

**Office of Enterprise Assessments Review of the Hanford Site
K-West Annex Facility
Construction Quality**



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Acronyms

AIE	American Ironworkers and Erectors
AISC	American Institute of Steel Construction
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials International
AWS	American Welding Society
CFR	Code of Federal Regulations
CGD	Commercial Grade Dedication
CHPRC	CH2M Hill Plateau Remediation Company
CMTR	Certified Material Test Report
COC	Certificate of Conformance
CRAD	Criteria, Review and Approach Document
CWI	Certified Welding Inspector
DOE	U.S. Department of Energy
DOE-ORP	DOE Office of River Protection
DOE-RL	DOE Richland Operations Office
EA	DOE Office of Enterprise Assessments
FCAW	Flux Cored Arc Welding
FCAW-G	Gas Shielded Flux Cored Arc Welding
FE&C	Federal Engineers & Constructors
ITA	Independent Testing Agency
NQA	Nuclear Quality Assurance
PQR	Procedure Qualification Record
QA	Quality Assurance
QAM	Quality Assurance Manual
QC	Quality Control
RCSC	Research Council on Structural Connections
SLRS	Seismic-Load Resisting System
SMAW	Shielded Metal Arc Welding
SSC	Structures, Systems, and Components
VT	Visual Examination
WPQ	Welder Performance Qualification
WPQR	Welder Performance Qualification Record
WPS	Welding Procedure Specification
WTP	Waste Treatment and Immobilization Plant

Office of Enterprise Assessments Review of the Hanford Site K-West Annex Facility Construction Quality

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) independent Office of Enterprise Assessments (EA) conducted an independent assessment of construction quality at the Hanford Site K-West Annex Facility. The initial portion of the review was performed by EA's predecessor organization. The onsite review was performed on March 9 and May 6, 2014, and included observations of structural steel construction work activities and completed work. The review of construction documents and quality records was performed offsite.

Activities included in this assessment of construction quality included review of preparations for erection of structural steel, observations of structural steel erection, and visual inspection of completed structural steel work. EA also reviewed records documenting the training and certification of Quality Control (QC) inspectors; quality records demonstrating that weld filler materials and structural steel bolts, nuts, and washers comply with specification requirements; and records documenting the qualification of welders and welding processes. Design and procurement programs were not included in the scope of the construction quality review. EA reviewed the drawings and specifications for structural steel erection construction activities and conducted a construction site walkthrough in conjunction with DOE Richland Operations Office (DOE-RL) project personnel. During the walkthrough on May 6, EA performed a visual inspection of the structural steel that had been erected; observed tensioning of structural steel bolts in connections, and visually examined some completed welds.

EA determined that structural steel construction, including welding, procurement, and welding activities, is being performed in accordance with the CH2M Hill Plateau Remediation Company (CHPRC) specification, referenced industry standards, and the CHPRC and Federal Engineers & Constructors (FE&C) Quality Assurance (QA) programs. The qualifications and certification of QC inspectors comply with industry standards and the FE&C and CHPRC QA programs. EA will continue to follow up on construction work at the K-West Annex Facility with additional review of Certified Material Test Reports for weld filler materials used for demand critical welds, weld travelers, and weld inspection records. EA will also review corrective actions to address discrepancies identified during construction.

Office of Enterprise Assessments Review of the Hanford Site K-West Annex Facility Construction Quality

1.0 PURPOSE

An independent assessment of structural steel construction quality at the Hanford Site K-West Annex Facility was performed from March through July 2014. The initial portion of the review was performed by the Office of Enterprise Assessments' (EA's) predecessor organization in March and April.

2.0 SCOPE

The scope of this assessment of construction quality included review of preparations for erection of structural steel, observations of structural steel erection, and visual inspection of completed structural steel work. EA also reviewed records documenting the training and certification of quality control (QC) inspectors; procurement records demonstrating that weld filler materials and structural steel bolts, nuts, and washers comply with specification requirements; and records documenting the qualification of welders and welding processes. Design and procurement programs were not included in the scope of the construction quality review. EA reviewed the drawings and specifications for structural steel erection construction activities and conducted a construction site walkthrough in conjunction with Department of Energy (DOE) Richland Operations Office (DOE-RL) project personnel. During the walkthrough on May 6, EA performed a visual inspection of the structural steel that had been erected; observed tensioning of structural steel bolts in connections, and visually examined some completed welds.

3.0 BACKGROUND

The DOE Hanford Site is undergoing extensive cleanup to remove waste generated by nine former nuclear reactors and associated processing facilities, dating from World War II, that produced plutonium for atomic weapons for the United States defense program. Two DOE offices manage the cleanup effort: DOE-RL and the DOE Office of River Protection (DOE-ORP). DOE-RL oversees the cleanup of the reactors, processing facilities, soil, and groundwater and also manages the demolition of the reactors and other facilities and the disposal of any plutonium and fuel rods remaining on the Hanford Site. Under contract to DOE-RL, CH2M Hill Plateau Remediation Company (CHPRC) performs the design, onsite construction work, and monitoring activities necessary to complete the Hanford Site cleanup. DOE-ORP was established in 1998 to manage the 56 million gallons of liquid or semi-solid radioactive and chemical waste stored in 177 underground tanks at the Hanford Site. DOE-ORP serves as DOE line management for two functions: the Tank Farms, which maintain the 177 underground storage tanks; and design, construction and operation of the Waste Treatment and Immobilization Plant (WTP), which will retrieve, treat, and dispose of the waste stored in the underground tanks. Design and construction of the WTP is managed by Bechtel National, Inc., under contract to DOE-ORP.

When the decision was made in the 1980s to end production of plutonium at the Hanford Site, the remaining fuel rods and rod fragments were temporarily stored in two water-filled underground tanks (basins) adjacent to the K-East and K-West Reactors. In the 1990s, the K-East Basin was found to be leaking. The fuel rods were removed from both basins, dewatered/dried, stored in casks, and transported to the Hanford Canister Storage Building, pending long term storage in a national repository. However, the fuel rods had started to deteriorate while stored in the underground basins, producing a material called sludge, which is a radioactive mixture of fuel corrosion particles, small fuel rod fragments, metal

fragments, and other materials. The sludge from the East Basin was transferred to the West Basin, and the East Basin was decontaminated and demolished.

The K-West Annex Facility is being constructed to serve as a load-out facility for the sludge stored in the K-West Basin. The sludge will be pumped into a tank enclosed within a cask in a special trailer, which will then transport the sludge to the T-Plant for treatment, processing, and preparation for long term storage at an offsite national repository, or disposal at an appropriately permitted offsite facility. The K-West Annex is classified as a hazard category 2 seismically designed safety significant reinforced concrete and structural steel building. The K-West Annex contains a loading bay that will enclose the trailer when the sludge is being pumped into the tank and an adjacent support facility. The loading bay portion of the K-West Annex is 30 feet wide by 53 feet long, with walls 20 feet high constructed of reinforced concrete that provide radiation shielding and missile protection. The top of the loading bay will be covered by a seismically designed structural steel frame enclosure that will house operators, controls, a bridge crane, and mechanical and electrical equipment. The adjacent support facility is a seismically designed structural steel building, 26 feet wide by 70 feet long, that is attached to the south side of the loading bay. The support facility will contain locker and changing rooms, administrative offices, additional mechanical and electrical equipment, ventilation equipment, high efficiency particulate air (HEPA) filters, and an exhaust stack. The design of the K-West Annex Facility was completed by AREVA Federal Services under contract to CHPRC. Federal Engineers and Constructors (FE&C) is the general construction contractor for the project and performs the work under the supervision of CHPRC. The requirements for performance of the work by FE&C are specified in the Statement of Work for Construction, Requisition # 240422, Modified FW Basin Annex Construction, Revision 2, dated May 16, 2012, prepared by CHPRC.

4.0 METHODOLOGY

EA conducted this independent assessment of the K-West Annex construction quality in accordance with the *Plan for the Independent Oversight Review of the Hanford K West Annex Facility Construction Quality*, dated May 2014, and the applicable sections of Nuclear Facility Construction Criteria Review and Approach Document (CRAD) HSS-CRAD-64-16, *Construction - Structural Steel*. This EA assessment focused on activities relating to preparations for erection of structural steel, inspection of in-process and completed structural steel work, observation of QC inspection and quality assurance (QA) activities, and review of inspection records.

After the March onsite review, site personnel provided EA with the Construction Specification for structural steel framing and QC and QA procedures covering processes for welding and welding inspections. After the May onsite review, the project office provided EA with procurement records documenting quality of structural steel bolts, nuts, and washers and weld filler materials; QC inspector certification and qualification records; and records documenting qualifications of welding processes and welders.

The review included examining documents (e.g., work instructions, procedures, specifications, drawings, and records); interviewing key personnel responsible for constructing and inspecting work activities; and site walkdowns to observe work activities. The review considered the requirements of 10 CFR 830, Subpart A, *Quality Assurance Requirements*, and DOE Order 414.1D, *Quality Assurance*. Title 10 CFR 830 and DOE Order 414.1D require DOE contractors to use appropriate national consensus standards to implement DOE QA requirements. The CHPRC Statement of Work requires that construction of the K-West Annex Facility be performed in accordance with a documented QA program and implementing procedures that meet the requirements of American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA)-1-2008, *Quality Assurance Requirements for Nuclear Facility Applications*.

The QA requirements in ASME NQA-1 are specified in 18 basic and supplemental criteria. The FE&C Quality Assurance Manual (QAM) dated December 16, 2013, describes the FE&C QA program. The FE&C program incorporates the basic and amplified requirements of the supplemental criteria from NQA-1-2008, Subpart A and applicable sections of Parts 2 through 4 through Addenda 1a-2009, and complies with DOE Order 414.1D. The QAM provides a detailed description of the application of the 18 NQA-1 requirements to construction of the K-West Annex Facility and establishes the planned and systematic actions necessary to provide adequate confidence that structures, systems, and components (SSCs) will perform satisfactorily in service.

5.0 RESULTS

Activities examined by EA during the review are discussed below. Each activity is briefly described, followed by a discussion of the review performed by EA. Conclusions are summarized in Section 6, and items for follow-up are discussed in Section 7.

Construction Status

The status of construction during the March 2014 assessment was as follows: concrete placements for the loading bay walls, foundations and floor slabs, and foundations and floor slabs for the adjacent support facility were complete; repairs to minor concrete defects that occurred during the concrete placements were complete; preparations were under way for start of the erection of structural steel; and delivery of structural steel from the steel fabrication shop to the site was in progress. During the May 2014 assessment, erection of structural steel was approximately 25 percent complete, and structural steel was being erected for the support facility. Activities in progress included tensioning of structural steel bolts, welding, and QC inspection of completed structural steel work. Holes were also being drilled in the loading bay walls for installation of post installed concrete anchors, which are required to anchor structural steel that was reconfigured as a result of a design change.

Two subcontractors to FE&C – Metalfab, Inc. and American Ironworkers and Erectors (AIE) – are performing the structural steel construction work. Metalfab, Inc. is completing offsite fabrication of the structural steel members, which involves cutting various sizes and types of structural steel shapes to the lengths shown on the design drawings, drilling holes in the members at locations shown on the connection detail drawings, and performing shop welds required to add steel plates shown on the design drawings to reinforce the steel members or to provide for an attachment point at a beam (column connection, or connection of a diagonal brace or other component). Each fabricated structural member is given a unique identification number. NQA-1 and the FE&C QA program require documentation to be maintained to provide traceability of the source of the structural steel, welding data, and QC inspection records. AIE performs erection of the structural steel at the jobsite; these activities include setting the structural steel accurately in locations and elevations shown on the design drawings, maintaining vertical and horizontal tolerances specified in American Institute of Steel Construction (AISC) criteria, installing and tensioning high strength structural bolts, and completing field welds as shown on the construction drawings in accordance with American Welding Society (AWS) criteria.

Review of Drawings and Specifications for Structural Steel Construction

Criteria: Work, such as structural steel erection, shall be performed in accordance with approved procedures, design drawings, 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 (NQA-1, Criterion 5; Section 5 of the FE&C QAM; and DOE Order 414.1D).

The critical characteristic for installation of the structural steel in the K-West Annex facility is completing the beam-to-beam and beam-to-column connections in accordance with the joint construction details shown on the design drawings to develop a seismic-load resisting system (SLRS). The connection details on the drawing include bolted connections using high strength structural steel bolts meeting the requirements of ASTM International (ASTM) A-325 or ASTM F1852, welded connections, or a combination of welded and bolted connections. The design engineer has designated several welds in the seismic framing as demand critical welds on the structural steel framing drawings. Failure of a demand critical weld could lead to significant degradation of the SLRS.

EA reviewed CH2M Hill Construction Specification for Modified KW Annex, Document number 44577-CSI-SPEC-001-051200, *Structural Steel Framing*. The Specification details the technical requirements for structural steel construction, including: (1) contractor submittals required to be provided to CHPRC for approval prior to performing work; (2) QA and QC requirements; (3) industry standards and specifications applicable to structural steel work; (4) material requirements, including structural steel shapes, high strength bolts, and weld filler materials; (5) fabrication and erection tolerances; and (6) requirements for bolted and welded connections. The connections and structural elements that resist seismic loads and make up the SLRS are listed in the Specification and are also shown on the structural steel framing drawings. The requirements for demand critical welds, listed in Specification sections 1.3.J.2 and 1.4.D, require that welders performing work on demand critical welds pass the supplemental welder qualification tests specified in AWS D1.8. Specification section 2.1.G.2 requires that weld filler materials comply with the provisions of AWS D1.8.

The Specification requires the contractor to comply with the following industry standards and codes:

- AISC Specification 303, *Code of Standard Practice for Structural Steel Buildings and Bridges*
- AISC Specification 341, *Seismic Provisions for Structural Steel Buildings*
- AISC Specification 360, *Specification for Structural Steel Buildings*
- ASTM A6, *Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Steel Piling*
- Research Council on Structural Connections (RCSC) *Specification for Structural Joints Using ASTM A325 or A490 Bolts*
- AWS *Structural Welding Code AWS D1.1*
- AWS D1.8 *Seismic Supplemental Welding Manual* (for demand critical welds).

EA reviewed the construction drawings showing the details for structural steel framing for the support structure between Grids 2 and 3, and between Column lines A and E. The drawings show the connection details, such as weld details or number and size of bolts, member sizes, structural steel erection details and tolerances; indicate the locations of demand critical welds; and list General Notes applicable to structural steel construction work.

EA also reviewed FE&C procedure KW-IP-48873-03, *Quality Assurance Inspection Plan Structural*, section 051200, *Structural Steel* and section 055000, *Metal Fabrications*. The Construction Specification

contains provisions for the contractor to retain an independent testing agency (ITA) to perform QC inspection of structural steel and other construction work. These inspection plans prescribe the inspection activities that the ITA is required to perform to ensure compliance with the requirements of Specification 44577-CSI-SPEC-001-051200. The required inspections include verification that structural steel shapes meet the dimensional requirements of ASTM A6, that structural steel is erected accurately and to specified tolerances, and that welded and bolted connections comply with details shown on the drawings. The AWS D1.1 welds are inspected using visual examination (VT) methods in compliance with AWS criteria. In addition to VT, demand critical welds are inspected using ultrasonic testing methods.

EA concluded that the procedures, design drawings, and other design basis documents for structural steel construction work are adequate.

Control of Welding Processes

Criteria: Special processes that control or verify quality, such as those used in welding, shall be controlled by written instructions, procedures, drawings, or other appropriate means and shall be performed by qualified personnel using qualified procedures in accordance with specified requirements. (NQA-1, Requirement 9; Section 9 of the FE&C QAM; and DOE Order 414.1D)

The requirements for control of special processes, such as welding, are detailed in Specification 44577-CSI-SPEC-001-051200, *Structural Steel Framing*. FE&C Procedure QAP-09-01, *Control Special Processes*, describes the general methods used by FE&C to control welding activities. These include using written instructions or procedures, using qualified individuals to perform welding, performing nondestructive examination of welds, and maintaining records documenting welding activities. The Specification requires structural welding to be performed in accordance with AWS D1.1, *Structural Welding Code – Steel*, which covers the welding requirements applicable to welded structures. The Code is comprehensive and provides general stipulations applicable to any situation, including requirements for: (1) welding prerequisites; (2) materials – base metals and filler metals; (3) weld joint preparation, joint cleaning, and fitup; (4) preheat; (5) purges; (6) interpass temperatures; (7) weld techniques; (8) criteria for completed welds; (9) weld inspections (VT); and (10) weld repairs. The Code also covers design of welds, the methods for qualifying welding procedures, control of weld filler materials, qualification of welders and weld inspectors, and weld documentation requirements.

The AWS Code requires that a company demonstrate that it has the ability to produce acceptable welds by performing a series of test welds witnessed by a qualified inspector, such as an AWS certified welding inspector (CWI). After the test welds are completed, they are subjected to a series of tests performed by an independent test laboratory. A procedure qualification record (PQR) is prepared to document the record of the test weld, including the weld joint setup, base metal and filler metal, thickness of base metal, welding method, welding current, preheat, purge, test results, and other pertinent information. After the weld test and the PQR are completed, a welding procedure specification (WPS) is prepared describing the welding procedures, which provides direction to the welder for making quality production welds that meet AWS Code requirements. Each WPS is supported by a PQR. Individual welders are certified with a qualification test documented in a welder performance qualification record (WPQR).

Specification 44577-CSI-SPEC-001-051200 requires that demand critical welds meet the requirements of AWS D1.8, *Seismic Supplemental Welding Manual*, which requires welders performing work on demand critical welds to pass the supplemental welder qualification tests and includes specific requirements for the weld filler materials to be used to make the demand critical welds. AWS D1.8 also requires additional information to be added to the WPS, such as filler metal manufacturer, data on heat inputs, and limitations on interpass temperatures.

EA reviewed the following written FE&C instructions and procedures that establish the processes used by FE&C for control of welding activities: FE&C QAP-02-003, *Welder Performance Qualification*; FE&C QAP-09-002, *Documentation and Tracking of Welder Performance Qualification*; FE&C QAP-08-002, *Weld Filler Metal Control*; and FE&C Procedure QAP-02-02, *Quality Assurance/Quality Control Qualification/Certification*,

Procedure FE&C QAP-02-003 establishes the requirements for the testing and qualification of FE&C and FE&C subcontractor welders. All welders are required to demonstrate their ability to make sound welds by welding test coupons using a qualified WPS under the supervision of a qualified welding inspector. The test coupons are subjected to various tests to verify that the weld is sound and meets AWS criteria. The welder qualification is limited to the essential variables listed in the WPS. A record of the welder's qualification performance test is documented in a welder performance qualification (WPQ). After initial qualification, the welder is assigned an identifying number. The performance qualification remains in effect unless the welder has not welded with the process for a period of six months or more, or there is a reason to question the welder's ability to make quality welds. Procedure FE&C QAP-09-002 establishes the process FE&C uses to document the welder's WPQ and to record the welder's performance by maintaining a WPQR that records the type and number of production welds, including records of unacceptable welds for each welder, and the welder's WPQ. The WPQR is used to track the welder's performance to verify that the welder's qualifications are current, to maintain a record of the type and number of welds completed by the welder, and to maintain a record of welds completed by the welder that did not pass inspection.

Procedure FE&C QAP-08-002 establishes the FE&C process for control, storage, and issue of weld filler materials used in welding operations. These materials are procured from approved suppliers and inspected on receipt by QC personnel. Controls for storage of filler materials include the requirement to maintain traceability at all times. Covered electrodes are required to be stored in weld rod ovens after the sealed containers are opened. Filler material issue is controlled by authorized weld room attendants and use of rod issue slips. At the end of each shift, welders are required to return unused filler materials to the filler material issue location. Records are maintained documenting weld rod oven temperatures and weld rod issue slips.

FE&C Procedure QAP-02-02 prescribes the process FE&C uses to qualify QC inspection personnel. These personnel are required to be qualified in accordance with the requirements of American Society for Nondestructive Testing SNT-TC-1A, which specifies the requirements for education and experience, written examinations, and physical examinations and requires annual examination of visual acuity and color contrast differentiation. Specification 44577-CSI-SPEC-001-051200 requires all QC inspectors who perform inspection of welds to be qualified to AWS QC1, *Standard for AWS Certification of Welding Inspectors*.

EA reviewed Metalfab, Inc. procedure MF-FCAW-I, *Structural Steel Welding Procedures*. This procedure covers welding of components to the requirements of AWS D1.1 but is not applicable to welding of demand critical welds. The Metalfab, Inc. procedure covers welding prerequisites, materials, joint preparation, cleaning, fitup, preheat, interpass temperatures, welding technique, criteria for completed welds, and weld repairs. Attachments to the procedure cover minimum fillet weld sizes, welder qualification, weld joint details, and Metalfab, Inc. prequalified weld procedure specifications

EA concluded that the instructions, procedures, and drawings for control of welding activities are adequate.

Structural Steel Construction

Criteria: Structural steel framing and appurtenances are safety significant SSCs. SSCs that perform a safety function shall be installed in accordance with approved procedures, design drawings, specifications, 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. (NQA-1, Requirement 5; Section 5 of the FE&C QAM; and DOE Order 414.1D)

EA performed a walkdown inspection and observed storage of structural steel members and bolts, pre-tensioning (tightening) of twist-off type bolts in several connections, and completed welds. Structural steel members were stored off the ground using dunnage and were adequately supported to prevent distortion or damage. The storage areas were covered with gravel and were graded so that the structural steel members would not be submerged in water. Fasteners were stored in an enclosed storage area in compliance with RCSC and ASTM requirements. The welds examined by EA were those in column-to-base plate connections and column-to-diagonal support connections between Elevation 100 and 105 in Grid 3, Column lines D and D.4. The bolts that EA observed during tensioning EA were located between Grid 2 and 3 between Column lines A and C. Prior to final pre-tensioning, the bolts had been installed and snug tightened in accordance with the requirements of RCSC *Specification for Structural Joints Using ASTM A325 or A490 Bolts*. The twist-off fastener assemblies were pre-tensioned by severing the splined ends of the fastener assemblies using the air-operated tool designed for this task.

EA determined that for the sample inspected, structural steel construction is being performed in accordance with specification and procedure requirements.

Qualification of QC Inspection Personnel

Criteria: Inspection and Test personnel shall be qualified and certified in accordance with NQA-1 requirements and shall pass an annual eye and physical examination. Records for qualification of inspection and test personnel shall be maintained. (NQA-1, Criterion 2; Section 2 of the FE&C QAM; and DOE Order 414.1D)

The requirements for weld inspector qualification are detailed in Sections 1.4.C and 1.4.E of Specification 44577-CSI-SPEC-001-051200. FE&C Procedure QAP-02-02, *Quality Assurance/Quality Control Qualification/Certification*, describes the process used by FE&C to qualify and certify QC inspectors. EA reviewed the records documenting the training and qualifications of five QC inspectors employed by the ITA to verify compliance with NQA-1 requirements. Records reviewed included summaries of work experience, including on-the-job training, formal education, satisfactory completion of technical training courses directly related to inspection duties, certification by a nationally recognized organization, and visual and physical examination records. The five inspectors are certified to perform weld inspections in accordance with AWS QC1, *Standard for AWS Certification of Welding Inspectors*. The documentation provided for one of the ITA inspectors was incomplete, but EA reviewed the AWS online database and verified that all five of the ITA welding inspectors were certified as AWS CWIs.

For the sample reviewed, EA concluded the qualification and certification of QC inspectors complies with the requirements of the NQA-1 requirements and DOE regulations.

Qualification of Welders and Welding Processes

Criteria: Special processes that control or verify quality, such as those used in welding, shall be performed by qualified personnel using qualified procedures in accordance with specified requirements. (NQA-1, Requirement 9; Section 9 of the FE&C QAM; and DOE Order 414.1D)

EA reviewed the records documenting the qualification and certifications of welders, the WPS, and supporting PQRs for structural steel shop and field welds for fabricating structural steel members and erecting the structural steel at the K-West Annex facility. FE&C procedures that control documentation and qualification of welders' activities are FE&C QAP-02-003, *Welder Performance Qualification*, and FE&C QAP-09-002, *Documentation and Tracking of Welder Performance Qualification*. Records reviewed included:

- Results of initial qualification tests for five Metalfab, Inc. welders (ID numbers 139,140, 146 150 &151) for gas shielded flux cored arc welding (FCAW-G) performed in accordance with Metalfab, Inc. WPS (WPS-17A) GP-1B.
- Pre-qualified Metalfab, Inc. non-demand critical FCAW-G welding performance specifications for the following WPS numbers:
 - (1) MF (WPI) G-1 for T-joint, lap-joint welds
 - (2) MF (WP4) G-3 for square groove T-joint welds
 - (3) MF (WP7) G-211 for single bevel T-joint welds
 - (4) MF (WPS11) G-2 for plug welds
 - (5) MF (WPS17) FLARE for flare bevel groove welds
 - (6) MF (WPS17A) GP-1B for single groove welds
 - (7) MF (WPS17B) PJP T/C for single bevel groove corner welds.
- Results of initial qualification tests for three AIE welders performed in accordance with Washington Association of Building Officials welder performance qualification tests. Welder ID numbers 00673 for shielded metal arc welding (SMAW) process, and welder ID numbers W07812 and W12733 for the SMAW and flux cored arc welding (FCAW) processes.
- AIE non-demand critical WPS numbers AIE 2013-2 and 2013-3 for SMAW fillet welds, AIE 2014-1 for SMAW T/corner joint welds, and AIE 2014-7 for self shielded flux cored arc welds (FCAW-S) for fillet welds.
- AIE demand critical WPS AIE 2013-1 for FCAW butt bevel groove weld, performed in accordance with AWS D1.8, using filler material meeting AWS D1.8 requirements.
- Results of initial qualification tests for two AIE welders (ID numbers AIE001 and AIE002) for qualification on FCAW demand critical welds.
- Certification records listed in the AWS database for three welding inspectors who supervised qualification testing of welders. These were two AWS CWIs who tested and qualified Metalfab, Inc. welders and one AWS CWI who tested and qualified AIE welders to perform demand critical welds.

EA concluded that, for the sample examined, welding is being performed by qualified personnel using qualified procedures.

Control of Purchased Items and Services

Criteria: A program shall be established for control of purchased items and services, including subcontractors. Subcontractors are required to maintain and implement a QA program in accordance with NQA-1. (NQA-1, Criterion 7; Section 7 of the FE&C QAM; and DOE Order 414.1D)

FE&C QAP-07-01, *Controlling Purchased Items and Services*, is the procedure used by FE&C to control purchased items and services and implements the requirements of Section 7 of the FE&C QAM. EA reviewed the procurement records for weld filler materials used by Metalfab, Inc. to fabricate structural steel for the K-West Annex Facility, and for the structural steel fastener assemblies (high strength bolts, nuts, and washers) used to assemble the structural steel connections. The technical requirements for the weld filler materials and structural steel fasteners are specified in Specification 44577-CSI-SPEC-001-051200.

Section 4.0 of FE&C QAP-08-002 requires that all weld filler materials are to be procured from approved suppliers. Section 6.1 of FE&C QAP-08-002 prescribes the receipt inspection requirements for weld filler materials. As part of the receipt inspection process, QC personnel are required to verify material certifications by reviewing supplier-furnisher certified material test reports (CMTRs) to ensure that weld filler materials meet Specification requirements.

EA reviewed documentation for the weld filler materials, including: (1) a CMTR for .045 ultra core 71A85 N33# spools, lot number 1068B; (2) a CMTR for ultra core 71A85 MIG (metal, inert, gas) wire .045 X N33# spools, lot number 13552528; and (3) Certificates of Conformance (COCs) for E7018H4R weld electrodes, lot numbers 13626063 and 13721306. The documents for weld electrode lot numbers 13626063 and 13721306 were labeled as COCs, not CMTRs as required in Section 6.1 of FE&C QAP-08-002. Although labeled as COCs, the data furnished in the documents for these weld electrode lot numbers included results of all chemical and mechanical test data to demonstrate that the electrodes complied with AWS requirements, so these COCs are equivalent to CMTRs. The weld electrodes documented on the COCs were furnished by the same manufacturer as the weld wire (lot numbers 13552528 and 1068B) that was documented on CMTRs. The COCs were signed by the manufacturer's certification manager. The results of mechanical and chemical tests documented on the CMTRs and COCs showed that the weld filler materials complied with AWS D1.1 specifications.

The commercial grade dedication (CGD) process was used to accept and verify the quality of fastener assemblies (high strength bolts, washers and nuts) used to assemble structural steel bolted connections. Since FE&C does not perform CGD activities, as stated in Paragraph 7.4 of the FE&C QAM, the CGD process for structural steel fastener assemblies for use in quality-related applications was developed by CHPRC. EA reviewed CHPRC CGD Package No. 48873-000-CGID-017, *Bolts, Nuts, Washers, Nelson H4L Studs and D2L Deformed Bar Anchors*. The CGD process for the fastener assemblies requires receipt inspections by the FE&C ITA QC inspectors. The receipt inspection program includes review of manufacturer's certificates listing chemical and mechanical properties of the bolts, washers, and nuts and verification of manufacturer's markings on the fastener assemblies. The ITA QC inspectors also perform physical measurements of the bolts, nuts, and washers to verify that the dimensions conform to the tolerances specified in following industry standards: ASME B18.2.1 for bolts, ASME B18.2.2 for nuts, ASTM F436 for washers, and ASME B1.1 for dimensions of screw threads on nuts and bolts.

The ITA QC inspectors also selected samples of the bolts and nuts to be shipped to an offsite independent testing laboratory for mechanical testing in accordance with ASTM A370 and ASTM F606. The laboratory was certified by the American Association for Laboratory Accreditation in accordance with criteria developed by the International Standards Organization. The sample sizes were based on the reduced sampling plan in Table 2-1 of Electric Power Research Institute TR-017218-R1, *Guidelines for Sampling for Commercial Grade Item Acceptance*.

EA reviewed the test and inspection records that documented acceptance of the fastener assemblies through the CGD program, including receipt inspection records, results of chemical and mechanical tests performed by the manufacturer, records of physical dimensional performed by ITA QC inspectors, and results of mechanical tests performed by the offsite laboratory. Specifically, EA reviewed:

- ASTM A325/A1852 Tension Control Bolts for heat numbers 04246, 34504, A04755, A10129, A10571, A10981, NF13202059 and 20188640.
- ASTM A563 DH Heavy Hex Nuts for heat numbers 573547, C80062, C92525, C92985, D84758, D84755, DL12105962, and M668801.
- ASTM F436 Type I Hardened Steel Washers for heat numbers 62010, 126314, 207707, 211556, 4127187, 4142167, and 4143547.

One minor discrepancy was identified during review of the above records. The acceptance criteria for thickness of the ½ inch washers for heat number 62010 was listed incorrectly on Inspection Record #FE&C-48873-2014-R1-022 as between 0.097 to 0.117 inch; the correct acceptance criteria for ½ inch washers listed in ASTM F436 is 0.097 to 0.177 inch. The thickness measured by the ITA QC inspectors for a sample of five washers was .150 and .151 inch, and the QC inspectors failed to identify that the thickness they measured exceeded the incorrect acceptance criteria for thickness listed on their inspection form (though actually within the correct range).

Based on review of the sample described above, EA concluded that weld filler materials and structural steel fastener assemblies are being procured in accordance with the FE&C and CHPRC QA programs and DOE regulations.

6.0 CONCLUSIONS

For the sample reviewed, EA determined that structural steel construction, including welding, procurement, and welding activities, is being performed in accordance with the CHPRC specification, referenced industry standards, and the CHPRC and FE&C QA programs. The qualifications and certification of QC inspectors comply with industry standards and the FE&C and CHPRC QA programs

7.0 ITEMS FOR FOLLOW-UP

EA will continue to follow up on construction work at the K-West Annex Facility with additional review of CMTRs for weld filler materials used for demand critical welds, weld travelers, and weld inspection records. EA will also review corrective actions to address discrepancies identified during construction.

Appendix A Supplemental Information

Review Dates

Onsite Review:	March 9 and May 6, 2014
Offsite Review (specifications, QC inspection and welding procedures)	April 19-24, 2014
Offsite Review (quality records)	June and July 2014

Office of Independent Enterprise Assessments

Glenn S. Podonsky, Director, Office of Enterprise Assessments
William A. Eckroade, Deputy Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
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EA Site Lead for Hanford Site

Jacob Wechselberger

EA Team Composition

Joseph Lenahan

Appendix B

Documents Reviewed, Interviews, and Observations

Documents Reviewed

- CH2M Hill Construction Specification for Modified KW Annex, Document number 44577 CSI – SPEC-001-051200, Rev. 2, Structural Steel Framing
- FE & C Quality Assurance Inspection Plan Structural KW-IP-48873-03
- FE & C QAP-02-02, Rev. 0, Quality Assurance/Quality Control Qualification/Certification, December 16, 2013
- FE & C QAP-02-003, Rev. 0, Welder Performance Qualification, July 14, 2010
- FE&C QAP-07-01, Rev. 0, Controlling Purchased Items and Services, December 16, 2013
- FE&C QAP-07-02, Rev. 0, Certificate of Conformance, December 16, 2013
- FE & C QAP-08-002, Rev. 0, Weld Filler Metal Control Qualification/Certification, July 28, 2010
- FE & C QAP-09-01, Rev. 0, Control Special Processes, December 16, 2013
- FE & C QAP-09-002, Rev. 0, Documentation and Tracking of Welder Performance Qualification, July 28, 2010
- FE&C Quality Assurance Manual, Rev. , December 16, 2013
- CH2M Hill Quality Assurance Manual
- Metalfab, Inc. Procedure MF-FCAW-1, Rev. 1, Structural Steel Welding Procedures, August 14, 2013
- Statement of Work for Construction, Requisition # 240422, Modified FW Basin Annex Construction, Rev. 2, May 16, 2012
- Drawing Number 96799, Rev. 7, Structural General Design – Notes & Legends
- Drawing Number 96809, Rev. 4, Structural Framing Elevations – Grid Line 3
- Drawing Number 96810, Rev. 2, Structural Framing Elevations – Sections & Details
- Chemical and Mechanical Test Results Furnished by Manufacturer for Weld Filler Materials, Lot Numbers 1068B, 13552528, 13626063 and 13721306
- CHPRC CGD Package No. 48873-000-CGID-017, Rev. 3, Bolts, Nuts, Washers, Nelson H4L Studs and D2L Deformed Bar Anchors, April 8, 2014

Interviews

- Field engineers
- Structural engineer
- Construction managers
- QC inspectors
- DOE project personnel

Observations

- Structural steel construction work
- Tensioning of structural steel bolts
- Completed welds
- Onsite storage of structural steel