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

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Acronyms

AISC	American Institute of Steel Construction
AFI	Assessment Follow-up Item
ASME	American Society of Mechanical Engineers
BC	Black Cells
BNI	Bechtel National, Incorporated
CDR	Construction Deficiency Report
CM	Commercial Grade
DOE	U.S. Department of Energy
DOE-WTP	DOE ORP Waste Treatment Plant Division
HLW	High-Level Waste Facility
HTR	Hard-To-Reach Areas
LAB	Analytical Laboratory
LAW	Low-Activity Waste Facility
NCR	Nonconformance Report
NDE	Nondestructive Examination
NQA	Nuclear Quality Assurance
ORP	Office of River Protection
PIER	Project Issues Evaluation Report
PT	Liquid Penetrant Examination
PTF	Pretreatment Facility
Q	Quality Related
QA	Quality Assurance
QC	Quality Control
RT	Radiographic Examination
SSC	Structures, Systems, and Components
UT	Ultrasonic Examination
VT	Visual Inspection
WTP	Waste Treatment and Immobilization Plant Project

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1.0 PURPOSE

The 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 Waste Treatment and Immobilization Plant Project (WTP). The independent oversight review, which was performed September 12-15, 2011, was the latest in a series of ongoing quarterly assessments of construction quality at the WTP construction site. Appendix A provides supplemental information about the independent oversight review.

2.0 BACKGROUND

The U.S. Department of Energy (DOE) Office of River Protection (ORP) was established in 1998 to manage the 53 million gallons of liquid or semi-solid radioactive and chemical waste stored in 177 underground tanks at the Hanford Site. ORP consists of two organizations: the Tank Farm Division, which maintains the 177 underground storage tanks, and the WTP Division, which is responsible for retrieval, treatment, and disposal of the waste stored in the underground tanks. WTP is an industrial complex for separating and vitrifying the radioactive and chemical waste stored in the underground tanks. The WTP complex consists of five major components: the Pretreatment Facility (PTF) for separating the waste, the High-Level Waste (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-plant facilities that will house support functions. WTP is currently in the design and construction phase. Design and construction activities at WTP are managed by Bechtel National, Incorporated (BNI) under contract to the DOE ORP. Construction oversight is provided by the DOE-WTP staff in the 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.

3.0 SCOPE

The scope of this independent oversight review encompassed various topics, including concrete placement activities, review of the welding inspection program for installation of piping and pipe supports in the black cells (BC) and hard-to-reach (HTR) areas, and review of records documenting training and qualification of welding engineers and quality control (QC) inspectors. A sample of nonconformance reports (NCRs) and construction deficiency reports (CDRs) identified by BNI under its corrective action program was reviewed. Independent oversight also examined structural steel erection activities and BNI's corrective action to resolve an earlier finding regarding deficiencies in the installation of structural steel bolts.

Independent oversight reviewed various construction quality documents and conducted several construction site walkthroughs, concurrent with DOE-WTP staff. During the walkthroughs, the independent oversight team observed four concrete placements and examined structural steel erection activities. Independent oversight examined drawings, specifications, and procedures that control concrete placement activities, piping and pipe support inspection activities, and structural steel erection activities.

4.0 RESULTS

Nonconformance reports and construction deficiency reports. NCRs are issued to document and disposition nonconforming conditions involving quality-related (Q) structures, systems, and components (SSC). Q components, previously designated QL, are constructed or manufactured in accordance with the WTP quality assurance (QA) program, which is based on the American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance standard (NQA-1). CDRs are issued to document and disposition nonconforming conditions for SSC that are constructed or manufactured as commercial items. Commercial grade (CM) components are purchased from vendors that are qualified as CM suppliers, but do not have a QA program that complies with ASME NQA-1. Evaluation for listing as a CM supplier requires assessment of the vendor's QA program against selected QA criteria designated by BNI engineering. Independent oversight reviewed the 109 NCRs issued by BNI from May 12 through September 14, 2011, and a sample of CDRs, to determine the type of nonconforming issues that were identified and subsequent mechanisms for resolution.

Approximately 50 percent of the NCRs were issued to resolve equipment and hardware procurement problems, including approximately 34 that were issued to document incorrectly fabricated structural steel members. The fabrication errors were generally minor (e.g., incorrectly drilled holes or incorrectly installed gusset plates) and were corrected on site by the WTP contractor. Other examples of procurement problems included hardware/components that were delivered to the site without the required supporting documentation demonstrating compliance with purchase specifications, and hardware/equipment that did not comply with project specification requirements. A large number of the procurement-related NCRs reviewed by independent oversight documented deficiencies involving hardware/components that had been delivered to the project several years ago. Several NCRs documented the disposition of 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 involved rework performed on site, or in some cases, the hardware was returned to the vendor. The CDRs reviewed by independent oversight covered a variety of issues including procurement problems, installation errors, and minor damage to installed equipment. The implementation of the NCR/CDR processes adequately resolved procurement and construction quality deficiencies.

Welding inspection program for piping and pipe supports in BC and HTR areas. Project areas identified as BC and HTR will be inaccessible after plant startup due to high radiation. BC are shielded rooms for which no maintenance or entry is planned for the 40-year design life of the plant. HTR areas are designated because of location and difficulty of performing maintenance or repairs. There are no valves in the BC areas, and no inaccessible valves in the HTR areas. Welded construction is used for all piping and vessels in these areas. The nondestructive examination (NDE) requirements for all BC and HTR piping welds are summarized in Table 7 of Engineering Specification 24590-WTP-3PS-PS02-T0003, *Field Fabrication and Installation of Piping*. A visual inspection (VT) is required for all welds, in addition to either radiographic examination (RT), ultrasonic examination (UT), or liquid penetrant examination (PT), depending on the weld type. All manufacturer-produced longitudinal seam welds on piping installed in BC and HTR areas are required to be examined using either RT or UT.

Training and qualifications of field welding engineers and special processes – welding, QC inspectors. Quality verification activities are activities used to verify the quality of construction installation activities by monitoring, witnessing, inspecting, or testing. Field welding engineers are responsible for performing quality verification of CM piping and pipe support installations to ensure design requirements are met. QC inspection personnel are responsible for performing quality verification of Q piping and pipe support installations to ensure design requirements are met.

The requirements for qualification and certification of field welding engineers and QC inspectors in NDE methods are established in Bechtel Construction Procedure 24590-WTP-MN-CON-01-001-10-22, *NDE Personnel Qualification and Certification NEPQ*. The levels of qualification, duties, and responsibilities specified in the Bechtel procedure are based on the American Society for Nondestructive Testing, Recommended Practice SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*. The procedure specifies physical requirements, which include an annual exam for visual acuity, education, training, and experience. To be certified, all individuals are required to pass a three-part examination administrated by the BNI WTP site Level III Examiner that covers the general, specific, and practical aspects of the NDE method. In addition, QC inspection personnel are certified to the requirements of Construction Procedure 24590-WTP-GPP-CON-7106, *Quality Control Personnel Certification*, which establishes additional education and experience requirements.

HSS reviewed the records documenting qualification and certification of 5 field welding engineers currently assigned to the PTF and 7 QC inspectors certified in the Special Processes - welding and/or piping/mechanical disciplines. These records included attendance at training courses, documented work experience, and practical and written examination results. In addition, several of the field welding engineers and QC inspectors are also Certified Welding Inspectors in VT by the American Welding Society. Overall, the average training and experience level is higher for the QC inspectors. Six of the QC inspectors were certified as VT Level II, while the remaining one was certified as Level III in VT, RT, PT, and UT. The qualifications of the QC inspectors meet or exceed ASME NQA-1 requirements.

Concrete placement activities. Independent oversight observed portions of four concrete placements. These concrete placements included wall numbers 3137, 3137A, and 3138, elevation 37.0’ to 41’ 10”, in the HLW building and wall number 0535, elevation 77’ to 97’, in the PTF facility. Independent Oversight observed QC testing of fresh concrete for slump, temperature, and unit weight; review of concrete batch tickets by QC inspection personnel; placement of the concrete in the forms; and consolidation of the concrete.

HSS reviewed the concrete pour cards and verified that they were signed to document all required construction work and that inspections were completed prior to the start of concrete placement. Testing of the concrete was performed in accordance with American Society for Testing and Materials (ASTM) standards specified in the project procedures. Test results showed the delivered concrete met project requirements for slump and temperature. Concrete was sampled and transported to the site concrete laboratory for molding of cylinders for unconfined compression testing. Molding of the cylinders in the lab precludes the necessity of storing the cylinders in curing boxes in the field under controlled environmental conditions. Review of the concrete batch tickets indicated that the proper concrete was being delivered.

Concrete forms were secure and cleaned (debris removed) prior to concrete placement. Equipment to deliver the concrete to the forms was suitable. A sufficient number of vibrators were used for consolidating the concrete. Vibrator operators, other construction craftsmen, and QC inspectors had sufficient access to the placement area. Concrete drop distances were within specification requirements, vibrators were properly used, and excess water did not accumulate in the forms during placement. During

the placement for the walls in the HLW, a periodic calibration check was performed on the concrete vibrators by QC inspectors to ensure that the vibrators were operating at the required frequency. Inspection of the concrete placement operations by BNI inspectors was adequate.

Structural steel construction activities. Most of the structural steel bolts used on the project are twist-off- type tension-control bolts with splined ends. Proper bolt tension is achieved when the splined end is severed from the bolt by the installation crew when the bolts are tightened. During the 2008 independent oversight assessment, a finding, Finding F-2, Structural Steel Bolting Issues, was identified for improper storage of structural steel bolts and failure to mark temporary erection bolts as required by site procedures. The temporary erection bolts are required to be painted yellow, as described in WTP construction procedure 24590-WTP-GPP-CON-3206, Rev. 3D, *Structural Steel Installation and On-Site Fabrication*. On the WTP site, yellow is the standard color used to indicate non-permanent plant material. Corrective actions for this finding included providing a briefing to structural steel installers and supervision on September 28, 2010, detailing requirements for managing incomplete work, with emphasis on painting bolts yellow if steel installation is interrupted and final tensioning is to be deferred. Training was held on August 30, 31, 2010, for civil QC inspectors regarding the need to monitor the structural steel erection process and to be aware when construction and final inspection is interrupted.

During examination of partially assembled structural steel connections in the HLW in November 2010, independent oversight identified a few bolts used as temporary erection bolts that had not been painted to indicate temporary status. The structural steel in these areas had not been inspected or accepted by BNI QC inspectors. This issue was identified to BNI through DOE-WTP as part of the finding regarding two improperly tensioned bolts in the PTF, discussed below.

During this September 2011 current independent review, independent oversight examined ongoing structural steel erection activities in the HLW and PTF buildings. Independent oversight identified four connections in the PTF at elevation 77', column lines N and 5 where permanent bolts had been installed in partially completed connections and had not been tensioned. These bolts were installed in late June 2011, and were not painted to identify them as temporary erection bolts. In the HLW building and the structural steel lay down areas adjacent to the HLW, independent oversight observed approximately 250 beams which had been pre-assembled using permanent bolts. For the most part, the nuts were finger tight on the bolts. However, a large number of pre-assembled beams were found in which the nuts were less than finger tight with the mating surfaces of the steel members not drawn together. In this condition, a portion of the bolt that will be tensioned is not protected from the elements. Some of the nuts were only loosely threaded on the bolts, leaving the threads where the nut would be seated upon tensioning exposed to the elements. This practice could result in deterioration of the lubricant on the bolt assembly prior to tensioning and contamination of the bolt threads with grit, which could then result in the spline severing from the bolt prior to the bolt achieving its designated pre-tension value.

Instructions for installation of the twist-off-type tension-control structural bolts are specified in American Institute of Steel Construction (AISC) 348, *Specification for Structural Joints Using ASTM A325 or A490 Bolts*. This specification requires that bolts and other fastener components be kept in protected storage until they are installed. The Commentary for AISC 348 references the background and provides further explanation of the importance of protected storage for twist-off-type tension-control bolts until final tensioning. The Commentary for Section 7.2, Required Testing, provides background information indicating: (1) That pre-installation testing is performed on as-received nuts and bolts to demonstrate that the twist-off tension bolts will develop the proper tension when the spline is severed; (2) That research has established that installed pretensions of twist-off-type tension-control bolts are affected by environmental conditions of storage and exposure, which could result in severing of the spline before the bolt develops its required pretension value; (3) That condition of fastener assemblies must be replicated in pre-installation verification; and (4) That deterioration of the lubricant due to exposure to the environment

is the primary cause of reduced pretension load. Note 2 of ASTM F 1852-08, *"Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies*, states: "No further lubrication shall be permitted other than that applied by the manufacturer, as the type and amount of lubrication is critical to performance."

The Commentary for Section 8.2.3, Twist-off-Type Tension-Control Bolt Pre-tensioning, states "Twist-off-type tension-control bolt assemblies must be used in the as delivered, clean, lubricated condition as specified in Section 2, (Storage of Fastener Components). Adherence to requirements in this Specification, especially those for storage, cleanliness, and verification, is necessary for their proper use". The Commentary for Section 9.2.3, Inspection of Twist-off Tension-Control Bolts Pretension, emphasizes the importance of limiting the time between the removal from protected storage and final twist-off of the splined end during tensioning.

Project Issues Evaluation Report (PIER) 24590-WTP-PIER-MGT-11-0866, Rev 0, *Bolt up of A325 and A490 Structural Steel Connections*, was issued by BNI to document this condition and to determine whether the method used to pre-assemble beams complies with AISC 348. DOE-WTP issued an assessment follow-up item to document this issue and to perform further review of compliance with AISC 348. Additional testing may be required to demonstrate that twist-off-type bolts exposed to the environment for an extended period of time, as discussed above, achieve their design pretension value prior to severing of the spline.

Follow up on improperly tensioned structural steel bolts. In April 2010, BNI QC inspectors identified six structural steel bolts in the HLW that were not properly tensioned; that is, the six bolts still had the splined ends in place. NCR 24590-WTP-NCR-CON-10-0105 was issued on April 13, 2010, to document and disposition this problem. In November 2010, during a field inspection to determine the effectiveness of BNI corrective actions to resolve this problem, independent oversight and DOE-WTP identified two additional permanent bolts in one connection in the PTF that had not been tensioned (i.e., the splined ends were not severed). BNI issued NCR 24590-WTP-NCR-CON-10-0359 to document and disposition the two deficient PTF bolts. DOE-WTP issued a finding for the improperly tensioned PTF bolts.

During the February and May 2011 site visits, independent oversight reviewed ongoing BNI corrective actions to further investigate and disposition improperly tensioned bolts. Corrective actions included BNI's re-inspection of all accessible bolts in connections in the PTF, HLW, LAW, and LAB facilities to verify that they were properly tensioned. During the May 2011 site visit, BNI's re-inspection of the tensioned structural steel bolts was approximately 90-percent complete. The re-inspection program has now been completed, and a report has been prepared summarizing the results of the re-inspection program. Independent oversight reviewed a draft of the report currently under review by the BNI engineering staff. The bolts on 12,700 connections were re-inspected to verify that they were properly tensioned. Non-tensioned bolts (splined end still in place) were identified on five connections during the re-inspection program. However, these non-tensioned bolts did not include all the bolts in the connection. The number of connections identified with improperly tensioned bolts was less that 0.04 percent of those inspected. The number of improperly tensioned bolts was less than 0.01 percent of the total inspected. An additional 6,200 connections were inaccessible, due to fire protection coatings or access restricted by other completed construction activities, although partial re-inspection of some bolts was possible. Independent oversight will review the final report and the engineering justification for concluding that the bolts in inaccessible connections that were not re-inspected are properly tensioned.

Follow up on inappropriate references in pipe support installation specification. During review of Specification 24590-WTP-3PS-PH01-T0002, Revision 5, *Engineering Specification for Installation of Pipe Supports*, in May 2011, independent oversight noted that references to some ASTM standards for bolt material substitutions appeared to be inappropriate. These inappropriate references had no immediate effect on construction quality but could affect future procurement activities for new supports or

replacement parts. Revision 6 of Specification 24590-WTP-3PS-PH01-T0002 was issued July 13, 2011, to incorporate other changes and to clarify pipe support installation requirements. Independent oversight reviewed Revision 6 of the specification and verified that the inappropriate references for bolt material substitutions were deleted from the specification when it was revised.

5.0 CONCLUSIONS

HSS determined that construction quality at WTP was adequate in the areas reviewed. BNI engineering had developed appropriate corrective actions to disposition the NCRs that independent oversight reviewed. Concrete placement and inspection activities are adequate. BNI's corrective actions to resolve the issue regarding improperly tensioned structural steel bolts had been completed at the time of this review, with a draft report documenting the re-inspection program under review by BNI engineering.

A potential issue was identified during this review regarding the practice of pre-assembling structural steel beams using permanent bolts that are installed in connections and not tensioned for an extended period of time. This practice appears to conflict with the recommendations, precautions, and good industry practices documented in AISC 348. This issue was identified to BNI through WTP-DOE as an assessment follow-up item pending further review.

6.0 ITEMS FOR FOLLOW-UP

HSS will review the final report documenting resolution of the issue regarding improper tensioning of structural steel bolts and follow-up on resolution of the issue regarding exposure of twist-off-type bolts to the environment for an extended period prior to final tensioning. Independent oversight will continue inspection of piping and pipe supports in the BC and HTR areas.

APPENDIX A
SUPPLEMENTAL INFORMATION

Review Dates

September 12-15, 2011

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
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Documents Reviewed

- DOE-WTP Surveillance Reports for May, June, and August, 2011
- Construction Procedure 24590-WTP-GPP-CON-3203, Rev. 09D, Concrete Operations (Including Supply), November 24, 2010
- Construction Procedure 24590-WTP-GPP-CON-3206, Rev. 3E, Structural Steel Installation and On-Site Fabrication, November 29, 2010
- Construction Procedure 24590-WTP-GPP-CON-3503, Rev. 5D, Aboveground Piping Installation, August 11, 2011
- Construction Procedure 24590-WTP-GPP-CON-3509, Rev. 2, Pipe Support Installation, July 28, 2011

- Specification No. 24590-WTP-3PS-D000-T0001, Rev. 7, Engineering Specification for Concrete Work, March 29, 2007
- Specification No. 24590-WTP-3PS-DB01-T0001, Rev. 8, Engineering Specification for Furnishing and Delivering Ready-Mix Concrete, March 26, 2007
- Specification No. 24590-WTP-3PS-SS00-T0001, Rev. 7, Engineering Specification for Welding of Structural Carbon Steel, January 30, 2008
- Specification No. 24590-WTP-3PS-PS02-T0003, Rev. 9, Engineering Specification for Field Fabrication and Installation of Piping, March 25, 2011
- Specification No. 24590-WTP-3PS-PH01-T0002, Rev. 6, Engineering Specification for Installation of Pipe Supports, July 13, 2011
- Specification No. 24590-WTP-3PS-SS02-T0001, Rev. 3, Engineering Specification for Erection of Structural Steel, December 1, 2008
- Construction Procedure 24590-WTP-GPP-CON-7106, Rev. 4A, Quality Control Personnel Certification, October 7, 2004
- Bechtel Construction Procedure 24590-WTP-MN-CON-01-001-10-22, Rev. 1, NDE Personnel Qualification and Certification NEPQ, June 23, 2009
- PIER 24590-WTP-PIER-MGT-11-0866, Rev 0, Bolt up of A325 and A490 Structural Steel Connections
- Construction Deficiency Reports numbers 24590-WTP-CDF-CON-11-300 through -340
- Nonconformance Report numbers 24590-WTP-NCR-CON-11-0172 through -0179, 24590-WTP-NCR-CON-11-0181 through -0253, 24590-WTP-NCR-CON-11-0255 through -0264, and 24590-WTP-NCR-CON-11-0266 through -0283. Note: Numbers 24590-WTP-NCR-CON-11-0180, -0254, and -0265 were canceled after it was determined that the documented concerns were not nonconforming.