



Construction Quality Structural Concrete Placement and Procurement Processes Assessment at the Uranium Processing Facility

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Acronyms

| | |
|--------|--|
| ACI | American Concrete Institute |
| ACPA | American Concrete Pavement Association |
| AMEC | AMEC Foster Wheeler |
| ASTM | American Society for Testing and Materials |
| BNI | Bechtel National, Inc. |
| CC | Commercial Control |
| CFR | Code of Federal Regulation |
| CGD | Commercial Grade Dedication |
| CNS | Consolidated Nuclear Security, LLC |
| C of C | Certificate of Conformance |
| CRAD | Criteria and Review Approach Document |
| DOE | U.S. Department of Energy |
| EA | Office of Enterprise Assessments |
| ESL | Evaluated Suppliers List |
| HEUMF | Highly Enriched Uranium Materials Facility |
| M&TE | Measuring and Test Equipment |
| MPB | Main Processing Building |
| MR | Material Requisition |
| NCR | Nonconformance Report |
| NNSA | National Nuclear Security Administration |
| NPO | NNSA Production Office |
| NQA | Nuclear Quality Assurance |
| PDSA | Preliminary Documented Safety Analysis |
| PSB | Personnel and Support Building |
| Q | Quality Level Designation for Safety Class or Safety Significant SSC |
| QA | Quality Assurance |
| QC | Quality Control |
| QLD | Quality Level Determination |
| RS | Risk Significant |
| SAB | Salvage and Accountability Building |
| SDRS | Safety Detection and Response System |
| SSC | Structures, Systems, and Components |
| TECAM | Technical Evaluation of Critical Attributes and Mitigation |
| UPF | Uranium Processing Facility |
| UPO | UPF Project Office |
| WOOD | John Wood Group, PLC |

Construction Quality Structural Concrete Placement and Procurement Processes Assessment at the Uranium Processing Facility

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Office of Nuclear Safety and Environmental Assessments, within the independent Office of Enterprise Assessments, conducted an assessment of construction quality and implementation of the quality assurance (QA) program at the Uranium Processing Facility (UPF) construction site from January 7 to 10, 2019.

The scope of this assessment included observing ongoing work activities for construction of the Main Processing Building and Salvage and Accountability Building foundations; reviewing the procurement program for safety-related components; and reviewing construction documentation consisting of plans, procedures, drawings, and specifications to determine whether the expectations of the project's QA program are being implemented sufficiently to ensure that the production, delivery, placement, and testing of concrete meets established construction specifications. In addition, the UPF Project Office (UPO) oversight processes were reviewed for effectiveness.

Consolidated Nuclear Security, LLC, the management and operating contractor for the Y-12 National Security Complex, is designing and constructing the UPF through a subcontract with Bechtel National, Inc. (BNI). UPO is monitoring the construction activities to evaluate the contractor's performance in meeting the requirements established by the contract and flowed down through concrete specifications to project implementing documents.

Project documents, including specifications, drawings, and procedures, are adequate to specify and control construction and inspection processes, and these documents reference applicable DOE directives and industry standards. Concrete production and placement specifications meet or exceed American Concrete Institute (ACI) Building Code Requirements for Structural Concrete.

The UPF project adequately plans and implements effective preparations for placement of concrete to ensure construction of the concrete structure in accordance with construction specifications. Pre-placement activities appropriately include installation of forms, installation of reinforcing steel and other hardware, removal of debris from forms before placement of concrete, availability of proper equipment, safe access to work areas, and preparation for adverse weather conditions. Pre-placement inspections by field engineers and quality control inspectors adequately ensure readiness for concrete placement.

BNI ensures a sufficient number of trained and experienced test personnel to sample and perform testing of the freshly mixed concrete within the time limits specified in the ACI and American Society for Testing Materials standards. Qualified technicians are sampling and testing the freshly mixed concrete with properly calibrated and maintained equipment in accordance with American Society for Testing Materials standards specified in the BNI concrete specifications.

BNI quality control (QC) inspectors continuously inspected concrete placement operations to ensure that the concrete placement and consolidation in the forms was consistent with ACI recommendations. The BNI QC inspectors are knowledgeable of critical attributes of the structural concrete and the surveillance methods used to verify compliance with the construction specification.

BNI uses sufficiently sized concrete placement crews, who place concrete in accordance with ACI-recommended practices. BNI's procurement procedures define an adequate process that effectively implements Nuclear Quality Assurance (NQA)-I requirements. BNI adequately evaluates and qualifies

suppliers to provide NQA-1 acceptable components based on appropriate engineering evaluations and specified criteria. BNI provides effective procured item receiving and storage facilities that meet requisite storage requirements, and effectively identifies and controls procured items to prevent damage, loss, or deterioration and ensure their proper use.

UPO is demonstrating strong oversight of construction activities and it should help to ensure that the UPF is built in a manner that meets nuclear safety design requirements.

Construction Quality Structural Concrete Placement and Procurement Processes Assessment at the Uranium Processing Facility

1.0 PURPOSE

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 Uranium Processing Facility (UPF). The purpose of this assessment was to review the procurement program and to evaluate the implementation of quality assurance (QA) program requirements that ensure that the appropriate structural concrete meeting approved concrete specifications is used in the UPF construction activities. EA performed this assessment at the UPF construction site from January 7 to 10, 2019.

2.0 SCOPE

As specified in the *Plan for the Office of Enterprise Assessments Quality Assessments of the Construction Activities at the Uranium Processing Facility Site, November 2018 to December 2019*, EA assessed the implementation of UPF QA requirements and concrete specifications for the manufacture, transportation, placement, and testing of structural concrete for the UPF construction activities. EA assessed concrete manufacturing and placement activities, which consisted of operations at the concrete batch plant, transportation of the concrete materials to the construction site for placement, installation of rebar, placement of concrete in forms, and testing of concrete to verify that materials meet construction specifications. Documentation for construction-related activities was reviewed to ensure that quality records are being properly established and maintained. In addition, the Bechtel National, Inc. (BNI) procurement program and the UPF Project Office (UPO) oversight activities were reviewed for effectiveness.

3.0 BACKGROUND

The Consolidated Appropriations Act, 2018 states that EA shall conduct oversight of projects for the construction of high-hazard nuclear facilities to ensure compliance with applicable nuclear safety requirements. EA implements this expectation through a series of project assessments, which include construction quality as one assessment area. In particular, this assessment focused on the manufacture and placement of structural concrete.

Consolidated Nuclear Security, LLC (CNS), the management and operating contractor for the Y-12 National Security Complex, is designing and constructing the UPF. The National Nuclear Security Administration (NNSA) 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 Building 9212 Complex, which houses multiple uranium processing capabilities, some of which are planned for installation in the UPF, including highly enriched uranium casting, special oxide production, chemical recovery, and support operations (e.g., maintenance shop, decontamination, and packaging). The multi-building layout of the UPF complex segregates the processes into buildings according to the magnitude of 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 structure. The Personnel and Support Building (PSB), 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.

CNS has partnered with BNI to manage construction site activities, including the manufacture and placement of structural concrete. BNI has retained two subcontractors for constructing the building concrete foundations and facility shell: Harrison Construction Company (hereafter referred to as Harrison) for batching and transporting the concrete to the work site and John Wood Group, PLC (WOOD) for testing the freshly mixed concrete at the point of delivery to the placement site and performing unconfined compression testing of sample specimens at WOOD's offsite laboratory. BNI employees perform concrete placement. BNI quality control (QC) inspection staff members oversee onsite concrete placement and monitor WOOD's concrete testing activities.

The PDSA 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. BNI uses three quality pedigrees: Commercial Control (CC), Risk Significant (RS), and Quality Level (Q) that define a graded approach to quality controls. BNI, the UPF construction contractor, prepared a Quality Level Determination (QLD) in accordance with the UPF procedure for quality grading, designating the structural concrete RS. Based on the designation of the structural concrete as defense-in-depth in the PDSA, a QLD of RS is a proper designation per the UPF processes. Following assignment of the RS quality designation, a technical evaluation of the critical attributes and mitigation process was conducted to identify the critical attributes of the structural concrete, along with the acceptance methods to verify compliance. The actions to implement the acceptance methods are specified in a surveillance plan to verify that the manufacturing and placement of the structural concrete is in compliance with construction specifications. The technical requirements (industry standards) are specified in the concrete specification and flow down to the construction activities associated with structural concrete for implementation.

4.0 METHODOLOGY

The DOE independent oversight program is described in and governed by DOE Order 227.1A, *Independent Oversight Program*. EA implements the independent oversight program through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides. Organizations and programs within DOE use varying terms to document specific assessment results. In this report, EA uses the terms "deficiencies, findings, and opportunities for improvement" as defined in DOE Order 227.1A. In accordance with DOE Order 227.1A, DOE line management and/or contractor organizations must develop and implement corrective action plans for the deficiencies identified as findings.

As identified in the assessment plan, this assessment considered requirements related to the manufacture, transport, and placement of concrete in 10 CFR 830 Subpart A, *Quality Assurance*; DOE Order 420.1B, *Facility Safety*; and applicable commercial concrete standards. Aspects of these requirements are included in the criteria and lines of inquiry of Criteria and Review Approach Document (CRAD) 31-17, *Nuclear Facility Construction Structural Concrete*, used by EA.

The Team examined key documents, such as construction work packages, procedures, manuals, policies, and training and qualification records. The Team also conducted interviews with key personnel responsible for developing and executing construction activities associated with structural concrete, and walked down significant portions of selected UPF buildings, focusing on the manufacture, transport, placement, and testing of concrete material. The members of the EA assessment team, the Quality Review Board, and EA management responsible for this assessment are listed in Appendix A. A detailed list of the documents reviewed, personnel interviewed, and observations made during this assessment, relevant to the findings and conclusions of this report, is provided in Appendix B.

EA did not identify any findings from the previous assessment of UPF structural concrete construction activities. Therefore, no findings for follow-up were examined during this assessment.

5.0 RESULTS

The team reviewed the BNI specifications and procedures for concrete production and placement to verify that they were technically adequate and complied with DOE QA regulations for constructing the reinforced concrete Hazard Category 2 facilities for the UPF. The Team also observed three concrete placements, concrete testing, and QC inspection activities. Materials, design, and construction of concrete for the UPF is governed by American Concrete Institute (ACI) 318-11, *Building Code Requirements for Structural Concrete*.

The concrete placements observed by the team during this assessment were pour numbers EB-8N (a base slab in the MPB), ET-1S (a topping slab in the MPB), and B7 (a base slab in the SAB).

5.1 Concrete Specifications and Placement Procedures

This section discusses the team's assessment of the specifications and procedures for manufacture, placement, and inspection of structural concrete in RS structures.

Criteria:

- *Concrete construction shall be performed in accordance with approved procedures, design drawings, manufacturer's instructions, and other design basis documents, including applicable codes and standards. The procedures, instructions, and drawings shall include or reference appropriate quantitative or qualitative acceptance criteria for determining that prescribed results have been satisfactorily attained. (American Society of Mechanical Engineers Nuclear Quality Assurance (NQA)-1, Requirement 5 and DOE Order 414.1D).*
- *Installation, inspection, and testing of structural concrete shall be performed in accordance with the amplified requirements specified in Subpart 2.5 of Part II of NQA-1.*
- *Concrete construction and inspection activities shall be performed in accordance with ACI 301, Specifications for Structural Concrete.*

The team reviewed BNI Engineering Specifications CS-ES-801768-033011-A001, *Engineering Specification for Furnishing and Delivering Ready-Mix Concrete*, and CS-ES-801768-033012-A001, *Construction Specification for Concrete Work*. Specification CS-ES-801768-033011-A001 contains the technical requirements for furnishing and delivering ready mix concrete, including materials required for manufacturing the concrete, to the UPF project site. The specification also specifies the QA requirements for the work included in the specification, including certification of the batch plant, quality requirements

for the materials used to manufacture the concrete, required inspections and testing, and required submittals. This specification is adequate.

Specification CS-ES-801768-033012-A001 contains the technical requirements for concrete construction work, including installation of forms, reinforcing steel, and other embedded items, such as anchor bolts; temperature controls in concrete placements thicker than three feet; hot and cold weather requirements; preparations prior to placing concrete; conveying, placing, and consolidating concrete; and finishing and curing the concrete. The specification also covers the requirements for concrete repairs, field QC, sampling and testing of concrete, and frequency of testing.

Specification CS-ES-801768-033012-A001 is adequate with the following exception: Section 3.15, D.3 states that concrete samples for testing may be taken at the discharge of the delivery truck for pumped concrete. This statement is not in accordance with NQA-1, Part II, Subpart 2.5, Section 711, which states that when concrete is pumped during its movement from the delivery point to the placement point, in-process strength tests shall be taken at the placement point unless correlation tests of air content, slump, and temperature are performed. To date, BNI has not placed any exterior building walls, which require air-entrained concrete to improve the durability of concrete by increasing its resistance to damage from repetitive freeze-thaw conditions. BNI exterior wall placement begins in the fourth quarter of fiscal year 2019, which will require placement of air-entrained concrete and pumping from the point of delivery to the point of placement. The above concrete sampling requirements for pumped concrete were discussed with the UPO staff and BNI construction personnel, and they agreed to address this inconsistency before the placement of air-entrained concrete.

Overall, the concrete specifications and placement procedures are adequate. However, the requirements of Specification CS-ES-801768-033012-A001, Section 3.15, D.3, for placement of air-entrained concrete in exterior walls that will be exposed to freeze-thaw conditions do not comply with the requirements of NQA-1, Part II, Subpart 2.5, Section 711, regarding sampling of pumped concrete.

5.2 Concrete Placement Preparations

This section discusses the team's assessment of the preparations for each concrete placement to ensure that pre-placement activities conform to industry standards and practices and that concrete placement cards list the properties of the concrete to be placed, placement methods, estimated concrete quantity, weather requirements, and required pre-placement inspections. The team observed concrete placement activities and QC inspector performance, and reviewed placement card records.

Criteria:

- *Surfaces where concrete is to be placed are cleaned to remove dirt and debris. Forms shall be properly secured to maintain their position during concrete placement. ACI 347, Guide to Formwork for Concrete, provides construction recommendations.*
- *Concrete reinforcing steel is installed in accordance with design and reinforcing steel fabrication drawings. (10 CFR 830.122(f))*
- *Adequate equipment, such as concrete vibrators, is available, and access for the workers to the concrete placement areas is provided by safe walkways and scaffolding constructed in accordance with DOE safety regulations.*

- *Preparations have been completed to protect concrete during inclement weather, such as availability of tarps to protect freshly placed concrete from rain, and availability of insulated tarps/blankets, or heaters and enclosures to prevent freshly placed concrete from freezing.*
- *Inspections are completed by field engineers and QC inspectors, as applicable, prior to placement of concrete to verify pre-placement activities.*

The planning for each concrete placement was properly documented on a concrete placement card listing the properties of the concrete to be placed, placement methods, estimated concrete quantity, weather requirements, and required pre-placement inspections. An important document used to prepare the concrete pour card is the Technical Evaluation of Critical Attributes and Mitigation (TECAM), which lists the required concrete strength and inspection requirements. BNI appropriately listed the critical inspection attributes and correct concrete strength listed in TECAM-ES-922601-A001, *TECAM for the Construction of the Salvage and Accountability Building* on the concrete pour card for placement number B7.

After craft supervisors sign the concrete placement cards, indicating that concrete preparation work is complete, BNI field engineers and BNI QC inspectors perform pre-placement inspections to ensure that debris has been removed from the surfaces on which the concrete is to be placed, forms are installed, reinforcing steel is properly installed, and other items to be imbedded in the concrete, such as embed plates and anchor bolts, have been installed. These inspections are recorded on the concrete placement card, with the release for placement after the card is signed by the BNI field engineer and BNI QC inspectors. The concrete placement cards for placement numbers B7 and EB-8N were properly signed prior to the concrete placement, and the required inspections were completed.

The concrete placement areas were properly prepared, cleaned, and wetted for placement numbers B7, ET-1S, and EB-8N. Anchor bolts, embedded plates, and reinforcing steel were properly secured so they would not be displaced during placement and consolidation of concrete. In addition, the team examined several areas in placement number EB-8N and compared the reinforcing steel installed in the top mat to the requirements shown on UPF Drawing Numbers S2E922600D003, *MPB East Rebar Placing FDN Slab Top Mat (T2)*, and S2E922600D004, R0, *MPB East Rebar Placing FDN Slab Top Mat (T1)*, and verified proper installation including proper length of lap splices and correct number, spacing, and size of the reinforcing steel bars. The ends of the bars were painted red, indicating that the reinforcing steel had been procured for installation in RS structures. The red paint is applied after QC inspectors complete receipt inspections of the reinforcing steel at the receipt inspection facility.

The team discussed and reviewed the preparation for cold weather with the BNI Lead QC inspector. These discussions disclosed that insulated tarps are available to cover the concrete placements during cold weather conditions. ACI 206.1, *Standard Specification for Cold Weather Concreting*, defines cold weather as three consecutive days when the average temperature is expected to drop below 40 degrees Fahrenheit. However, Section 3.12, *Cold Weather Concreting*, of BNI Specification CS-ES-801768-033012-A001 has more conservative requirements to protect concrete during expected cold weather conditions.

Overall, UPF adequately plans and implements effective preparations for placement of concrete to ensure construction of the concrete structure in accordance with construction specifications. Pre-placement activities appropriately include installation of forms, installation of reinforcing steel and other hardware, removal of debris from forms before placement of concrete, availability of proper equipment, safe access to work areas, and preparations for adverse weather conditions. Pre-placement inspections by field engineers and QC inspectors adequately ensure readiness for concrete placement.

5.3 Freshly Mixed Concrete Testing

This section discusses the team's assessment of testing of the freshly mixed concrete by WOOD technicians during concrete placement numbers B7 in the SAB foundation and EB-8N in the MPB foundation.

Criteria:

- *Adequate fresh concrete samples are obtained and equipment used to test freshly mixed concrete (slump cones, tape measures, air meters, scales, and thermometers) is available. Equipment is in good condition and calibrated in accordance with NQA-1 requirements. (10 CFR 830.122 (h))*
- *A sufficient number of trained and experienced test personnel (QC inspectors) are available to perform testing of the freshly mixed concrete within the time limits specified in ACI standards and American Society for Testing Materials (ASTM) standards. (10 CFR 830.122(b))*
- *Personnel performing concrete inspections are qualified in accordance with ASTM E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection, and ACI 301, Standard Specifications for Concrete.*
- *After casting, test specimens (concrete cylinders) are handled and stored in a controlled environment for 24 hours in accordance with ACI-recommended practices and ASTM standards before transporting to an offsite laboratory.*

WOOD technicians collected fresh concrete samples per ASTM C172, *Standard Practice for Sampling Freshly Mixed Concrete* and BNI Specification CS-ES-801768-033012-A001, by diverting the delivery truck chute to acquire a properly sized sample. After determining the acceptability of the concrete based on the sample, the concrete is discharged from the concrete truck into a pumper truck, which pumps the concrete over to point of placement. This sampling methodology is appropriate for all concrete placement except for air entrained concrete that may be exposed to freeze-thaw condition, such as for an exterior concrete wall. The ACI specifications for air entrained concrete requires concrete samples be taken at point of placement and not delivery, because pumping of the concrete could have an effect on the air voids needed to prevent concrete deterioration from freeze thaw conditions. In addition, sampling at delivery point is not in conformance with the *UPF – Materials Testing Services Exhibit “D” Scope of Work and Technical Specifications* for the UPF Material Testing subcontract, for WOOD, which states in paragraph 2.8: “Test pumped and conveyed concrete at the point of placement.” To date this has not caused any issues since no exterior walls have been erected, as explained in Section 5.1, above. The UPF management team has been made aware of the inconsistency in specification and have committed to correct the documentation prior to placement of exterior walls. WOOD utilized an appropriately sized and qualified crew to perform the required sample tests. EA observed the testing activities and independently checked the results. The testing activities were appropriately performed and the results were correctly interpreted and applied to accept a concrete batch.

WOOD technicians used appropriate equipment (e.g., slump cones, hammers, tape measures, scales, tamping rods, measures, and thermometers) to test freshly mixed concrete at the site. The test equipment displayed properly completed calibration stickers, with the last date of calibration and the expiration date. EA verified that the calibration status of all the equipment was up to date.

The team witnessed the WOOD technicians performing fresh concrete tests in accordance with ASTM standards to measure concrete temperature, slump, and density (unit weight). The results were recorded by the WOOD technicians and reported to the BNI field engineer responsible for concrete operations.

BNI QC inspectors also monitor the concrete testing activities. The technicians completed slump, temperature, and density tests, including proper preparation, filling, rodding, surface strike-off, mold removal, and vertical slump measurements per 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 team also witnessed the WOOD technicians preparing test specimens (cylinders 4 inches in diameter and 8 inches in height) for unconfined compression testing. The cylinders were molded in accordance with ASTM C31, *Standard Practice for Making and Curing Concrete Test Specimens in the Field*. The cylinders are stored in a portable metal storage container, called a CONEX box, which is used as the onsite storage facility for 24 hours prior to being transported to an offsite laboratory for additional curing and testing. ASTM C31 requires the temperature in the onsite storage facility to be maintained between 60 and 80 degrees Fahrenheit. The team verified the temperature of the storage facility was being controlled in accordance with ASTM C31 recommendations.

WOOD provided a sufficient number of trained and experienced test personnel to sample and test freshly mixed concrete within the time limits specified in ACI and ASTM standards. Qualified WOOD technicians are sampling and testing the freshly mixed concrete with properly calibrated and maintained equipment in accordance with the ASTM Standards referenced in the BNI specifications.

5.4 Placement of Concrete

This section discusses the assessment of staffing levels to support the proper placement of concrete and the QC inspectors' performance and qualification. The team observed the three concrete placements listed above and observed concrete placement workers performing the work.

Criteria:

- *Sufficient personnel are available to accomplish the work. (10 CFR 830.122(b))*
- *Concrete placements are completed in accordance with ACI recommendations for consolidating concrete, prohibiting lateral movements of concrete using vibrators, and controlling the rate of rise in forms.*
- *Concrete placement operations require continuous inspection by QC personnel to ensure that the mix delivered to the point of placement meets specification requirements, and to ensure that placement of concrete into the forms and concrete consolidation is performed in a manner consistent with ACI recommendations.*

The team observed concrete delivery at the job site. When the delivery trucks arrived, the BNI field engineer, who is responsible for oversight of concrete operations, collected and reviewed the concrete batch tickets to verify that the proper mix was delivered to the job site. The batch tickets list the material quantities in the concrete batch, the time batched (mixed) at the concrete plant, and the truck number, and show the quantity of water withheld from the batch. Before the concrete was discharged at the job site, the drum was turned 30 times at mixing speed to ensure that the concrete was well mixed.

The BNI field engineer then performed a visual inspection of the concrete when discharging commenced, to estimate the concrete slump. Although this method is an approximation, an engineer experienced in concrete operations can, through observation, identify concrete that may have a high or low slump. If the field engineer suspects that the concrete slump is outside the specification limits, he or she directs WOOD

technicians to obtain a sample of the concrete in order to perform a slump test at the job site. If the measured slump is not within specification limits, the corrective actions are as follows:

1. If the slump measurement is too low, an additional quantity of water that was withheld at the batch plant, not to exceed the quantity noted on the batch ticket, can be added to the concrete on the delivery truck. The drum is then rotated 30 times to mix in the water, the concrete is sampled, and another slump test performed. If the slump is within specification limits, the concrete is discharged into the concrete pump. The concrete is sent to a disposal area if, after the addition of the withheld water, the slump is still lower than the specification limits.

Or

2. If the slump is high, the concrete is rejected and sent to a disposal area.

The BNI field engineer also checked the time the concrete was batched and recorded the number of revolutions the drum had revolved since the concrete was discharged into the delivery truck. The BNI specifications and ASTM standards require concrete to be discharged from the truck within 90 minutes after the batch time or before 300 revolutions of the drum. After the field engineer determines that the concrete meets specification requirements, the delivery trucks discharge the concrete into a concrete pump, which pumps the concrete to the point of placement. After the discharge of the concrete was complete, the time of completion and number of drum revolutions was recorded on a concrete truck log.

During concrete placement for number B7 in the SAB, at approximately two-thirds completed, the BNI field engineer observed a batch of concrete that appeared to have a slump higher than permitted by the concrete specification. Slump tests performed by WOOD confirmed that the slump was too high. Concrete placement was stopped and the concrete plant was immediately notified and actions were initiated to adjust the mix to produce acceptable concrete. Several additional trucks were identified with a high slump and rejected. Concrete placement restarted once new concrete being delivered was within specification limits for the slump. After concrete placement re-started, the BNI field engineer directed WOOD technicians to increase the sample size of slump tests on concrete delivery trucks until the placement activities were completed for B7 to ensure that all concrete placed in the structure met specifications. These actions demonstrated that BNI had no reservations in rejecting out-of-specification concrete loads.

The BNI workers performing the concrete placement work activities demonstrated proficient performance with an adequately sized crew. Two concrete pumps operated from opposing sides of the pour to ensure efficient concrete placement. Concrete was placed in 18-inch lifts from a satisfactory height and handled in a manner that would not cause segregation, in accordance with ACI recommendations. A BNI worker using a rod marked in 18-inch increments controlled the lift height and held the rod on top of the previous lift so that the concrete pump operator could readily observe when a sufficient amount of concrete had been placed in an area before moving the pump discharge hose. Vibrator operators 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 avoided using the vibrators to latterly move concrete. Concrete finisher workers operated a mechanical screed to level the pour. All observed performance was in accordance with ACI recommendations.

BNI QC inspectors continuously inspected concrete placement operations to ensure that the concrete placement and consolidation in the forms was consistent with ACI recommendations. The BNI QC inspectors are knowledgeable of critical attributes of the structural concrete and the surveillance methods

used to verify compliance with the construction specification. The team's assessment of the QC inspectors' qualifications is discussed in Section 5.6.

BNI uses sufficiently sized concrete placement crews, who place concrete in accordance with ACI-recommended practices. BNI uses qualified QC inspectors, who are performing requisite inspections consistent with industry standards.

5.5 Post-Placement Activities

This section discusses the assessment of concrete post-placement activities for concrete placement numbers B7 in the SAB and EB-8N in the MPB.

Criteria:

- *Concrete is properly cured for the period cited in the design specifications. (10 CFR 830.122(e))*
- *Post-placement inspections of concrete surfaces are performed by trained personnel and documented in QC records.*
- *Defects in concrete placements are repaired in accordance with design specifications, following recommendations in the design documents and ACI standards. (10 CFR 830.122(c))*

BNI concrete finishing crews applied a curing compound to the surface of the concrete after it had set. Concrete placement cards specify the curing method, and BNI QC inspectors monitor the curing for seven days after the concrete placement is completed and record their observations on the concrete placement card.

The team examined concrete placement numbers B7 and EB-8N in order to assess the methods used to protect the concrete. Because outside air temperatures were projected to be below 40 degrees Fahrenheit, the pours were covered with insulated tarps/blankets to prevent the concrete from being exposed to cold weather as specified in ACI 306.

The BNI QC inspectors also perform post-placement inspections to identify any concrete defects that require repair. If repair is necessary, a nonconformance report (NCR) is initiated to document and disposition any observed concrete defects. EA reviewed NCR 00119, *PSB W2 Structural Defects*, which was initiated to document what appeared to be surface defects in an interior basement wall in the PSB in concrete pour number PSB W-2. During removal of unsound concrete, reinforcing steel was exposed and the defects were reclassified as structural.

The onsite Design Engineering representative—the Resident Engineer—was properly notified in accordance with Section 3.10B of Specification CS-ES-801768-033012-A001. The Resident Engineer directed BNI construction to continue efforts to remove the unsound concrete, in accordance with Section 3.10D, which provides a procedure to repair concrete that is in accordance with ACI standards. BNI construction also identified other areas from pour PSB W-2 that appeared to have unsound concrete that will be removed in accordance with Section 3.10D of the specification. After all of the unsound concrete is removed, the Resident Engineer will approve the repair methods and document the corrective actions and concrete repairs in response to closure of the NCR. EA examined the walls in pour number PSB W-2 and examined the areas where the unsound concrete was removed. Construction crews were still in the process of removing unsound concrete. However, the sections completed indicated adequate removal of concrete to support compliant repair activities.

Curing of the recently placed concrete is adequate, and the in-progress repairs for the concrete defects in the walls placed in PSB pour number PSB W-2 are proceeding satisfactorily. BNI QC inspectors adequately perform and document post-placement inspections of concrete.

5.6 Quality Control Personnel Qualification

This section discusses the assessment of the QC inspector qualification process and observation of QC inspectors performing duties to fulfill surveillance requirements by verifying that critical attributes of concrete meet the construction specification.

Criterion:

- *Qualifications of personnel performing QC inspections of concrete work activities comply with NQA-1, Quality Assurance Requirements for Nuclear Facility Applications, requirements, or applicable codes/standards referenced in contract documents, regarding experience, training, and certification. (DOE Order 414.1D)*

The team reviewed BNI procedure Y17-95-64-809, *UPF Quality Control Personnel/Certification Program*, which specifies the requirements for qualification, indoctrination, training, certification, and recertification of QC personnel performing inspections and testing at the UPF project, with additional requirements for personnel performing welding inspections. Qualification and certification of QC personnel performing welding inspections are also required to meet the requirements of Recommended Practice No. SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*. The qualification levels for QC inspectors (Levels 1, 2, and 3), as well as physical and annual eye exams, specified in the BNI procedure comply with the requirements of NQA-1. Discipline areas in which qualification/certification may be obtained are defined in Appendix B, Endorsement Categories, in the procedure. The BNI procedure also specifies the requirements for generation and retention of records documenting QC personnel qualifications. QC inspectors who perform inspections of concrete work activities are required to be certified in Appendix B Endorsement Categories C1, Concrete Batching and Testing, and C2, Concrete placement including Pre- and Post-Placement. The procedure is adequate.

The team interviewed four BNI QC inspection personnel involved in inspecting concrete placements. The interviews disclosed that all four had previously performed QC inspections of concrete work at other nuclear projects. The team verified that the inspectors were certificated by reviewing BNI records showing that they were qualified based on training and experience. The records showed that the four inspectors had Appendix B Endorsement Categories C1 and C2. Based on observations of the QC inspectors during the concrete placements discussed above the team concluded the QC inspectors were knowledgeable and demonstrated sufficient proficiency to fulfill the role of QC inspector. The establishment of QC inspections by BNI provides assurance that concrete quality will conform to design specification requirements. This assessment concluded through interviews, observations, and record examinations that all interviewed BNI QC inspection personnel were qualified.

5.7 Quality Assurance

This section addresses QA aspects of the concrete production and procurement of safety-related components (Q and RS). The objective of this portion of the assessment was to verify that BNI is acquiring conforming concrete and safety-credited facility equipment.

Criteria:

- *QA programs are established and implemented in accordance with 10 CFR 830, Subpart A, Quality Assurance Requirements; NQA-1, Quality Assurance Requirements for Nuclear Facilities*

Applications; DOE Order 414.1D, Quality Assurance; and DOE Order 226.1A, Implementation of DOE Oversight Policy.

- *The concrete batch plant has been inspected and certified in accordance with National Ready Mixed Concrete Association recommendations or other standards. (EA CRAD 31-17)*
- *Materials used to produce concrete are measured and proportioned in the quantities determined through controlled mix designs that were completed to establish that the concrete mix would produce concrete with the properties required by the design criteria. (EA CRAD 31-17)*
- *Requirements are established for procurement and verification of items and services. (10 CFR 830.122, Criterion 7)*
- *Processes are established and implemented that ensure that approved suppliers continue to provide acceptable items and services. (10 CFR 830.122, Criterion 7)*
- *Inspect and test specified items, services, and processes using established acceptance and performance criteria. (10 CFR 830.122, Criterion 8)*
- *Identify and control items to ensure proper use. (10 CFR 830.122, Criterion 5)*
- *Commercial grade dedication (CGD) activities shall be performed in accordance with the amplified requirements specified in Subpart 2.14 of Part II of NQA-1)*

Quality Assurance Program

A previous EA assessment identified effective flow down of BNI QA requirements to subcontractors' QA programs, including Harrison for concrete production, with a few exceptions. BNI has since resolved these exceptions as follows:

- BNI has approved Harrison's revised QA program submittal.
- The Harrison QA program now identifies ASTM Standard C-685 for controlling concrete production, consistent with the subcontract requirements.
- Harrison contract documents specify the quality pedigree for the concrete as CC, whereas the UPF QLD identifies the concrete as RS and CC, with a final conclusion of RS. BNI adequately explained this inconsistency as the concrete delivery is CC, but considers cured concrete as RS when concrete samples successfully attain compressive strength test results at 28 days post-placement.

In October 2017, WOOD acquired AMEC Foster Wheeler (AMEC), the concrete testing subcontractor. In accordance with *Uranium Processing Facility – Material Testing Services Exhibit “D” - Scope of Work and Technical Specifications*, Section 1.5, the subcontractor (WOOD) must submit the contractor's QA program for acceptance. BNI indicated that WOOD continues to use the AMEC QA program (25774-YRD-HC4-HASA-00001-VDS-41.0-0005_2, *Quality Assurance Project Document*) for RS concrete testing, which BNI accepted on March 13, 2017.

Concrete Plant Certification

The team examined BNI's approach to ensuring that Harrison provides conforming concrete and interviewed key BNI and Harrison personnel. The team walked down the Harrison concrete production plant, examined concrete uniformity test data, and investigated measuring and test equipment (M&TE) calibration.

UPF Field Change Document BOP-FCS-C-17-0007 requires certification of the subcontractor's concrete batch plant in accordance with the National Ready Mixed Concrete Association (NRMCA) plant certification checklist or an independent audit verifying that the batch plants are capable of producing ready mix concrete in accordance with ASTM C-94, *Standard Specification for Ready-Mixed Concrete*, or ASTM C-685, *Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing*. An independent audit through the American Concrete Pavement Association (ACPA) issued a Certificate of Conformance (C of C) on January 26, 2017, with an expiration date of January 26, 2019 (see 25774-YRD-FC5-DB02-VDV-17.1-0005, NRMCA Certification). An ACPA recertification audit performed on January 2, 2019, resulted in a preliminary notification of the recertification C of C, with an expiration date of January 2, 2021.

BNI adequately resolved the following UPF concrete-plant-related issues previously identified by an EA assessment:

- Neither Harrison nor AMEC/Wood completed requisite concrete uniformity tests in accordance with the six-month frequency specified in ASTM 94 and ASTM C-685. Current records indicate that Harrison is adequately performing the requisite concrete uniformity tests within the specified frequency. BNI explained that they included concrete uniformity testing in the AMEC/WOOD contract provisions to provide performance flexibility in the event Harrison did not fulfil this requirement.
- Harrison was not storing chemical admixtures with adequate spill containment or freeze protection per ACPA certification requirements. The team observed that Harrison has repositioned chemical admixture containers in a new CONEX box with an approximate 16-inch threshold and a functioning door. Chemical admixture mixing equipment is now located in a small insulated shed with supplemental heat available, as needed. Harrison has insulated chemical admixture distribution lines between the CONEX box and mixing shed and heat traced (resistive wire heating) chemical admixture pipes/hoses in elevated conveyance trays leading to the production line. Harrison's reconfigured chemical admixture storage and delivery system now adequately achieves spill containment and freeze prevention.
- BNI was not monitoring long-term trends of concrete compressive strength through its monthly BNI Quality Dashboard Metrics. The team interviewed the Lead Concrete Planning Engineer, who exhibited a spreadsheet used to consistently monitor concrete compressive strength test results at various time intervals to confirm installation of conforming concrete and monitor trends.

The previous assessment determined that Harrison was not routinely submitting calibration records for each piece of M&TE to BNI in accordance with its subcontract. However, Harrison is now providing copies of requisite calibration records to BNI, but BNI is not routinely entering these records into its record management system, INFOWORKS. The BNI Subcontract Technical Representative agreed to catch up on transmitting these Harrison submittals for entry into INFOWORKS. All Harrison M&TE calibration records indicate conformance with periodic calibration requirements.

Procurement

The team examined the BNI procurement process, procurement documents, receipt inspection records, and CGD plans and results, and walked down the BNI receipt inspection facility/procured item storage warehouse and laydown yard. BNI has only recently begun Q procurements. UPO provided the team with a list of all Q and RS level planned and in-process procurements, from which EA sampled components that were most advanced in the procurement process, including:

- HDPE (High Density Polyethylene) Bulk Pipe (Non-Spooled) (RS & Q) – Qualified Supplier
- Pressure Transmitters (Q) – Qualified Supplier
- Manual Valves (Ball, Plug) (Q) – Qualified Supplier
- Safety Detection and Response System (SDRS) (Q) – Qualified Supplier
- Electrical Grounding Tails – CGD
 - Strand Soft Drawn Bare Copper (Q)
 - Copper Compression C Connector (Q)
 - Copper Compression Grounding Plate (Q)
 - Silicone Bronze Hex Head Bolt (Q).

Review of the BNI's procurement procedures define an adequate graded approach, roles and responsibilities, and process for developing procurement documents and verifying the receipt and qualification of procured safety-related components. UPF-3DP-G06B-00020, *Commercial Grade Dedication and Attribute Verification*, effectively implements NQA-1, Part II, Subpart 2.14, *Quality Assurance Requirements for Commercial Grade Items and Services*, 2009. Each EA-sampled in-process Q procurement adequately included the required UPF QLD Checklist, which designates the quality pedigree (CC/RS/Q) for each critical function addressed in the PDSA or other design basis documents; TECAM, which identifies critical attributes, acceptance criteria, and acceptance methods for CGDs (if needed); and Material Requisitions (MRs), which provide the technical requirements for developing procurement bid packages. BNI engineering personnel appropriately developed, checked, and reviewed QLDs and TECAMs for each Q component, which provides confidence that the specified component performance criteria are consistent with the safety basis. EA-sampled MRs also adequately address requirements for in-process inspections of Suspect/Counterfeit Items.

Qualified Suppliers

Of particular interest to the team was the SDRS specified in the PDSA as an engineered safety system to provide detection of seismic activity and/or process upset conditions and initiate required safety response actions (e.g., valve isolation, process equipment shutdown) in support of safety functions designed to prevent energetic events. The commercial nuclear power industry commonly utilizes this system to similarly control nuclear reactor shutdowns. INVENSYS, Inc. manufactures the system, but Framatome, Inc. has recently acquired INVENSYS, Inc. Based on this system's high reliability in the nuclear power industry, BNI is obtaining this system through a sole source procurement. The interviewed BNI Supplier Quality audit team leader provided objective evidence of requisite documentation to appropriately include Framatome, Inc. on the BNI Evaluated Suppliers List (ESL) as an NQA-1 qualified supplier. Similar objective evidence justifies maintaining Lincoln Structural Solutions (supplier of the HDPE bulk pipe) on the BNI ESL and adding Nuclear Logistics (supplier of the SDRS pressure transmitters) and Fluid Controls and Components, Inc. (supplier of the SDRS manual valves) to the BNI ESL.

Receipt Inspection/Commercial Grade Dedication

UPF-procured item receipt of items requiring Level B storage (protection from temperature extremes and humidity) normally occurs at the UPF Building 1065 E receiving and storage warehouse where BNI has located full-time Receiving and QC Inspectors. Individual qualification records provide adequate documented bases for all BNI Level II QC inspectors. BNI controls authorized personnel entry into Building 1065 E through a gate requiring individuals to sign in. Warehouse personnel effectively organize stored items within floor-marked areas segregating receiving areas, holding areas, and accepted item storage racks and floor storage areas.

UPF-procured item receipt for items requiring Level D storage (no environmental protection) normally occurs at the UPF Laydown yard (near Building 1065 E), a fenced and controlled storage area covered in gravel to control blowing dust and weeds. BNI operators effectively place all stored items, including structural and non-structural steel, on dunnage to prevent contact with the ground. BNI operators used tarps to securely cover some structural steel components with fabricated pockets to control rainwater collection on the tarps. QC inspectors properly tagged and either segregated items subject to QC holds in distinctly marked areas of the facility or erected temporary marked fencing around items too large or heavy to move (e.g., structural steel components). For example, painted steel rebar ends visually designate the material as RS (blue paint indicates Q, whereas red paint indicates RS) and attached tags identify the associated MR, drawing number, and heat number. Both receiving facilities adequately prevent procured item damage, loss, or deterioration and identify items to ensure their proper use.

BNI is in the process of performing the first UPF RS/Q level procurement for electrical grounding tails. The interviewed QC inspector was familiar with the CGD process and demonstrated his role in the electrical grounding tails CGD activity. The QC inspector demonstrated how BNI receipt inspectors had properly marked the material with a red tag (signifying an RS procurement) that included the MR number and moved the material into a segregated, fenced, and locked holding area within the facility pending CGD completion.

The assigned Quality Engineer (certified by the American Society for Quality) explained some identified issues associated with this CGD including unfamiliar bolt head marking. This indicates appropriate attention to Suspect/Counterfeit Items awareness.

However, BNI records CGD inspection/testing results on the CGD plan's open space and margins. This approach is necessary because BNI has no CGD data form for recording such information as found/as measured data, acceptance criteria, pass/ fail indication, inspection date, or inspector's initials in comparison to other DOE site CGD processes. This may present an error likely situation.

Quality Assurance Conclusions

BNI has adequately addressed flow down of QA subcontract requirements to subcontractors' QA programs and resolved previously identified concerns about the UPF concrete plant, with the exception of entering Harrison M&TE records into INFOWORKS. BNI's procurement procedures define an adequate process that effectively implements NQA-1 requirements. BNI adequately evaluates and qualifies suppliers to provide NQA-1 acceptable components based on appropriate engineering evaluations and specified criteria. BNI provides effective procured item receiving and storage facilities that meet requisite storage requirements, and effectively identifies and controls procured items to prevent damage, loss, or deterioration and ensure their proper use. CGD documents associated with BNI's first CGD RS/Q level procurement provide reasonable assurance that commercially obtained components will perform their intended safety function.

5.8 UPO Oversight

This section addresses that Federal oversight programs are established and effective in ensuring that construction activities comply with contractual and safety basis requirements.

Criteria:

- *The Federal office has established and implemented effective oversight processes to apply engineering expertise in its oversight of construction activities. (DOE O 226.1B)*
- *The oversight efforts of the Federal office are planned based on risk and importance to safety. (DOE O 226.1B)*
- *The roles and responsibilities of the oversight personnel are defined, are understood, and serve the mission needs. The organization conducting oversight ensures that the personnel adequately accomplish their oversight duties in compliance with the documented and approved oversight program. (DOE O 226.1B)*
- *The Federal office effectively communicates identified issues to the construction contractor and monitors the contractor's processes to ensure that issues are evaluated and corrected on a timely basis in order to prevent recurrence. (DOE O 226.1B)*

UPO has implemented an oversight process that includes procedures that establish management's expectations for oversight planning, execution, and reporting. UPO Procedure UPO-95-A003, *UPO Oversight Planning Process*, establishes the expectations for various types of oversight to be conducted, including operational awareness and assessments. To identify the assessments to be conducted in a fiscal year, UPO developed an integrated assessment schedule, which included a risk ranking based on the contractor's performance and impact on project success. Impact on project success includes evaluation of conditions that affect both worker safety and compliance with design standards. Review of the fiscal year 2019 integrated assessment schedule indicated that a number of assessment activities are focused on construction activities that could affect nuclear safety design requirements. Moreover, the number of assessment activities is commensurate with the oversight staffing of UPO. Review of the UPO monthly assessment performance indicator report for the period of January 2018 to January 2019 indicated that UPO completed 185 oversight activities, including 61 in construction and environment, safety, and health; 28 in engineering; and 39 in QA and procurement.

In addition to the UPO procedure for oversight planning, UPO Procedure UPO-95-A004, *UPO Oversight Execution/Reporting Process*, establishes the expectations to be implemented for formality in the assessment process. The procedure requires an assessment plan, a criteria and review approach document, and an assessment report documenting the results, including issues identified. The UPO oversight processes provide for the characterization of issues based on significance associated with worker safety and compliance with design standards, and the effect on the overall project success.

All UPO oversight personnel who were interviewed demonstrated adequate knowledge of the UPO oversight processes and implementation mechanisms. Review of the documentation of the UPO assessments of the BNI work planning and control processes and hydrostatic pressure testing of fire protection piping demonstrated compliance with the UPO oversight processes described in the UPO oversight procedures, and assessment activities evaluated both compliance and performance. The UPO assessments identified seven findings due to non-compliances with BNI procedural requirements and insufficient control of hydrostatic testing conditions. All findings met the conservative definition of a finding in the UPO oversight procedures. The findings were formally communicated to CNS for

resolution through its issues management process. Per CNS issues management processes, condition reports, which assign an issues significance and identify proposed corrective actions, were generated for all findings. In addition, the CNS condition report review committee and management review board reviewed all condition reports for adequacy. UPO attended both meetings to monitor CNS actions to resolve UPO findings and provided feedback when necessary. Furthermore, UPO requested a formal response from CNS for the findings, which included the corrective actions identified, in order to support future follow-up actions, including closure actions for findings.

During walkdowns of the construction site and observation of construction activities, UPO oversight personnel demonstrated in-depth knowledge of the construction site, construction practices, and nuclear safety design requirements. In particular, oversight personnel demonstrated in-depth knowledge of the specific construction activities, including those that could affect the site's ability to meet nuclear safety design requirements. Because the UPO offices are adjacent to the construction areas, oversight staff members have immediate access to the work areas, which allows for almost continuous oversight of construction activities. During this assessment, oversight staff members were in the construction work areas multiple times throughout the work day observing activities and following up on previous concerns.

Overall, UPO is demonstrating strong oversight of construction activities and it should to help ensure that the UPF is built in a manner that meets nuclear safety design requirements. Example assessment reports and supporting documentation show that UPO is adequately identifying weaknesses, communicating issues to the construction contractor, and ensuring corrective actions are effective.

6.0 FINDINGS

EA did not identify any findings during this assessment.

7.0 OPPORTUNITIES FOR IMPROVEMENT

EA did not identify any opportunities for improvement during this assessment.

Appendix A Supplemental Information

Dates of Assessment

Onsite Assessment: January 7-10, 2019

Office of Enterprise Assessments (EA) Management

Nathan H. Martin, Director, Office of Enterprise Assessments
John S. Boulden III, Acting Deputy Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
C.E. (Gene) Carpenter, Jr., Director, Office of Nuclear Safety and Environmental Assessments
Kevin G. Kilp, Director, Office of Worker Safety and Health Assessments
Gerald M. McAteer, Director, Office of Emergency Management Assessments

Quality Review Board

Steven C. Simonson
John S. Boulden III
Michael A. Kilpatrick

EA Site Lead for Uranium Processing Facility

Jimmy S. Dyke

EA Assessors

Jimmy S. Dyke – Lead
Joseph J. Lenahan
Michael A. Marelli

Appendix B Key Documents Reviewed, Interviews, and Observations

Documents Reviewed

- UPO-95-A003, *UPO Oversight Planning Process*, Revision 2, January 4, 2018
- UPO-95-A004, *UPO Oversight Execution/Reporting Process*, Revision 9, August 20, 2018
- UPO-PCA-95-A005, *UPO Suspend Work Protocol*, Revision 0, December 3, 2013
- ASM-ESH-9.29.2017-758745, *CNS/BNI Work Control MEB*, September 29, 2017
- ASM-C&ESH-11.2.2018-814453, *CNS/BNI Construction Emergency Egress Door Frame Awareness Activity*, November 2, 2018
- ASM-C&ESH-12.3.2018-818104, *UPO UPF Construction Awareness Activity, CNS/BNI MEB Utilities Phase C Potable and Fire Water Installation and Hydrostatic Pressure Testing*, December 3, 2018
- ASM-C&ESH-12.4.2018, *PSB Basement W-2 Wall Concrete Placement*, December 4, 2018
- ASM-C&ESH-12.12.2018, *PSB Wall W-4 Concrete Replacement*, December 12, 2018
- Letter UPO to CNS UPF, *Transmittal of the UPO Awareness Activity of CNS UPF Utilities Phase C Potable Water and Fire Water Lines Installation and Hydrostatic Pressure Testing*, December 21, 2018
- 25774-YRD-FC5-DB02-00001-VDS-6.0-0001, *Harrison Inc. Quality Program for UPF Concrete Batch Plant*, February 13, 2018
- *Uranium Processing Facility – Material Testing Services Exhibit “D” - Scope of Work and Technical Specifications*, Rev. 7, October 18, 2018
- 25774-YRD-HC4-HASA-00001-VDS-41.0-0005, *Quality Assurance Project Document*, March 13, 2017
- UPF BOP-FCS-C-17-0007, *UPF Field Change Document*, February 3, 2017
- *UPF - Harrison Batch Plant Concrete Uniformity Testing*, November 30, 2017
- QLD-EZ-940427-FWD03-A001, *Fire Water Distribution 03*, August 31, 2017
- TECAM-ED-801768-A005, Rev. 1, *HDPE Bulk Pipe (Non-Spoiled)*, February 1, 2018
- 25774-QL-YZS-PP00-30001, *Supplier Survey Assessment – Lincoln Structural Solutions*, November 22, 2017
- 25774-000-YAA-2018-10010, *Audit Report – Lincoln Structural Solutions*, February 14, 2018
- 25774-QL-YQA-PP00-30003, *Quality Surveillance Report*, March 8, 2018
- 25774-QL-MRA-PP00-00003, Rev. 5, *Material Requisition Cover Sheet*, November 5, 2018
- QLD-EM-922600-MEXLO-C002, Rev. 3, *Quality Determination Checklist*, December 18, 2018
- TECAM-EI-801768-A025, Rev. 0, *VEN-F5-7689 Pressure/Level/Flow Transmitter (Q)*, September 13, 2017
- 25774-QL-YZS-PV01-40001, *Supplier Survey Assessment*, Nuclear Logistics LLC, October 10, 2017
- 25774-000-YAA-2018-10016, *Audit Report - Nuclear Logistics, Inc.*, May 1, 2018
- 25774-QL-MRA-JP02-00001, *Material Requisition - Pressure Transmitters (Q)*, March 1, 2018
- TECAM-ED-801768-A004, Rev. 1, *VEN-F6-5149 TECAM - Manual Valves (Ball/Plug) (Q)*, September 28, 2017
- 25774-QL-YZS-PV01-10001, *Supplier Survey Assessment - Fluid Controls & Components Inc.*, November 11, 2017
- 25774-000-YAA-2018-10036, *Audit Report - Fluid Controls & Components Inc.*, November 13, 2018
- 25774-QL-MRA-PV03-00005, *Material Requisition - Manual Valves (Ball, Plug)*, September 25, 2018
- QLD-EI-801768-SDRS-A004, *Safety Detection & Response System (SDRS), Seismic Monitor and Seismic Power Isolation Contactors*, September 18, 2018

- TECAM-EI-801768-A026, *VEN-F5-7540: Safety Detection and Response System (SDRS)*, September 12, 2017
- 25774-QL-YZS-JD03-10001, *Supplier Survey Assessment of Framatome, Inc. in Lake Forest CA for the SDRS*, August 28, 2018
- 25774-QL-MRA-JD03-00001, Rev. 1, *Material Requisition - Safety Detection & Response System Hardware/Software*, December 5, 2018
- CGD-EE-801768-A001, *Commercial Grade Item/Commercial Grade Service Evaluation Form – Grounding*, October 9, 2018
- Procedure 3.17, *Solicitations, Proposal Evaluation, Negotiations, Award Documentation, and Award*, Revision 009, April 23, 2018
- Y17-95-64-847, *UPF Field Material Control and Traceability*, Revision 4, November 17, 2018
- Y17-95-64-846, *UPF Material Receiving*, Revision 7, November 17, 2018
- UPF-3DP-G06B-00020, *Commercial Grade Dedication and Attribute Verification*, Revision 2, December 19, 2018
- CS-ES-801768-033011-A001 R3, *Engineering Specification for Furnishing and Delivering Ready-Mix Concrete*, October 25, 2018
- UPF Field Change Document (FCN/FCR) No. FCD-C-00201 to Engineering Specification CS-ES-801768-033011-A001 R3
- CS-ES-801768-033012-A001 R4, *Construction Specification for Concrete Work*, October 25, 2018
- UPF Project Procedure Y17-95-64-828, *UPF Concrete Operations*, R2, February 23, 2016, and Procedure Change Notice PRCN-Y17-95-64-828-R02-02, effective date September 6, 2018
- CS-ES-801768-033023-A001 R1, *Construction Specification for Furnishing, and Fabricating Steel for MPB, SAB, PSB, HCON, and Yard Structures*, R1, December 9, 2016
- UPF Drawing No. S2E922600A061, R1, *MPB Structural General Notes*
- UPF Drawing No. S2E922600A062, R0, *MPB Structural Design Criteria*
- UPF Drawing No. S2E922600D003, R0, *MPB East Rebar Placing FDN Slab Top Mat (T2)*
- UPF Drawing No. S2E922600D004, R0, *MPB East Rebar Placing FDN Slab Top Mat (T1)*
- BNI Procedure Y17-95-64-809, R1, *UPF Quality Control Personnel Certification/Qualification Program*, April 11, 2018
- BNI Procedure Y17-95-64-807, R6, *UPF Construction Process for Inspection, Testing, and Inspection Records*, December 5, 2018
- 25774-YRD-FC5-DB02-00001-VDE-41.0-0040, Harrison Transmittal #0089r2, UPF Mix Submittal (033011) Mix G-1, June 29, 2017
- AMEC Subcontract: Exhibit “D” – *Scope of Work and Technical Specifications*, February 9, 2016
- TECAM-ES-912601-A002, R1 *TECAM for the Construction of the Personnel and Support Building*
- TECAM-ES-922601-A001, R0, *TECAM for the Construction of the Salvage and Accountability*
- Quality Control Inspector Qualification Records (3)

Interviews

- UPO Staff Engineers and Oversight Staff (6)
- BNI QC Manager
- BNI Quality Control Engineer
- BNI Quality Control Inspectors (2)
- BNI Supplier Auditor
- BNI Engineering Group Supervisor - Instrumentation & Controls
- BNI Subcontract Technical Representative - Harrison Production Plant
- Harrison Production Plan QC Manager
- WOOD Concrete testing technicians (4)
- SDRS Engineer

- Lead Concrete Field Engineer
- Lead Concrete Planning Engineer

Observations

- Placement of concrete Pour number B7 in the SAB
- Placement of concrete Pour number EB-8N in the MPB
- Placement of concrete Pour number ET-1S in the MPB
- Top mat of reinforcing steel placement for base slab in sections of MPB
- Curing of placement numbers B7 and EB-8N
- WOOD testing of freshly mixed concrete for placement numbers B7, EB-8N, and ET-1S
- Onsite facility for storing concrete cylinders
- In process repairs to concrete walls for placement PSB W-2
- Harrison Concrete Production Plant
- UPF Building 1065 E receiving and storage warehouse at East Tennessee Technology Park
- UPF Laydown Yard