Office of Enterprise Assessments
Assessment of the Uranium Processing Facility Construction Quality – Structural Concrete

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Office of Nuclear Safety and Environmental Assessments
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Acronyms

ACI	American Concrete Institute
ACPA	American Concrete Paving Association
AMEC	AMEC Foster Wheeler
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BNI	Bechtel National, Inc.
CC	Commercial Control
CNS	Consolidated Nuclear Security, LLC
DOE	U.S. Department of Energy
EA	Office of Enterprise Assessments
GEOS	GEO Services
HEUMF	Highly Enriched Uranium Materials Facility
M&TE	Measuring and Test Equipment
MPB	Main Processing Building
NCR	Nonconformance Report
NNSA	National Nuclear Security Administration
NPO	NNSA Production Office
NQA	Nuclear Quality Assurance
NRMCA	National Ready Mixed Concrete Association
OFI	Opportunity for Improvement
PDSA	Preliminary Documented Safety Analysis
QA	Quality Assurance
QAP	Quality Assurance Program
QAPD	Quality Assurance Program Description
QC	Quality Control
RS	Risk Significant
SAB	Salvage and Accountability Building
UPF	Uranium Processing Facility
UPO	UPF Project Office

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EXECUTIVE SUMMARY

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 quality and implementation of the quality assurance (QA) program at the Uranium Processing Facility (UPF) construction site from November 13 to 16, 2017.

The scope of this EA assessment included observing ongoing work activities for construction of the mass concrete fill and reviewing construction documentation consisting of plans, procedures, drawing, and specifications to determine if the expectations of the project's quality assurance program are being implemented sufficiently to ensure that the production, delivery, placement, and testing of concrete meets established construction specifications.

Consolidated Nuclear Security, LLC (CNS), the management and operating contractor for the Y-12 National Security Complex, is designing and constructing the UPF through subcontract with Bechtel National, Inc. (BNI). All the BNI subcontractors have incorporated DOE QA requirements into their QA programs except one. For the one exception, the subcontractor's QA program documentation was not approved by BNI and is under revision. The UPF Project Office is monitoring the subcontractor's progress in obtaining approval for the QA documentation. The deficiencies in the subcontractor's QA program documentation have not had an impact on the structural concrete manufacturing and placement.

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 Building Code Requirements for Structural Concrete.

The production, transportation, and placement of concrete is adequately planned and implemented to ensure construction of the concrete structure in accordance with construction specification. The project uses qualified quality control inspectors, who perform requisite inspections consistent with industry standards

Testing of concrete samples is being performed in accordance with American Society for Testing and Materials (ASTM) standards with properly calibrated and maintained equipment. Testing results of the installed concrete reviewed by EA verified that the concrete strength exceeded design specification. The UPF Project is maintaining the proper concrete construction quality records, and the records reviewed were retrievable, legible, and maintained in accordance with Nuclear Quality Assurance (NQA)-1 requirements. In addition, review of some personnel training records indicates there is a process in place to ensure personnel are sufficiently qualified for assigned work activities.

EA identified as a deficiency that the subcontractor operating the continuous mixing concrete plant has not conducted the concrete uniformity tests that are required every six months in accordance with ASTM C685, *Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing*. Also, weaknesses were identified regarding the reliability of weight scales used in concrete testing and not using trending of concrete strength tests as a leading indicator of concrete production effectiveness.

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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 the EA assessment was 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 November 6 through 10, 2017.

2.0 SCOPE

As specified in the *Plan for the Enterprise Assessments Construction Quality of the Concrete Plant operations at the Uranium Processing Facility Site*, November 2017, 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, placement of concrete in forms, and testing of concrete to verify that materials meet construction specifications. In addition, documentation for construction-related activities was reviewed to ensure that quality records are being properly established and maintained.

3.0 BACKGROUND

The Consolidated Appropriations Act of 2016 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. The manufacture and placement of structural concrete was chosen as the focus area for the completion of this construction quality assessment.

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) 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 Building 9212 Complex processing capabilities that are planned for installation in the UPF include 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 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 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.

CNS has partnered with BNI to manage construction site activities, including the manufacture and placement of structural concrete. BNI has retained three subcontractors for constructing the mass fill concrete foundation: Harrison Construction Company (Harrison) for batching and transporting the concrete to the work site; Blaine Construction Corporation (Blaine) for placing and consolidating the mass fill concrete; and AMEC Foster Wheeler (AMEC) for receiving and testing the freshly mixed concrete at the point of delivery to the placement site and performing laboratory testing at their offsite laboratory. Blaine's subcontract with BNI also requires them to employ an independent inspection agency to perform inspections of the concrete placement work activities. BNI has an onsite quality control (QC) inspection staff that oversees the inspections performed by Blaine Construction's inspection agency, GEO Services (GEOS), and monitors testing of the concrete performed by AMEC.

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. The UPF construction contractor BNI prepared a quality level determination (QLD), following the UPF procedure for quality grading, and designated the structural concrete at a risk significant (RS) quality level. 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 (OFIs)" 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. Other important deficiencies not meeting the criteria for a finding are also highlighted in the report and summarized in Appendix C. These deficiencies should be addressed consistent with site-specific issues management procedures.

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. Key aspects of these requirements are included in the criteria and lines of inquiry of Criteria and Review Approach Document 31-17, *Nuclear Facility Construction Structural Concrete*, used by EA.

EA examined key documents, such as construction work packages, procedures, manuals, policies, training and qualification records, and numerous other documents. EA also conducted interviews of 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 during this assessment. Appendix C summarizes the deficiencies discussed in this report. EA has not conducted a recent assessment of the UPF structural concrete construction activities. Therefore, there were no items for follow-up examined during this assessment.

5.0 RESULTS

5.1 Quality Assurance Program Documents

This section discusses EA's assessment of the flow down of QA subcontract requirements from BNI to subcontracts, specifications, and work documents. EA reviewed subcontracts, quality assurance program (QAP) documents, construction specifications, QC inspection protocols, and work plans controlling the concrete work activities, and determined in general that sufficient detail is provided to control the manufacture, placement, and testing of structural concrete to ensure that construction activities fulfil the UPF construction specifications.

Criteria:

- *Quality assurance programs are established and implemented in accordance with 10CFR830, Subpart A, Quality Assurance Requirements; ASME 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 construction specifications translate design requirements into details sufficient to define the technical requirements for concrete construction activities. (10 CFR 830.122(d))*
- *Procedures, specifications, and drawings should ensure that concrete construction and inspection activities are controlled and performed in accordance with applicable requirements. (10 CFR 830.122(d))*
- *Construction procedures must reference the required inspection hold points and must also address the QA department authority to stop work. (NQA-1, Quality Assurance Requirements for Nuclear Facility Applications, requirements, or applicable standard referenced in contract document)*
- *Laboratory and field-testing procedures must provide for verification of correct material usage and correct selection of reference standards. (10 CFR 830.122(h))*

The BNI UPF Project has established a written QA program description (QAPD) through Y60-95-102PD, *Uranium Processing Facility Quality Assurance Program Description*. The QAPD fulfills the expectations of 10 CFR 830, Subpart A, *Quality Assurance Requirements*; American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (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*. To flow down the QAPD expectations to subcontract companies, BNI/UPF developed a Construction Subcontract – Exhibit "B" – Special Conditions, Appendix B-7, *Quality Assurance* template, which adequately specifies the quality requirements for four levels of quality – commercial control (CC), enhanced commercial control, RS, and quality – based on DOE Order 414.1D and NQA-1-2008/NQA-1a-2009.

BNI adequately specified QA requirements in the subcontracts for the companies performing construction activities associated with structural concrete. Each subcontractor was required to submit a QAP to BNI for approval before starting work. BNI approved the QAPs for Blaine (December 5, 2016) and AMEC (March 13, 2017). However, BNI considered Harrison's QAP submittal (November 7, 2017) to be inadequate and issued direction to revise and resubmit. UPO was aware of the deficient condition of the Harrison QAP, and is monitoring the update and approval progress.

EA's review of the subcontractors' QA documentation identified two additional issues. Neither issue had impact on the manufacturing and placement of structural concrete.

- AMEC's QAP does not adequately describe or include procedures addressing some applicable elements of NQA-1, including training/qualification, fresh concrete testing, and test cylinder handling/shipping/testing, as required by BNI/UPF Material Testing Services Exhibit "D" Scope of Work and Technical Specifications, February 2016, Section 1.5.
- The contract documents for Harrison specify the quality level for the concrete as CC, whereas the UPF Quality Level Determination concluded that the concrete work is RS.

EA reviewed the two BNI Specifications, UPF CS-ES-801768-033011-A001, *Engineering Specification for Furnishing and Delivering Ready-Mix Concrete*, and CS-ES-801768-033012-A200, *Construction Specification for Mass Fill and Mud Mat Concrete Work* that identify the technical requirements for implementation during the manufacturing, transportation, and placement of structural concrete. The review found that both specifications contained the necessary technical requirements for performing the following structural concrete construction activities:

- Furnishing feed materials for the concrete batching
- Conducting batching operations for concrete production
- Transporting ready-mix concrete for placement in the mass concrete fill
- Preparing for concrete placement
- Placing and consolidating concrete
- Post placement inspecting
- QC testing of the concrete.

Both of the specifications reference appropriate American Concrete Institute (ACI) and American Society for Testing and Materials (ASTM) standards applicable to producing and testing concrete and the concrete constituents. Furthermore, the requirements in these specifications equal or exceed those specified in ACI 318, *Building Code Requirements for Structural Concrete*.

Review of work plans, procedures, and drawings indicated the work processes and controls that implement the construction specifications for placement of the structural concrete for the mass concrete fill are adequately described. The work plans reviewed were: (1) *Mass Concrete Fill (MCF) Placement Plan*, which provides the details for forming and placing the concrete; (2) *Blaine Concrete Repair Procedure PP-85665-01*, which provides details for repair to any identified concrete defects; and (3) *AMEC Concrete Testing Work Plan*, which provides the plan and details for testing the freshly mixed concrete on site and performing other testing at the AMEC Knoxville Laboratory. These work plans collectively provide an adequate basis for implementing an effective QC inspection program.
Overall, BNI and the BNI subcontractors' QA programs include DOE QA regulations for constructing the unreinforced mass fill concrete foundation that will support Hazard Category 2 facilities for the UPF.

Project documents, including specifications, drawings, and procedures, are adequate to specify and control construction and inspection processes and reference applicable DOE directives and industry standards. Concrete production and placement specifications meet or exceed ACI Building Code Requirements for Structural Concrete (ACI 318-11). EA identified and communicated two additional issues to BNI and UPO on the adequacy of QA program documentation; these issues have not affected the production, placement, and testing of structural concrete.

5.2 Concrete Plant Certification

This section discusses EA's assessment of BNI's approach to ensuring that Harrison provided a certified concrete plant. EA walked down the Harrison concrete production plant, verified the certification of Harrison concrete delivery trucks, evaluated the adequacy of concrete materials (cement, fine and coarse aggregate, etc.), and reviewed the calibration of measuring and test equipment (M&TE).

Criteria:

- *The concrete batch plant and trucks have been inspected and certified in accordance with National Ready Mixed Concrete Association (NRMCA) Standards.*
- *The materials (cement, fine and coarse aggregate, water, and admixtures) used in batching of concrete are tested in accordance with ASTM or other approved Standards to verify the materials meet design specification requirements.*
- *Materials used to produce concrete are measured and proportioned in the quantities determined through controlled laboratory mix designs that were completed to establish that the concrete mix would produce concrete with the properties required by the design criteria.*

BNI UPF Specification CS-ES-801768-033011-A001, Section 1.5 B, requires certification of the subcontractor's concrete batch plant and delivery trucks in accordance with the National Ready Mixed Concrete Association (NRMCA) plant certification checklist. However, Harrison submitted a request to BNI to utilize a continuous concrete mixing plant as an alternate to a central batch plant based on the high flow rate of concrete required. The continuous concrete plant is not certifiable under NRMCA due to the difference in the material (aggregate, cement, etc.) feed system. The NRMCA checklist for certification does not contain criteria to certify the material feed system of a continuous concrete mixing plant. Therefore, Harrison requested a waiver from BNI subcontract requirements, and proposed an alternate industry recognized process to certify the concrete plant.

Harrison provided BNI an adequate basis for waiving the NRMCA certification requirement for their continuous mixing concrete production plant via Transmittal #0117, *NRMCA Certification*, which included: 1) a letter from the NRMCA Vice President of Engineering proposing a waiver of the NRMCA certification based on differences in the batching systems, and 2) Harrison's independent audit using an NRMCA-approved inspector (see 25774-YRD-FC5-DB02-VDV-17.1-0005). EA discussed the letter with the author and verified that the individual who performed the certification of the Harrison concrete plant was an NRMCA-approved inspector listed on the NRMCA website. Harrison's independent auditor utilized a combination of the NRMCA certification checklist and an American Concrete Paving Association (ACPA) certification checklist that references ASTM C685, *Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing*. The ACPA checklist is more comprehensive than the NRMCA checklist and provides an acceptable method for certification of this type of concrete production facility. BNI Design Engineering documented the approval of certification of the concrete plant and the acceptance of the NRMCA plant certification waiver in UPF Field Change Document BOP-FCS-C-17-0007 that revised Section 1.5 B of Specification CS-ES-801768-033011-A001.

Harrison self-certifies concrete delivery trucks using an internet-connected NRMCA truck certification checklist, which is an approach consistent with NRMCA protocols. The Harrison truck certification technician, who has over 20 years of direct experience, was knowledgeable of the certification checklist process, and the actions taken to verify conformance. Completion of the online checklist results in a printed inspection record and certification sticker on the truck. The trucks are equipped with dual recording devices mounted in the truck cabs to record the number of revolutions of the drum on a mechanical and electronic recorder. The trucks are in good mechanical condition. EA verified that the Harrison concrete delivery trucks in use during the three concrete placements observed by EA possessed current inspection records and certification stickers.

Harrison has adequately configured the concrete production plant to accommodate efficient delivery of cement, fly ash, and aggregates and concrete truck loading. The feed materials (e.g., cement, fine and coarse aggregate) used in batching of concrete are tested in accordance with ACI and ASTM standards. The proportions of materials that make up the structural concrete mix were determined in a laboratory-controlled concrete mix design process, and testing results indicate that the concrete being produced meets or exceeds the concrete construction specification. Harrison stockpiles aggregates in designated bins with concrete slabs for cleanliness. Each individual aggregate stockpile has the proper signage required by ACPA, showing the aggregate size. Aggregate distribution conveyors provide for adequate loading of hoppers to preclude cross contamination. Load cells on the cement/fly ash hopper were in satisfactory condition, free from any obstructive debris. Harrison injects liquid nitrogen into the fresh concrete to control concrete temperatures during hot weather and has a sufficiently large liquid nitrogen tank. Harrison has installed a propane tank at the plant for heating batch water to control concrete temperatures during cold weather. The batch plant is computer controlled and provides a printed concrete batch ticket that lists the quantities of each constituent in the batch that is discharged into the delivery truck (e.g., concrete volume, truck number, and time of batching). The production facility is in good condition; however, EA noted the following issues:

- Harrison has not performed the requisite concrete uniformity test at intervals not exceeding six months, in accordance with ASTM C685. (**Deficiency**)
- The AMEC UPF Material Testing Services Exhibit "D" Scope of Work references ACI 349 as the Code of Record for concrete work, instead of ACI 318, and also specifies performing concrete uniformity tests per ASTM C94, *Standard Specification for Ready-Mixed Concrete*, Annex A1 (equivalent to the ASTM C685 uniformity test), a test that BNI does not expect AMEC to perform.
- The Harrison QAP does not identify which ASTM standard (C94 or C685) is used for controlling concrete production.
- Chemical admixtures are stored in a CONEX box to provide spill containment, an expectation for ACPA certification. However, the door remains open with admixture dispensing hoses exiting the door at floor level. Such configuration does not provide the expected 110% spill containment capability, an ACPA checklist criterion. In addition, this configuration (door cannot be closed due to hoses in the doorway) may expose admixtures to freezing temperatures if the CONEX box cannot be heated sufficiently with the open door to maintain the admixtures above freezing. Many admixtures subjected to low temperatures undergo chemical changes that affect their performance.
- Water and admixture distribution hoses were lying haphazardly on the ground, subject to concrete encasement and accidental damage.

All concrete plant material production system calibrations were satisfactorily documented and met acceptance criteria. Harrison is adequately maintaining M&TE used for determining the moisture content of concrete aggregates on a daily basis at the concrete plant. The measured moisture content in the aggregates provides a basis for determining the quantity of water added into the concrete batches. Harrison's subcontractor, Systems and Controls, adequately calibrated cement, fly ash, and slag hopper load cells through their normally used operating range on August 10, 2017. CEI Enterprises, Inc., another Harrison subcontractor, verified water and admixture Coriolis flowmeters were within calibration on August 11, 2017, using a satisfactory procedure. The Harrison concrete production plant began operations on April 5, 2017. Accordingly, Harrison has completed calibration checks within the minimum six-month time frame specified in the Harrison QAP. However, BNI did not possess calibration records for each piece of M&TE, in contrast to the Harrison Subcontract, 25774-YRD-FC5-DB02-00001, Section 014300, *Quality Assurance*, subsection 1.03, A.5.c requirement to submit calibration records for each piece of M&TE. Harrison subsequently provided M&TE calibration records upon BNI request.

Overall, Harrison has appropriately certified its continuous concrete mixing plant and delivery trucks to produce RS concrete. While a few issues were identified, materials (cement, fine and coarse aggregate, water, and admixtures) used in concrete production are adequately tested in accordance with specified ASTM standards to verify that materials meet design specifications. Calibration of M&TE was found within required calibration frequencies, and these calibrations ensure that conforming proportions of concrete production materials are produced that meet installed concrete construction specifications.

5.3 Concrete Placement Preparations

This section discusses EA's assessment of preparations for each concrete placement to ensure that pre-placement activities conform to industry standards and practices, and are documented on a concrete placement card that lists the properties of the concrete to be placed, placement methods, estimated concrete quantity, weather requirements, and required pre-placement inspections. EA 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.*
- *Adequate equipment, such as concrete vibrators, are 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 heaters and enclosures to prevent freshly placed concrete from freezing.*
- *Inspections are completed by craft supervisors, field engineers, and QC inspectors, as applicable, prior to placement of concrete to verify pre-placement activities.*

As observed at the work site, Blaine workers properly prepared concrete surfaces for concrete placement. Blaine workers properly removed the curing compound and concrete laitance on the previous placements (below the new placements) using a traveling machine that lightly scarifies the concrete surface using small steel shot. Other Blaine workers cleaned debris from emplacement surfaces with hand tools and water hoses. Forms were properly configured and secure. Blaine provided proper equipment to convey, place, and consolidate the mass fill concrete. Working area access was sufficient to ensure worker safety.

EA reviewed the preparation for adverse weather with the BNI lead QC inspector. Tarps are available to cover the concrete placements in the event of adverse weather, such as heavy rain, or cold weather. For lightning hazards, outside work is terminated and works crews are sheltered. Lightning conditions occurred on May 31, 2017, during placement number LF1.06, causing an unplanned construction cold joint. EA reviewed Nonconformance Report (NCR) BOP-NCR-C-17-0010 that documented this issue.

The BNI Design Engineering department recommended adequate actions to resolve this cold joint and adequately completed corrective actions to support closure of this NCR. EA also reviewed NCR numbers BOP-NCR-C-17-0018, -0032, and -0033 that were initiated to document similar concrete pours interrupted by weather conditions or concrete plant mechanical issues. BNI Design Engineering adequately dispositioned these NCRs.

The BNI field engineer and the GEOS and BNI QC inspectors properly performed pre-placement inspections to ensure removal of debris from the concrete emplacement surfaces, proper form installation and integrity, and the installation of required imbedded items. The inspectors appropriately documented these inspections on the concrete placement card, and the BNI field engineer and the GEOS and BNI QC inspectors properly approved the placement. EA reviewed the concrete placement cards for placement number LF7.43 and verified dated card signatures prior to the concrete placement dates. EA verified that the concrete placement areas were properly prepared, cleaned, and wetted for placement numbers LF7.4, LF7.43, and LF7.44.

Overall, the UPF Project adequately plans and implements effective preparations for placement of concrete to ensure construction of the concrete structure in accordance with construction specification. Pre-placement activities appropriately include installation of forms, removing debris from forms prior to placement of concrete, availability of proper equipment, safe access to work areas, and preparing for adverse weather conditions. Pre-placement inspections by field engineers and QC inspectors adequately ensured readiness for concrete placement.

5.4 Fresh and Cured Concrete Testing

This section discusses EA's assessment of trucks delivering concrete to the job site area and testing of the freshly mixed concrete by AMEC technicians during concrete placement numbers LF7.4, LF7.43, and LF7.44. Furthermore, EA evaluated cured concrete testing activities off site to ensure that proper testing is being completed to verify that installed concrete meets design strength requirements.

Criteria:

- *Adequate fresh concrete samples are obtained and equipment used to test freshly mixed concrete (slump cones, tape measures, air meters scales 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, experienced, and certified test personnel (QC inspectors) are available to perform testing of the freshly mixed concrete within the time limits specified in ACI and 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.*
- *Test specimens (concrete cylinders) are handled, cured, and tested in accordance with ACI recommended practices and ASTM Standards.*
- *Results of tests (unconfined compressions tests) performed on the concrete cylinders are evaluated by qualified personnel per ACI 214, Evaluation of Strength Results of Concrete, to determine if in-place concrete strength meets design requirements.*

As observed, when the concrete delivery trucks arrived at the job site, a BNI QC inspector collected the concrete batch tickets, reviewed the tickets to verify that the proper mix was delivered, 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 Specification 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. Prior to discharging the concrete at the job site, the drum is turned 30 revolutions at mixing speed to ensure that the concrete is well mixed. After completing the discharge of the concrete, the time of completion and number of drum revolutions is recorded on a concrete truck log. The delivery trucks discharge the concrete onto belt conveyors, which transport the concrete to the point of placement.

A BNI QC inspector performs a visual inspection of the concrete when discharging of the concrete commences, to estimate the concrete slump. Although this is only an approximate method, an experienced QC inspector can, through observation, identify concrete that may have a high or low slump. If the QC inspector suspects that the concrete slump is outside of the specification limits, the inspector obtains a sample of the concrete to perform a slump test at the job site. If the measured slump is not within specification limits, the QC inspector takes another sample of the concrete for transport to the testing area. Further required tests (discussed below) are performed on the concrete, and cylinders are molded for strength testing. If test results indicate out of specification for concrete already placed, an NCR is written to disposition the nonconforming concrete.

AMEC technicians collected fresh concrete samples per ASTM C172, *Standard Practice for Sampling Freshly Mixed Concrete*, by diverting the delivery truck chute twice from the middle of the batch to acquire a properly sized sample. The samples were obtained at the point of discharge from the delivery trucks as specified in Specification CS-ES-801768-033012-A200, BNI document number BOP-FCS-C-17-0050. AMEC transported the fresh concrete samples to a nearby testing area where an appropriately sized and qualified crew was waiting to perform the required tests. EA observed the remixing and wet-sieving of the sample, which removes aggregate exceeding 1.5 inches in preparation for testing. EA also noted that wet-sieving resulted in the removal of less than or equal to three pieces of coarse aggregate in excess of four inches in any dimension, compliant with document 25774-TRD-HC4-HASA-00001-VDS-41.0-0119, *Removal and Collection of Large Aggregate During the Casting of Compressive Strength Specimens*.

AMEC QC inspectors 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. The calibration status of all the equipment was current. EA randomly selected three calibrated instruments (thermometer, hammer, and scale) to review the calibration records. Contrary to the AMEC subcontract Exhibit D, requirement 1.4, which requires AMEC provide BNI testing equipment calibration records, the current AMEC M&TE calibration status report provided to BNI did not list two of the three pieces of equipment (thermometer and scale) that were calibrated. Completed calibration records for this equipment confirmed that the error was that the AMEC M&TE calibration status report was incomplete. Although AMEC annually calibrates the weight scales used to weigh the freshly mixed concrete at the site, the harsh work environment where AMEC used the scales could potentially result in the scales being knocked out of calibration. (See **OFI-CNS-1**.)

EA witnessed the AMEC inspectors perform fresh concrete tests in accordance with ASTM standards to measure concrete temperature, slump, and density (unit weight). AMEC recorded and reported the test data to a BNI QC inspector who performs oversight and observes the concrete testing. The technicians completed slump, temperature, and density tests, including proper preparation, filling, rodding, surface strike-off, mold removal, and vertical slump measurement 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 AMEC technicians promptly evaluated results of the in-process test results and communicated these results to the concrete production plant.

EA also witnessed preparation of test specimens by AMEC (6 inch diameter cylinders and 12 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*, and stored in a CONEX, adjacent to the area where they were molded, for 24 hours prior to being transported to an offsite laboratory for additional curing and testing. ASTM C31 requires the temperature in the temporary onsite storage facility to be maintained between 60 and 80 degrees Fahrenheit. EA examined the storage facility and verified that the temperature was being controlled per ASTM C31.

AMEC provided a sufficient number of trained, experienced, and certified test personnel (QC inspectors) to obtain fresh concrete samples and perform testing of the freshly mixed concrete within the time limits specified in ACI and ASTM standards. EA verified that the AMEC QC inspectors and the AMEC site supervisor were ACI-certified Level 1 inspectors.

EA observed unconfined compression tests performed on three concrete cylinders that were seven days of age, and reviewed the results of concrete strength testing. The AMEC Knoxville laboratory performs concrete compressive strength tests in accordance with ASTM C39, *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*. EA, accompanied by a BNI QC inspector, examined the laboratory and witnessed unconfined compression tests performed on three cylinders listed in Appendix B. EA examined the curing tanks and verified properly maintained temperatures within the limits specified in ASTM C31 for curing concrete cylinders.

EA verified that the laboratory equipment displayed currently calibrated stickers and that the AMEC technician who performed the unconfined compression tests was certified by ACI as a Level I inspector. The technician performed the tests in accordance with ASTM C39, by checking the cylinder dimensions, verifying that the ends of the cylinders were plane within the specified tolerances, and applying the test load at the rate specified in ASTM C39. One of the cylinders tested did not meet the criteria for plane tolerance, so the end was saw cut in accordance with ASTM C39 to meet the specified tolerance. The tests demonstrated that the concrete strength exceeded the 28-day design strength requirement. The results of all unconfined compression tests completed to date show that the concrete placed in the mass fill foundation exceeded the 28-day minimum design strength.

EA reviewed two NCRs addressing concrete with slumps that exceeded specification requirements (NCR numbers BOP-NCR-C-17-0040 and -0041). BNI appropriately evaluated these NCRs. EA also reviewed a sample of other NCRs initiated to document issues with concrete that did not comply with specification requirements. These issues included high concrete temperatures, out of specification size aggregates, exceeding the lift thickness, and exceeding the allowable number of drum revolutions. NCRs reviewed by EA included NCR numbers BOP-NCR-C-17-0023, -0027, -0029, -0030, and -0037. BNI appropriately evaluated and resolved the NCRs.

BNI compiles and evaluates monthly Quality Dashboard Metrics addressing such areas as engineering, procurement, construction, and project management. Metrics including design deliverables, construction inspection record acceptance, nonconformance reports, and issues management performance provide meaningful information. Currently, AMEC promptly provides individual concrete test results to BNI, identifying any test results not meeting specified design compressive strength. However, BNI is not monitoring long-term trending test measurements of concrete compressive strength, an important work scope attribute, through their monthly BNI Quality Dashboard Metrics to identify problems for investigation. (See **OFI-CNS-2**.)

Overall, AMEC is acquiring proper fresh concrete samples and performing testing in accordance with ASTM standards, with properly calibrated and maintained equipment. Qualified inspectors are performing concrete testing in accordance with ASTM standards. AMEC appropriately handles, cures, and tests concrete test specimens (concrete cylinders) in accordance with ASTM standards. NCRs reflect appropriate evaluation. Timely reported concrete strength test results demonstrate that installed concrete exceeds design specification requirements; however, BNI is not performing long-term trending of concrete compressive strength test measurements.

5.5 Placement of Concrete

This section discusses EA's assessment of the training and staffing levels to support the proper placement of concrete. EA observed the placement of concrete and interviewed concrete placement workers regarding training and mentoring.

Criteria:

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

Blaine hires workers based on previous experience and expertise in concrete placement, and does not need to have a specific training program for concrete placement workers. However, Blaine provides orientation training for all placement workers to acquaint them with the unique UPF quality and safety requirements.

The Blaine workers performing the concrete placement work activities demonstrated proficient performance with an efficiently sized crew. Two conveyor operators simultaneously operated two concrete conveyors from opposing sides of the pour to ensure efficient concrete placement. Concrete conveyor operators placed concrete in a manner that would not cause segregation of coarse aggregate from the mortar or of water from the other ingredients, in accordance with ACI recommendations. Two machine-operated vibrator operators also performed layer consolidation work from opposing sides of the pour, with one additional worker operating a hand-held vibrator to consolidate material along the form sides. Blaine 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. One other worker methodically retrieved spill concrete cream from the side of the forms for placement back into the pour. A final worker operated a mechanical screed to level the pour. All observed performance was in accordance with ACI recommendations.

EA interviewed one mechanical screed operator with 21 years of concrete placement experience, who confirmed that his employer provided quality and safety training specific to the UPF construction work and that he was hired based on his skills and many years of experience. Experienced workers mentor less experienced workers.

Blaine's independent subcontracted QC inspector (GEOS) and a BNI QC inspector continuously inspected concrete placement operations to ensure that the concrete placement and consolidation in the forms is consistent with ACI recommendations. Observation of these QC inspectors conducting inspections of the construction activities indicated that the personnel were knowledgeable of the critical attributes of the structural concrete and the surveillance methods to verify compliance with the construction specification. QC inspectors effectively communicated their priority observations, including placement drop height, avoidance of cold joints, consolidation depth between layers, ensuring vibrators are not used to move concrete, and proper consolidation along forms. The BNI QC manager demonstrated skilled and effective leadership to ensure consistent QC performance among all concrete production, installation, and testing participants. The establishment of multi-QC inspection levels (BNI, Harrison, Blaine/GEOS, and AMEC) provides increased assurance that concrete quality will conform to construction specifications

Overall, Blaine has implemented an acceptable program for ensuring placement workers are adequately trained/experienced and familiar with UPF quality and safety requirements. Blaine uses efficiently sized concrete placement crews, who place concrete in accordance with ACI-recommended practices. Blaine uses qualified QC inspectors, who are performing requisite inspections consistent with industry standards.

5.6 Post-Placement Activities

This section discusses EA's assessment of testing of the freshly mixed concrete by AMEC technicians during concrete placement for lift numbers LF7.4, LF7.43, and LF7.44.

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 specification, following recommendations in the design documents and ACI Standards. (10 CFR 830.122(c))*

Blaine applies a curing compound to the surface of the concrete. Concrete placement cards record the curing method. The BNI field engineer and GEOS and BNI QC inspectors perform post-placement inspections to identify any concrete defects that require repair and to monitor concrete curing, which are also documented on the concrete placement cards. Blaine Procedure PP-85665-01 provides details for repair to any identified concrete defects. NCR numbers BOP-NCR-C-17-0010, -0018, -0032, and -0033 were initiated to document concrete pours that were interrupted and required repair to the concrete in some areas. As stated in Section 5.3 above, the NCRs were adequately evaluated and corrective actions were completed.

QC inspectors adequately perform and document post-placement inspections of concrete.

5.7 QC Personnel Qualification

This section discusses EA's 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)*

EA verified the certification of QC inspectors by reviewing BNI and ACI training records. Interviews and record examinations confirmed that all interviewed QC inspection personnel (BNI, Harrison, Blaine/GEOS, and AMEC) were ACI-certified Level 1 inspectors based upon training, experience, and professional certifications, consistent with subcontract requirements. A selected sample of GEOS, AMEC, and BNI QC inspectors interviewed presented their ACI-certified Level 1 cards and effectively communicated their inspection priorities and focus areas. The QC inspectors interviewed and observed performing duties were qualified and demonstrated sufficient proficiency to fulfill the role of QC inspector.

5.8 Quality Records

This section discusses EA's assessment of the implementation of record retention requirements for quality-related documentation from surveillance activities that verify the critical attributes of the structural concrete.

Criterion:

- *Records documenting production, placement, and inspection of concrete work are required to comply with NQA-1 requirements, or applicable Codes/Standards referenced in contract documents. (DOE Order 414.1D)*

EA reviewed record retention requirements and implementation performance. Each of the three BNI subcontracts (Harrison, Blaine, and AMEC) specifies the collection of required production, placement, inspection, and testing records, and submittal to BNI. Only the Blaine subcontract specifies the retention of records in fire-rated containers, and only the AMEC subcontract specifies a reporting time frame. The fiscal year *2018 BNI Management Assessment and Management Surveillance Schedule* and the fiscal year *2018 UPF Quality Assurance Audit and Surveillance Schedule* indicate planned assessments/surveillances of records but do not specifically address verification of subcontractor temporary record storage protection.

BNI is effectively maintaining UPF records through the BNI official records system, INFOWORKS, which ensures long-term records retention and compliance with DOE and NQA-1 requirements. This approach minimizes the risk of subcontractor record loss. BNI specifies this commitment in PL-PJ-801768-A001, *Document Control and Records Management Plan*, but BNI does not address this in the UPF QAP. All records reviewed by EA were complete and legible.

EA reviewed the following sample of records that document the quality of materials used for production of concrete: gradation records for concrete aggregates (#3 stone, #57 stone, and manufactured sand) submitted by the aggregate supplier (Rogers); ASTM C33 qualification tests for concrete aggregates; a sample of completed concrete pour packages prepared by Blaine that include placement cards, concrete batch tickets, and concrete truck logs; a sample of completed concrete placement cards; and AMEC test reports, concrete mix design data, and concrete compressive test data. The records reviewed indicate that UPF concrete construction quality records are retrievable, legible, and maintained in accordance with NQA-1 requirements.

6.0 FINDINGS

EA identified no findings during this assessment.

7.0 OPPORTUNITIES FOR IMPROVEMENT

EA identified some OFIs to assist cognizant managers in improving programs and operations. While OFIs may identify potential solutions to findings and deficiencies identified in appraisal reports, they may also address other conditions observed during the appraisal process. EA offers these OFIs only as recommendations for line management consideration; they do not require formal resolution by management through a corrective action process and are not intended to be prescriptive or mandatory. Rather, they are suggestions that may assist site management in implementing best practices or provide potential solutions to issues identified during the assessment.

CNS:

- **OFI-CNS-1:** BNI/AMEC should consider establishing periodic use (several times a day) of a “check weight” to ensure continuous accurate performance of the scales used in concrete testing (e.g., slump testing) at the construction site.

- **OFI-CNS-2:** CNS/BNI should consider trending concrete compressive strength test data results to identify any negative or positive trends for appropriate investigation.

Appendix A
Supplemental Information

Dates of Assessment

Onsite Assessment: November 6-10, 2017

Office of Enterprise Assessments (EA) Management

William A. Eckroade, Acting Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
William E. Miller, Deputy 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
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Quality Review Board

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

Appendix B
Key Documents Reviewed, Interviews, and Observations

Documents Reviewed

- Y60-95-102PD R4, *Uranium Processing Facility Quality Assurance Program Description*, April 5, 2017
- BNI/UPF Construction Subcontract – Exhibit "B" – Special Conditions, Appendix B-7, *Quality Assurance*, March 18, 2016
- Harrison Subcontract: 25774-YRD-FC5-DB02-00001, Section 014300, *Quality Assurance*
- Blaine Subcontract: Exhibit "B" Special Conditions, Appendix B-7, *Quality Assurance/Quality Control*, June 30, 2016
- AMEC Subcontract: Exhibit "D" – *Scope of Work and Technical Specifications*, February 9, 2016
- CS-ES-801768-033011-A001 R1, *Engineering Specification for Furnishing and Delivering Ready-Mix Concrete*, June 6, 2016
- CS-ES-801768-033012-A200 R3, *Construction Specification for Mass Fill and Mud Mat Concrete Work*, April 24, 2017
- 25774-YRD-HC4-HASA-00001-VDS-41.0-0009, [AMEC] *Commercial Quality Assurance Plan*, October 19, 2016
- 25774-YRD-HC4-HASA-00001-VDS-41.0-0005_2, [AMEC] *QAPD* [Quality Assurance Project Document], Rev 5, March 6, 2017
- 25774-CON-FC3-DB00-00001-VDS-41.0-0004, [Blaine] *Project Quality Assurance Plan*, November 18, 2016
- 25774-YRD-FC5-DB02-00001-VDS-6.0-0001_3QAP, [Harrison] *Quality Assurance Program*, November 7, 2017
- 25774-YRD-FC5-DB02-00001-VDS-6.0-0001_7, [BNI comments on Harrison QAP], November 8, 2017
- 25774-YRD-FC3-DB02-00001-VDS-34.0-0005, *Blaine Mass Concrete Fill (MCF) Placement Plan*, September 20, 2017
- 25774-YRD-HC4-HASA-00001-VDS-41.0-0014, *AMEC Concrete Testing Work Plan*, February 21, 2017
- 25774-YRD-FC5-DB02-VDV-17.1-0005, Harrison Transmittal #0117, *NRMCA Certification*, December 22, 2016
- UPF BOP-FCS-C-17-0007, *UPF Field Change Document*, February 3, 2017
- 25774-YRD-FC5-DB02-00001-VDE-41.0-0042_2, [Harrison] List of M&TE, February 16, 2017
- 25774-YRD-FC5-DB02-00001-VDE-41.0-0053, [Harrison] *Scale Test Record*, September 2, 2017
- 25774-YRD-FC5-DB02-00001-VDV-17.1-0012_2, [Harrison] NRMCA Mixer Truck Certification, November 1, 2017
- 25774-TRD-HC4-HASA-00001-VDS-41.0-0119, R2, *Removal and Collection of Large Aggregate During the Casting of Compressive Strength Specimens*, October 6, 2017
- 25774-YRD-HC4-HASA-00001-VDS-41.0-0040, [AMEC] Project Equipment Calibration Records, October 26, 2017
- 25774-YRD-FC3-DB00-00001-VDS-41.0-0065, Pour Package #37, Loc ID L3.16 & L3.17
- 25774-YRD-FC5-DB02-00001-VDE-41.0-0054, Harrison Aggregate Moisture Test Reports – Batch Plant Stock Pile, July 5 through July 26, 2017
- 25774-YRD-FC5-DB02-00001-VDV-17.1-0025, Harrison Submittal - Fine Aggregate – Mfg Sand Gradation, Rogers Quarry test reports for September, 2017
- 25774-YRD-FC5-DB02-00001-VDV-17.1-0020, Harrison Submittal - Coarse Aggregate grading #57 Stone, Rogers Quarry test reports for July 11 to August 30, 2017

- 25774-YRD-FC5-DB02-00001-VDV-41.0-0022, Harrison Submittal - Coarse aggregate grading #3 Stone, Rogers Quarry test reports for July 11 to August 30, 2017
- 25774-YRD-FC5-DB02-00001-VDE-41.0-0025, Harrison submittal for Concrete Mix Design
- Nonconformance report Numbers BOP-NCR-17-0010, -0018, -0023, -0027, -0029, -0030, -0032, -0033, -0037, -0040, and -0041
- AMEC G1-12 calibration report – scale, September 7, 2017
- AMEC PCC13-0007 calibration report – thermometer, November 2, 2017
- UPF Quality Dashboard Metrics, September 2017
- 2018 BNI Management Assessment and Management Surveillance Schedule, September 29, 2017
- 2018 UPF Quality Assurance Audit and Surveillance Schedule, September 2017
- PL-PJ-801768-A001, *Document Control and Records Management Plan*, May 2017
- Blaine Construction work plan, titled *Mass Concrete Fill (MCF) Placement Plan*
- *Blaine Concrete Repair Procedure PP-85665-0*
- AMEC Concrete Testing Work Plan

Interviews

- CNS/QA Manager
- BNI QC Manager
- BNI QC Field Engineer
- BNI/QA Manager
- BNI Subcontracts Manager
- Harrison Assistant QC Manager
- Harrison Concrete Truck Inspector
- Harrison Plant Operations Manager
- Harrison QC Inspector
- Blaine/GEOS QC Inspector
- Blaine Concrete Installation Worker
- Blaine QA Technician
- AMEC QC Site Supervisor
- AMEC QC Technicians (2)

Observations

- Pre-Job Briefing and Concrete Placement for Lift Plan 7.9
- Pre-Job Briefing and Concrete Placement for Lift Plans 7.43 & 7.44
- AMEC Fresh Concrete Testing during placement numbers 7.9, 7.43, & 7.44
- Harrison Concrete Production Plant Operations
- Unconfined Compression Tests performed at seven days of age on cylinder# MCF.L7.11-01, L7.17-03, and L7.17-04

Appendix C
Deficiencies

Deficiencies that did not meet the criteria for a finding are listed below, with the expectation from DOE Order 227.1A for site managers to apply their local issues management processes for resolution.

- Harrison has not performed the requisite concrete uniformity test at intervals not exceeding six months in accordance with American Society for Testing and Materials (ASTM) C685, *Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing*.