal System C3 Rad Lab Collection System (Marked up for system pressure test, Document No. 24590-LAB-PPTR-CON-12-0072)
- Drawing Number 24590-BOF-M6-FSW-00002, Rev. 5, P&ID-BOF Fire Service Water System (Partial detail marked up for system pressure test, Document No. 24590-LAB-PUPIR-CON-12-0041)
- Drawing Number 24590-BOF-M6-FSW-00003, Rev. 5, P&ID-BOF Fire Service Water System (Partial detail marked up for system pressure test, Document No. 24590-LAB-PUPIR-CON-12-0041)
- Drawing Number 24590-BOF-M6-FSW-00004, Rev. 6, P&ID-BOF Fire Service Water System (Partial detail marked up for system pressure test, Document No. 24590-LAB-PUPIR-CON-12-0041)