Construction Quality – Structural Concrete Placement and Structural Steel Procurement Assessment at the Y-12 National Security Complex Uranium Processing Facility

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Office of Enterprise Assessments
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Acronyms

ACI	American Concrete Institute
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
CNS	Consolidated Nuclear Security, LLC
DOE	U.S. Department of Energy
EA	Office of Enterprise Assessments
MPB	Main Processing Building
PDSA	Preliminary Documented Safety Analysis
Q	Quality Level Designation for Safety Class or Safety Significant Structures, Systems, and Components
QA	Quality Assurance
QC	Quality Control
RS	Risk Significant
SAB	Salvage and Accountability Building
UPF	Uranium Processing Facility
UPO	UPF Project Office

Construction Quality – Structural Concrete Placement and Structural Steel Procurement Assessment at the Y-12 National Security Complex Uranium Processing Facility July 23-25, 2019

Summary

Scope:
This assessment evaluated Consolidated Nuclear Security, LLC (CNS) activities associated with the receipt, placement, and testing of concrete for the structural walls of the Main Processing Building (MPB) and procurement, receipt inspection, and storage of structural steel for the MPB and the Salvage and Accountability Building.

Significant Results for Key Areas of Interest:
Overall, CNS adequately plans and effectively implements the concrete placement processes. In addition, QA practices and processes ensure that procurement of RS structural steel and associated hardware, and other construction materials, conforms to procurement specifications.

Concrete Construction Activities
Construction of the concrete structure is in accordance with concrete specifications. However, during this assessment, a deficiency was noted involving the lack of compensatory measures to ensure that critical inspection attributes of future Quality Level (Q) work products will be verified until the resolution of a self-identified issue concerning proper verification of critical inspection attributes.

Structural Steel Procurement
The procurement specifications for structural steel are consistent with design criteria. Procured item receiving and storage facilities meet requisite storage requirements, and include controls for procured items to prevent damage, loss, or deterioration, and to ensure proper use.

Best Practices and Findings
There were no best practices or findings identified as part of this assessment.

Follow-up Actions:

The assessment approach for UPF is to focus early on key areas (safety basis, engineering processes, procurement, and construction quality) that have the highest potential to affect nuclear safety, and have historically been problematic in other Department of Energy nuclear construction projects. To date, EA has conducted assessments of the UPF in these areas. Overall, these assessment activities have revealed positive results, as well as identifying a few deficiencies but no findings. A future assessment focus area will be to ensure the proper resolution of the self-identified issue regarding the verification of critical inspection attributes for Q work activities.

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1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Office of Nuclear Safety and Environmental Assessments, within the independent Office of Enterprise Assessments (EA), conducted an assessment of construction activities at the Y-12 National Security Complex Uranium Processing Facility (UPF). The purpose of this assessment was to evaluate the implementation of quality assurance (QA) program requirements that ensure that structural concrete and steel meet approved specifications for the UPF construction activities. This assessment was performed at the UPF construction site from July 23 through 25, 2019.

As specified in the *Plan for the Office of Enterprise Assessments Quality Assessments at the Uranium Processing Facility Site, November 2018*, EA assessed the implementation of UPF QA requirements and specifications for the receipt, placement, and testing of structural concrete, and receipt and storage of structural steel. For structural concrete, EA assessed placement activities, which consisted of receipt of the concrete materials at the construction site, placement of concrete in forms, and testing of concrete to verify that materials meet construction specifications. For structural steel, procurement documentation, receipt inspection, and storage were reviewed. In addition, documentation for construction-related activities was reviewed to ensure that quality records are being properly established and maintained.

Consolidated Nuclear Security, LLC (CNS), the management and operating contractor for the Y-12 National Security Complex, is designing and constructing the UPF. CNS has contracted with Bechtel National Incorporated (construction contractor) to manage construction site activities. The National Nuclear Security Administration (NNSA) UPF Project Office (UPO) provides management and oversight of the project for NNSA. The NNSA Production Office (NPO) provides direct support to UPO for independent review and approval of the safety design basis. The NPO manager is the Safety Basis Approval Authority, and NPO approved revision 1 of the preliminary documented safety analysis (PDSA) on November 9, 2017.

The UPF design incorporates a multi-building strategy to replace the 9212 complex of buildings housing multiple uranium processing capabilities. The multi-building layout of the UPF complex segregates the processes into buildings according to the magnitude of the nuclear safety and security risks, with the Main Processing Building (MPB) containing the most hazardous processes. The Salvage and Accountability Building (SAB), next to the MPB, will house medium-risk support processes and services needing only a moderately robust steel structure. The Personnel and Support Building, connecting the MPB and SAB, will provide a material transfer area, a loading dock, an enclosed dock, and a personnel monitoring station to support transferring material and personnel to and from the complex and between buildings within the complex. A separate, standard industrial building, called the Mechanical/Electrical Equipment Building, will contain most of the supporting utility equipment. Finally, the Highly Enriched Uranium Materials Facility (HEUMF) Connector will physically connect the MPB to the HEUMF.

The PDSA accident analysis designated the UPF concrete structures as a structure, system, and component that provides a defense-in-depth function during and after a seismic event to prevent the release of radioactive material, functions as a fire barrier, and ensures that personnel are able to safely evacuate the facility.

2.0 METHODOLOGY

The DOE independent oversight program is described in and governed by DOE Order 227.1A, *Independent Oversight Program*, which is implemented through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides. This report uses the terms "best practices, deficiencies, findings, and opportunities for improvement" as defined in DOE Order 227.1A.

As identified in the assessment plan, this assessment considered requirements related to the receipt and placement of concrete, and the receipt and staging of structural steel in 10 CFR 830 Subpart A, *Quality Assurance*; DOE Order 420.1B, *Facility Safety*; and applicable commercial concrete standards. The assessment team used Criteria and Review Approach Document 31-17, Rev. 0, *Nuclear Facility Construction – Structural Concrete*, and 31-16, Rev. 0, *Nuclear Facility Construction – Structural Steel*.

The assessment team examined key documents, such as construction work packages, procedures, manuals, policies, and training and qualification records. The assessment team also interviewed key personnel responsible for developing and executing construction activities associated with structural concrete and steel, and walked down significant portions of selected UPF buildings, focusing on the receipt, placement, and testing of concrete material. The assessment team observed concrete placement in A-S5, a 28-foot-high wall in the MPB, and staging of structural steel.

EA conducted a previous assessment of the UPF in January 2019 and did not identify any findings. Therefore, no findings for follow-up were examined during this assessment. However, the assessment team followed up on concerns related to concrete QA records.

3.0 RESULTS

3.1 Concrete Construction Activities

The objective of this portion of the assessment was to determine whether the construction contractor's practices and processes for placement of risk significant (RS) structural concrete in hazard category 2 facilities complied with DOE QA regulations and the recommended practices specified in the American Concrete Institute (ACI) 318-11, *Building Code Requirements for Structural Concrete*.

Concrete Placement Preparations

Engineering specifications CS-ES-801768-033-011-A001, *Engineering Specification for Furnishing and Delivering Ready-Mix Concrete*, and CS-ES-801768-033-012-A001, *Construction Specification for Concrete Work*, provide adequate technical and QA requirements for RS concrete construction work. A sampled work package, CWP-6040311201-C09, *MPB West Walls Level 1*, appropriately contained the construction drawings (including those for installation of reinforcing steel, installation of embed plates and pipe sleeves, openings in the wall, and installation and bracing details for concrete forms), approved field change documents, and work procedures related to the concrete placement.

Concrete placement cards properly documented the properties of the concrete to be placed, placement methods, estimated concrete quantity, weather requirements, and required pre-placement inspections. The pre-placement inspections completed by field engineers and quality control (QC) inspectors adequately ensured the readiness for concrete placement. These inspections included: installation of forms, reinforcing steel, embed plates, pipe sleeves, and miscellaneous hardware. In addition, the inspections verified that surfaces receiving concrete were properly prepared (debris removed from forms),

availability of proper equipment, safe access to work areas, and preparations for adverse weather conditions.

The proper flow down of verification methods for critical inspection attributes ensures that construction contractor Quality Level (Q) work products meet the construction specification and drawings. However, during a UPO oversight activity of concrete placement, the flow down was not in compliance with the QA program description and associated implementing procedure. For example, the pour card lists critical attributes, but the construction contractor does not perform any physical verifications. In addition, the UPF Design Authority identified a similar issue for a single critical attribute and prepared a condition report to identify the issue for resolution. The construction contractor properly entered this issue into the issues management system, but had not performed a causal analysis or extent-of-condition review at the time of this assessment. Contrary to DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*, Attachment 1, Section 2.b(3)(a), the construction contractor has not identified compensatory measures to ensure adequate verification of future work products pending issue resolution. (See **Deficiency D-CNS-1**.)

Freshly Mixed Concrete Testing

The concrete testing subcontractor provided an adequate number of trained and experienced test personnel to sample and test freshly mixed concrete within the time limits specified in ACI and American Society for Testing and Materials (ASTM) standards. Concrete testing subcontractor QC inspectors properly collected fresh concrete samples per ASTM C172, *Standard Practice for Sampling Freshly Mixed Concrete*, including obtaining samples at the point of discharge from the delivery trucks as specified in the construction contractor specification CS-ES-801768-033-012-A001.

Concrete testing technicians adequately performed fresh concrete tests to measure concrete temperature, slump, and density in accordance with ASTM C143, *Standard Test Method for Slump of Hydraulic-Cement Concrete*; ASTM C1064, *Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete*; and C138, *Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete*. The technicians used properly calibrated equipment (e.g., slump cones, hammers, tape measures, scales, tamping rods, measures, and thermometers) to test the freshly mixed concrete. Test equipment exhibited properly completed calibration stickers identifying the last date of calibration and the expiration date, which indicated that the calibration status was current for all equipment. The technicians properly recorded and reported test results to the construction contractor field engineer responsible for concrete operations. The assessment team also noted the construction contractor QC inspectors monitoring all concrete testing activities.

Concrete Placement

A construction contractor field engineer (responsible for oversight of concrete operations) properly collected and reviewed the concrete batch tickets listing, for example, the material quantities in the concrete batch, the time batched (mixed) at the concrete plant, and the truck number, for each delivery truck to verify the proper delivered mix. The construction contractor field engineer also properly verified that the time duration and the number of revolutions the drum had revolved since the concrete batch plant loaded the concrete into the delivery truck was within the ASTM standard (i.e., 90 minutes after the batch time and less than 300 revolutions of the drum).

The construction contractor workers performing the concrete placement activities demonstrated proficient performance with an appropriate crew size. Workers placed concrete in 18-inch lifts from a satisfactory height and handled the concrete in a manner that would not cause segregation, in accordance with ACI recommendations. Workers carefully controlled the concrete placement rate so that the lateral pressure

from the concrete would not overstress the forms. Vibrator operators properly performed layer consolidation work from opposing sides of the pour, with one additional worker operating a vibrator to consolidate material along the form sides. The vibrator operators inserted the vibrators vertically into the pour to a sufficient depth to penetrate the lower lift of concrete and properly avoided using the vibrators to laterally move concrete.

QC inspectors continuously inspected concrete placement operations to ensure that the concrete placement and consolidation in the forms was consistent with ACI recommendations. Interviews with QC inspectors indicated that they are knowledgeable of the structural concrete critical attributes and the inspection methods used to verify compliance with the construction specification.

Quality Assurance Records

The assessment team performed a follow-up review on Nonconformance Report (NCR)-00119, which was initiated to identify, analyze, and resolve a significant concrete emplacement quality issue in the Personnel and Support Building. The construction contractor correctly identified the concrete-placement quality issue, properly documented required repairs, approved repair methods, and initiated appropriate corrective actions to repair the concrete. The assessment team examined the area that was repaired and verified that the repairs had been completed.

A previous EA assessment noted that batch plant measuring and test equipment calibration records were not being captured in the INFOWORKS permanent record system. The assessment team verified that this issue has been resolved.

Concrete Construction Activities Conclusions

The construction contractor's placement of RS structural concrete adequately complies with DOE QA regulations and applicable ASTM standards embedded in ACI 318-11. The construction contractor appropriately integrates engineering specifications and QA regulations into work packages.
In addition, the construction contractor adequately plans and effectively prepares for concrete placements. Qualified concrete test personnel perform adequate testing in accordance with ASTM standards using properly calibrated and maintained equipment. Concrete placement crews are of appropriate size and consist of proficient workers who demonstrated adequate concrete placement performance. Vigilant field engineering and QC inspections ensure proper concrete placement preparations, testing, and emplacement performance. The construction contractor adequately maintains quality records to document the concrete pedigree.

3.2 Structural Steel Procurement

The objective of this portion of the assessment was to verify implementation of QA practices and processes that ensure that the procurement of RS structural steel and associated hardware, and other construction materials, conform to procurement specifications.

Reviewed procurement specifications for structural steel and associated hardware, such as weld filler materials and fasteners (high strength bolts, nuts, and washers), are consistent with the design criteria. The construction contractor appropriately included critical inspection attributes listed in the SAB and MPB Technical Evaluation of Critical Attributes and Mitigation in the procurement specifications, which were consistent with the American Institute of Steel Construction specifications for structural steel members; ASTM standards for bolts, nuts, and washers; and the American Welding Society codes for weld filler material properties and shop welding processes.

A sampled purchase order properly requires the steel manufacturer to a) purchase structural steel and fasteners from suppliers who provide certified material test reports that demonstrate compliance with specifications, b) fabricate the structural steel members in accordance with shop drawings approved by the construction contractor design engineering, c) perform QC inspections of the fabricated members, and d) maintain an approved Nuclear Quality Assurance (NQA)-1 program. The construction contractor QA and procurement personnel performed an adequate pre-award survey to ensure that the steel manufacturer was implementing an NQA-1 QA program and to verify that the manufacturer fabrication facility had the capacity to supply the requisite quantity of structural steel. In addition, the construction contractor assigned five supplier quality representatives to the manufacturer's facility to perform periodic independent inspections and monitor quality records, providing increased assurance that procured structural steel meets specifications.

Observation of receipt inspection activities, document reviews, and interviews with the receiving manager and lead QC inspector indicate effective receipt inspection performance, including preparation of material receiving reports (MRRs), Kick and Count reports (quantity and condition), material receiving inspection reports, verification of critical inspection attributes, and control of non-conforming materials. Sampled, procured Q-level weld electrodes, grounding wire, and hardware were traceable to the original receipt inspection documentation. Two sampled MRR packages for structural steel and fasteners show that structural steel and hardware for structural steel construction delivered to the project complies with the physical, mechanical, and chemical properties specified in the procurement specification. The supplier-certified material test reports show that the purchased materials meet specifications. Welding documentation shows that the manufacturer performed welding in accordance with the American Welding Society codes. Completed documentation of the construction contractor's only commercial grade dedication package properly accepts critical attributes for procured commercial grounding wire/tails based on appropriate inspection and testing results.

The assessment team also reviewed pre-installation verification testing results performed on tension control structural fasteners. The construction contractor tested three bolts from each lot to verify that the fasteners achieved the minimum tension in accordance with American Institute of Steel Construction/Research Council on Structural Connections, *Specification for Structural Joints Using High-Strength Bolts*.

Observation of storage facilities indicates that the construction contractor effectively organizes received materials in a Level C (temperature/humidity controlled) receiving/storage facility and a Level D (no environmental protection) laydown yard, including areas for receiving and inspection, segregation of non-conforming items, and storage for accepted materials. Hold tags appropriately designate non-conforming items, and color-coded labeling effectively designates commercial control, RS, and Q items. These controls ensure that stored items are fit for construction use.

Structural Steel Procurement Conclusions

The construction contractor effectively implements QA practices and processes that ensure that procurement of RS structural steel and associated hardware, and other construction materials, conforms to procurement specifications. Reviewed procurement specifications for structural steel are consistent with design basis documents, and critical inspection attributes were consistent with requisite industry construction standards. Receipt inspection performance and documentation demonstrates delivered structural steel and hardware for structural steel construction complies with the procurement specification. The construction contractor's only commercial grade dedication package, and pre-installation verification testing results provides requisite assurance of product conformance with specifications. In addition, received material storage, marking, and segregation activities adequately control materials that are fit for construction use.

4.0 BEST PRACTICES

There were no best practices identified as part of this assessment.

5.0 FINDINGS

There were no findings identified as part of this assessment.

6.0 DEFICIENCIES

Deficiencies are inadequacies in the implementation of an applicable requirement or standard. Deficiencies that did not meet the criteria for findings are listed below, with the expectation from DOE Order 227.1A for site managers to apply their local issues management processes for resolution.

Consolidated Nuclear Security, LLC

Deficiency D-CNS-1: Contrary to DOE Order 226.1B, Attachment 1, Section 2.b(3)(a), CNS has not implemented compensatory measures while addressing a self-identified issue concerning the lack of physical verifications for Q-level critical inspection attributes.

7.0 OPPORTUNITIES FOR IMPROVEMENT

There were no opportunities for improvement identified as part of this assessment.

8.0 ITEMS FOR FOLLOW-UP

The assessment approach for UPF is to focus early on key areas (safety basis, engineering processes, procurement, and construction quality) that have the highest potential to affect nuclear safety, and have historically been problematic in other Department of Energy nuclear construction projects. To date, EA has conducted assessments of the UPF in these areas. Overall, these assessment activities have revealed positive results, as well as identifying a few deficiencies but no findings. A future assessment focus area will be to ensure the proper resolution of the self-identified issue regarding the verification of critical inspection attributes for Q work activities.

Appendix A
Supplemental Information

Dates of Assessment

Onsite Assessment: July 23-25, 2019

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