

**INSPECTION TECHNICAL PROCEDURE**

**I-115**

**STRUCTURAL STEEL WELDING INSPECTION**

March 8, 2002  
Revision 0

Approved: \_\_\_\_\_ Date: \_\_\_\_\_  
Verification and Confirmation Official

Concur: \_\_\_\_\_ Date: \_\_\_\_\_

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## **INSPECTION TECHNICAL PROCEDURE I-115, REV. 0 STRUCTURAL STEEL WELDING INSPECTION**

### **1.0 PURPOSE**

This procedure provides for assessing the Contractor's activities for structural steel welding. This guidance is based on the requirements set forth in the Safety Requirements Document (SRD), the Quality Assurance Manual (QAM), and the Integrated Safety Management Plan (ISMP).

This procedure assesses the adequacy and effectiveness of the following:

- Structural steel welding implementing procedures
- Structural steel welding activities
- Training and qualification of personnel
- Records system.

### **2.0 OBJECTIVES**

This procedure verifies the Contractor has developed and implemented an effective program for welding steel structures important-to-safety at the River Protection Project (RPP) Waste Treatment Plant (WTP). This includes addressing programs for the following: (1) implementing commitments for welding steel structures; (2) managing and providing oversight to ensure that welding of steel structures and related quality control has been adequately addressed by specifications, drawings, and procedures; (3) managing and providing oversight to ensure that the as-constructed condition of welded steel structures is according to the design; and (4) recording welding activities for important-to-safety structural steel construction.

This inspection procedure is a component of a complete construction inspection program. This inspection procedure and others will be used, as needed, to ensure that construction activities are being conducted as required by authorization basis commitments and Contractor procedures. During the construction phase, a significant portion of this inspection procedure is expected to be completed at least once for the Contractor and each major subcontractor involved with the activities covered by this procedure. However, the entire procedure is not expected to be completed during any one inspection or every time the inspection procedure is used.

### **3.0 INSPECTION REQUIREMENTS**

#### **3.1 Adequacy and Effectiveness of Construction Implementing Procedures**

- 3.1.1 The inspector should verify the Contractor and all subcontractors with construction responsibilities in the area of welding important-to-safety steel structures have approved implementing procedures describing administrative controls and work processes implementing the structural steel welding design requirements. (QAM, Policy Q-05,

Sections 3.1.1 and 3.3; ISMP, Table 1-3, item 5; and SRD, Safety Criterion (SC) 4.1-2 and 7.3-5)

- 3.1.2 The inspector should verify procedures prescribe adequate methods of quality control (QC) inspection to ensure the as-built condition of welded steel structures meet specified engineering requirements and drawings. As part of the assessment of the QC inspection procedures, ensure that the procedures include or reference appropriate quantitative or qualitative acceptance criteria for determining that the prescribed activities have been accomplished satisfactorily. (QAM, Section 3.3.2, Policy Q-05.1, Section 3.5.1; ISMP, Table 1-3, items 5 and 8; and SRD, SC 4.1-2 and 7.3-7)
- 3.1.3 The inspector should verify procedures require that equipment used for process monitoring or data collection are calibrated and maintained. (QAM, Policy Q-12.1, Sections 3.1.2 and 3.2; ISMP, Table 1-3, items 5 and 8; and SRD, SC 7.3-5 and 7.3-7)
- 3.1.4 The inspector should verify the Contractor has established procedures for ensuring craft and QC inspection personnel performing quality related structural steel welding and testing activities are qualified to perform their assigned work. (QAM, Policy Q-02.2, Section 3.3.2; and ISMP, Table 1-3, item 2)

### **3.2 Adequacy and Effectiveness of Construction Activities**

The inspector should verify structural steel welding is accomplished under controlled conditions using approved instructions, procedures, and checklists prepared at a level of detail consistent with the importance and complexity of the work process being performed. (QAM, Policy Q-05.1, Section 3.1.1; SRD, SC 7.3-5; and ISMP, Table 1-3, item 5)

### **3.3 Adequacy and Effectiveness of the Training and Qualification of Personnel**

The inspector should verify craft, testing, and quality assurance (QA)/QC personnel involved in performing structural steel welding and inspection activities are qualified to perform their job functions. (QAM, Policy Q-02.2, Sections 3.2.2, 3.3.1, and 3.3.3; and SRD, SC 7.3-3)

### **3.4 Adequacy and Effectiveness of the System of Records**

The inspector should verify the as-built records of structural steel welding and testing are as specified, reviewed by the Contractor for accuracy and assurance the recorded information meets project requirements, approved, and stored and maintained sufficient to support technical and Contract requirements. (QAM, Policy Q-17.1, Sections 3.1.2, 3.3.1 and 3.6.1; SRD, SC 4.0-3, 4.1-2, and 7.3-4; and ISMP, Section 8 and Table 1-3, item 4)

## 4.0 INSPECTION GUIDANCE

For each of the inspection elements, the inspector should (1) obtain a copy of the Contractor's procedures and the related industry codes and standards to which the Contractor has committed; (2) become familiar with the contents of the procedures and standards; and (3) assess whether the procedures and implementation of the procedures adequately conform to the applicable commitments. The SRD, SC 4.1-2, refers to American National Standards/American Institute of Steel Construction (ANS/AISC) N690-94, *Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities*. ANS/AISC N690-94 references American Welding Society (AWS) D1.1 for all structural steel welding.

AWS D1.1 is the primary industry standard referenced for welding steel structures. By determining how well the Contractor's welding procedures for structural steel address the requirements of AWS D1.1, the adequacy and effectiveness of the Contractor's procedures can be assessed.

Section 4.2 below includes suggested sample selections. Follow the suggestions or choose samples more appropriate for the inspection based on construction progress, completion of Contractor's QA/QC reviews, or inspector experience. Use judgment in determining sample selection, focusing on examining the most important aspects of the particular activity being inspected. The intent is to establish a high level of assurance that the end product meets requirements.

### 4.1 Adequacy and Effectiveness of Construction Implementing Procedures

4.1.1 The inspector should review the implementing procedures for important-to-safety structural steel welding. Verify that the procedures (1) are approved and (2) specify the work processes and management controls for the major welding activities. The major welding activities to be verified are listed in Sections 4.1.1.1 through 4.1.1.4 below. For each major activity, specific requirements have been selected from AWS D1.1. Additional specific requirements may be selected to improve the assessment.

#### 4.1.1.1 Prequalification of Weld Procedure Specifications (WPS)

The inspector should determine whether the construction procedures for welding important-to-safety steel structures address the following requirements:

- Only welding processes that meet all the applicable requirements of AWS D1.1-96, Section 3, are prequalified. (AWS D1.1-96, Section 3.2)
- Only base metals and filler metals combinations listed in AWS D1.1-96, Table 3.1, are acceptable. (AWS D1.1-96, Section 3.3)
- Minimum preheat and interpass temperatures are according to AWS D1.1-96, Table 3.2. (AWS D1.1-96, Section 3.5)

- A new or revised prequalified weld procedure specification (WPS) shall be written, if changes to any of the four variables (i.e., amperage, voltage, travel speed, and shielding gas flow) are beyond the limitations prescribed in AWS D1.1-96, Table 4.5. (AWS D1.1-96, Section 3.6)
- All the requirements of Table 3.7 of AWS D1.1-96 (including maximum electrode diameter, maximum current, maximum root pass thickness, etc., for weld position, weld type, and welding process) shall be met for prequalified WPSs. (AWS D1.1-96, Section 3.7)

#### 4.1.1.2 Qualification of WPS

The inspector should determine whether the construction procedures for welding important-to-safety steel structures address the following requirements:

- Except for prequalified WPSs that conform to AWS D1.1, Section 3, a WPS shall be qualified in conformance with AWS D1.1-96, Section 4, Part B. (AWS D1.1-96, Section 4.1.1)
- Welding positions qualified by a WPS (e.g., flat, horizontal, vertical, and overhead) shall conform to the requirements of AWS D1.1-96, Table 4.1. (AWS D1.1-96, Section 4.3)
- The type and number of qualification tests required to qualify a WPS for a given thickness, diameter, or both shall conform to the requirements of AWS D1.1-96, Table 4.2, Table 4.3, or Table 4.4, as appropriate for joint type. (AWS D1.1-96, Section 4.4)
- A written WPS that specifies all the applicable essential variables referenced in Section 4.7 of AWS D1.1 shall be prepared. The specific value of these WPS variables shall be obtained from the procedure qualification record (PQR), which serves as a written confirmation record of a successful WPS qualification. (AWS D1.1-96, Section 4.6)
- The WPS shall be requalified when changes to the PQR essential variables are beyond those listed in AWS D1.1-96, Tables 4.5 or 4.6. (AWS D1.1-96, Section 4.7)
- Welded test assemblies for WPS qualification shall be prepared for testing according to AWS D1.1-96, Section 4.8. (AWS D1.1-96, Section 4.8)
- WPS test specimens shall be prepared for visual inspection, nondestructive testing, and mechanical testing in conformance with AWS D1.1-96, Figures 4.12, 4.13, 4.14, and 4.18, as applicable. (AWS D1.1-96, Sections 4.8.1, 4.8.2, and 4.8.3)

- Acceptable qualification welds shall meet the following AWS D1.1- 96 acceptance criteria:
  - The visual inspection requirements in Section 4.8.1
  - The ultrasonic test (UT) or radiographic test (RT) requirements of Section 6, Part C (Section 4.8.2.2)
  - The mechanical testing requirements of Sections 4.8.3.3, 4.8.3.5, and 4.8.4.1, as applicable.

#### 4.1.1.3 Qualification of Welding Personnel

The inspector should determine whether the construction procedures for welding important-to-safety steel structures address the following requirements:

- Welders, welding operators, and tack welders using welding processes covered by AWS D1.1 shall have been qualified by the applicable test described in AWS D1.1-96, Part C. (AWS D1.1-96, Section 4.1.2)
- Welders or weld operators not engaged in a given welding process, for which they are qualified, for a period exceeding six months shall be requalified before engaging in the welding process. (AWS D1.1-96, Section 4.1.3.1)
- Tack welders qualified for a given process retain their qualification indefinitely, unless there is some specific reason to question the tack welder's ability. (AWS D1.1-96, Section 4.1.3.2)
- The welding position for which a welder is qualified shall conform to AWS D1.1-96, Table 4.8. (AWS D1.1-96, Section 4.18.1.1)
- The range of welding thickness and diameters for which a welder or welding operator is qualified shall conform to D1.1-96, Table 4.9. (AWS D1.1-96, Section 4.18.2.1)
- The type and number of qualification tests required for a welder or welding operators shall conform to AWS D1.1-96, Table 4.9. (AWS D1.1-96, Section 4.19.1)
- Welders, welding operators, and tack welders who are qualified for a given process shall be required to requalify if essential variables for the process are changed beyond the limitations shown in AWS D1.1-96, Table 4.10. (AWS D1.1-96, Section 4.22)
- The acceptance criteria for welder and welding operator qualifications shall conform to D1.1-96, Section 4.30. (AWS D1.1-96, Section 4.30)

## 4.1.1.4 Fabrication

The inspector should determine whether the construction procedures for welding of important-to-safety steel structures address the following requirements:

- The classification and size of electrode, arc length, voltage, and amperage shall be suited to the thickness of material, type of groove, welding position, and other circumstances attending the work. Welding current shall be within the range recommended by the electrode manufacturer. (AWS D1.1-96, Section 5.3.1.2)
- Shielded metal arc welding (SMAW) electrodes shall be purchased and stored according to the requirements of Section 5.3.2 of AWS D1.1-96. (AWS D1.1-96, Section 5.3.2)

NOTE: Ensure that the Contractor's procedures include adequate controls for handling and storing low hydrogen electrodes.

- SMAW electrodes having low-hydrogen coverings conforming to ANSI/AWS A5.1 or A5.5 exposed to the atmosphere for periods greater than those permitted in AWS D1.1-96, Table 5.1, shall be rebaked. (AWS D1.1-96, Section 5.3.2.4)
- Submerged arc welding (SAW) electrodes and fluxes shall be purchased and stored according to the requirements of Section 5.3.3 of AWS D1.1. (AWS D1.1-96, Section 5.3.3)
- The electrodes and shielding gas for gas metal arc welding (GMAW) or flux cored arc welding (FCAW) shall conform to the latest edition of ANSI/AWS A5.18, *Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding*, or ANSI/AWS A5.20, *Specification for Carbon Steel Electrodes for Flux Cored Arc Welding*, as applicable. (AWS D1.1-96, Section 5.3.4)
- Electroslag and electrogas welding processes shall not be used for welding quenched and tempered steel nor for welding cyclically loaded structural members subject to tensile stress or reversal stress. (AWS D1.1-96, Section 5.4.1)
- Welding variables shall conform to a written WPS. (AWS D1.1-96, Section 5.5)
- Base metal shall be heated, if required, to a temperature not less than the minimum value listed on the WPS. (AWS D1.1-96, Section 5.6)
- Backings, if used to prevent melting through, shall conform to AWS D1.1, Section 5.10. (AWS D1.1-96, Section 5.10)
- The welding environment (e.g., temperature, wind, rain, and snow) shall conform to AWS D1.1, Section 5.12. (AWS D1.1-96, Section 5.12)



- Temporary and tack welds shall be subject to the same welding procedure requirements as the final welds. (AWS D1.1-96, Section 5.18)
- Arc strikes outside the area of permanent welds should be avoided on any base metal. Cracks or blemishes caused by arc strikes shall be ground to a smooth contour and checked to ensure soundness. (AWS D1.1-96, Section 5.29)

4.1.2 The inspector should review the QC inspection procedures for welding important- to-safety structural steel structures. Verify that the procedures (1) are approved and (2) require adequate QC inspections and provide adequate inspection methods to ensure that the major construction activities are completed according to drawing and procedure requirements and include or reference appropriate quantitative or qualitative acceptance criteria. The major construction activities are listed in Sections 4.1.2.1 through 4.1.2.5 below and include selected requirements from AWS D1.1 that should be addressed in the QC procedures. NOTE: Section 4.1.2 and 4.1.3 should be performed together.

#### 4.1.2.1 Prequalification of WPS

The inspector should determine whether the QC inspection procedures for welding important-to-safety steel structures are adequate to ensure the following:

- Prequalified welding processes meet all the applicable requirements of AWS D1.1-96, Section 3. (AWS D1.1-96, Section 3.2)
- Base metals and filler metals combinations are specified. The procedure should reference AWS D1.1-96, Table 3.1, for acceptance criteria. (AWS D1.1-96, Section 3.3)
- Minimum preheat and interpass temperatures are specified. The procedure should reference AWS D1.1-96, Table 3.2 for acceptance criteria. (AWS D1.1-96, Section 3.5)
- A new or revised prequalified WPS is specified if significant changes are made to any of the four variables (i.e., amperage, voltage, travel speed, and shielding gas flow). The procedure should reference AWS D1.1-96, Table 4.5, for acceptance criteria. (AWS D1.1-96, Section 3.6)
- Prequalified WPS meet the requirements for maximum electrode diameter, maximum current, maximum root pass thickness, etc., for weld position, weld type, and welding process. The procedure should reference AWS D1.1-96, Table 3.7, for acceptance criteria. (AWS D1.1-96, Section 3.7)
- As an acceptance criterion, fillet welds are at least the minimum size specified in AWS D1.1-96, Table 5.8. (AWS D1.1, Section 3.9)

#### 4.1.2.2 Qualification of WPS

The inspector should determine whether the QC inspection procedures for welding important-to-safety steel structures are adequate to ensure the following:

- WPS are qualified in conformance with AWS D1.1-96, Section 4, Part B. (AWS D1.1-96, Section 4.1.1)
- Welding positions (e.g., flat, horizontal, vertical, and overhead) are qualified by a WPS. The procedure should reference AWS D1.1-96, Table 4.1, for acceptance criteria. (AWS D1.1-96, Section 4.3)
- The type and number of qualification tests required to qualify a WPS for a given thickness, diameter, or both are specified. For acceptance criteria for joint type, the procedure should reference AWS D1.1-96, Tables 4.2, 4.3, or 4.4, as appropriate. (AWS D1.1-96, Section 4.4)
- A written WPS is prepared that specifies all the applicable essential variables referenced in AWS D1.1-96, Section 4.7. The specific values for these WPS variables shall be obtained from the PQR, which serves as a written confirmation record of a successful WPS qualification. (AWS D1.1-96, Section 4.6)
- The WPS are requalified when significant changes are made to the PQR essential variables. The procedure should reference AWS D1.1-96, Tables 4.5 or 4.6, for acceptance criteria. (AWS D1.1-96, Section 4.7)
- Welded test assemblies for WPS qualification are prepared for testing according to AWS D1.1-96, Section 4.8. (AWS D1.1-96, Section 4.8)
- WPS test specimens are prepared for visual inspection, nondestructive testing, and mechanical testing. The procedures should specify conformance with AWS D1.1-96, Figures 4.12, 4.13, 4.14, and 4.18, as applicable. (AWS D1.1-96, Sections 4.8.1, 4.8.2, and 4.8.3)
- Qualification welds are acceptable. The procedures should specify the following AWS D1.1-96 acceptance criteria:
  - The visual inspection requirements in Section 4.8.1 (AWS D1.1-96, Section 4.8.1)
  - The UT or RT requirements of Section 6, Part C (AWS D1.1-96, Section 4.8.2.2)
  - The mechanical testing requirements of Sections 4.8.3.3, 4.8.3.5, and 4.8.4.1, as applicable. (AWS D1.1-96, Sections 4.8.3.3, 4.8.3.5, and 4.8.4.1)

#### 4.1.2.3 Qualification of Welding Personnel

The inspector should determine whether the QC inspection procedures for welding important-to-safety steel structures are adequate to ensure the following:

- Welders, welding operators, and tack welders using welding processes covered by AWS D1.1 are qualified by the applicable test described in AWS D1.1-96, Section 4, Part C. (AWS D1.1-96, Section 4.1.2)
- Welders or weld operators not engaged in a given welding process for which they are qualified for more than six months are requalified before engaging in the welding process. (AWS D1.1-96, Section 4.1.3.1)
- The welding position for which a welder is qualified is specified. The procedure should reference AWS D1.1-96, Table 4.8, for acceptance criteria. (AWS D1.1-96, Section 4.18.1.1)
- Welder or welding operators are qualified for a range of welding thickness and diameters appropriate for the WPS being used. The procedure should reference AWS D1.1-96, Table 4.9, for acceptance criteria. (AWS D1.1-96, Section 4.18.2.1)
- The type and number of qualification tests required for welders or welding operators are specified. The procedure should reference AWS D1.1-96, Table 4.9, for acceptance criteria. (AWS D1.1-96, Section 4.19.1)
- Welders, welding operators, and tack welders who are qualified for a given process are required to requalify if an essential variable for the process is changed beyond the limitations shown in AWS D1.1-96, Table 4.10. (AWS D1.1-96, Section 4.22)
- The acceptance criteria for welder and welding operator qualifications conform to AWS D1.1-96, Section 4.30. (AWS D1.1-96, Section 4.30)

#### 4.1.2.4 Fabrication

The inspector should determine whether the QC inspection procedures for welding important-to-safety steel structures are adequate to ensure the following:

- The classification and size of electrode, arc length, voltage, and amperage are suited to the thickness of material, type of groove, welding position, and other circumstances of the work. Welding current is within the range recommended by the electrode manufacturer. (AWS D1.1-96, Section 5.3.1.2)
- SMAW electrodes are purchased and stored according to the requirements of AWS D1.1-96, Section 5.3.2. (AWS D1.1-96, Section 5.3.2)

NOTE: If low-hydrogen electrodes are used, the QC procedures should ensure that the Contractor has adequate controls for the distributing, handling, and storing the electrodes.

- SMAW electrodes having low-hydrogen coverings are controlled to limit the exposure to the atmosphere. When the electrodes conform to ANSI/AWS A5.1 or A5.5, the procedures should reference AWS D1.1-96, Table 5.1, for exposure limits. Rebake requirements should be according to AWS D1.1-96, Section 5.3.2.4. (AWS D1.1-1996, Section 5.3.2.4)
- SAW electrodes and fluxes are purchased and stored according to the requirements of Section 5.3.3 of AWS D1.1. (AWS D1.1-96, Section 5.3.3)
- The electrodes and shielding gas for GMAW or FCAW conform to the latest edition of ANSI/AWS A5.18 or ANSI/AWS A5.20, as applicable. (AWS D1.1-96, Section 5.3.4)
- Electroslag and electrogas welding processes are not used for welding quenched and tempered steel nor for welding cyclically loaded structural members subject to tensile stress or reversal stress. (AWS D1.1-96, Section 5.4.1)
- Welding variables conform to a written WPS. (AWS D1.1-96, Section 5.5)
- Base metal shall be heated, if required, to a temperature not less than the minimum value listed on the WPS. (AWS D1.1-96, Section 5.6)
- Backings, if used to prevent melting through, conform to AWS D1.1, Section 5.10. (AWS D1.1-96, Section 5.6)
- The welding environment (e.g., temperature, wind, rain, and snow) is specified. The procedure should reference AWS D1.1, Section 5.12, for acceptance criteria. (AWS D1.1-96, Section 5.12)
- Temporary and tack welds are subject to the same welding procedure requirements as the final welds. (AWS D1.1-96, Section 5.18)
- Arc strikes outside the area of permanent welds are avoided on any base metal. Cracks or blemishes caused by arc strikes are ground to a smooth contour and checked to ensure soundness. (AWS D1.1-96, Section 5.29)

#### 4.1.2.5 Inspection

The inspector should determine whether the Nondestructive Test Inspection, I-120, has recently been performed at the site. If not, review the construction procedures for visual inspection, radiographic inspection, ultrasonic inspection, and magnetic particle inspection according to that procedure. In addition, determine whether the QC inspection

procedures for welding important-to-safety steel structures are adequate to ensure the following:

- Inspectors and assistant inspectors have passed an eye examination with or without corrective lenses to prove (1) near vision acuity of Snellen English, or equivalent, at 12 inches, and (2) far vision acuity of 20/40, or better. (AWS D1.1-96, Section 6.1.3.4)
- Inspectors ensure that the size, length, and location of all welds conform to the requirements of the AWS D1.1 Code. (AWS D1.1-96, Section 6.5.1)
- Inspectors ensure that electrodes are used only in the positions and with the type of welding current and polarity for which they are qualified. (AWS D1.1-96, Section 6.5.3)
- Inspectors identify with a distinguishing mark or other recording method all parts or joints they have inspected and accepted. (AWS D1.1-96, Section 6.5.6)

4.1.3 When determining the adequacy of the QC procedures per Section 4.1.2 of this procedure, the inspector should also determine whether the procedures require that test equipment or instruments used for process monitoring or data collection identified in Sections 4.1.2.1, 4.1.2.2, and 4.1.2.4 are calibrated and maintained. The calibration standards should be traceable to industry recognized criteria (e.g., the National Bureau of Standards, **Not Committed**).

4.1.4 The inspector should review the procedures establishing the requirements for qualifying craft and inspection personnel and determine whether the procedures conform to the requirements of the QAM.

## 4.2 Adequacy and Effectiveness of Construction Activities

Before performing work observation inspections in the field, the inspector should review the procedures and industry standards which apply to the work that will be observed to ensure familiarity with the requirements and acceptance criteria pertinent to the planned observations. Based on the preliminary design submitted by the Contractor, the applicable standard is ANS/AISC N690. SRD, SC 4.1-2 references ANS/AISC N690. ANS/AISC N690 references AWS D1.1 for welding of structural steel. During the field observations, carry a copy of the sections of the procedure and industry standards pertinent to the planned observations and verify that work is being accomplished using procedures of the proper revision.

The major construction activities for welding steel structures are listed in Sections 4.2.1 through 4.2.5 below and include selected requirements from AWS D1.1 to be verified. The inspector should ensure the Contractor is adequately implementing the construction procedure for each activity.

During the field observations, interview and obtain the names of a sample of the craft and QC personnel performing the observed activities to assess whether their knowledge of the job and procedures is satisfactory. The sample size will be determined by the number of Contractor personnel performing the activity and generally should be one to four for each discipline (craft and QC personnel). Information on these same personnel will be used pursuant to Section 4.3 below to determine the adequacy of their experience and training.

#### **4.2.1 Verification of Welds Used for Prequalification of WPS**

The inspector should select two welds used to prequalify WPS and verify the following:

- The welds met all the applicable requirements of AWS D1.1, Section 3. (AWS D1.1-96, Section 3.2.1)
- Base metals and filler metals used for the welds were as specified in the WPSs and were listed in AWS D1.1-96, Table 3.1. (AWS D1.1-96, Section 3.3)
- If preheat was required, minimum preheat and interpass temperatures recorded were according to AWS D1.1-96, Table 3.2. (AWS D1.1-96, Section 3.5)
- All the requirements of AWS D1.1-96, Table 3.7 (including maximum electrode diameter, maximum current, maximum root pass thickness, etc., for weld position, weld type, and welding process) were met. (AWS D1.1-96, Section 3.7)
- The minimum fillet weld size was according to AWS D1.1-96, Table 5.8. (AWS D1.1-96, Section 3.9)

#### **4.2.2 Welds Used for Qualifying WPSs**

The major activities for qualifying WPSs are listed below.

4.2.2.1 The inspector should select two welds used to qualify WPSs and verify the following:

- The welds conform to AWS D1.1-96, Section 4, Part B. (AWS D1.1-96, Section 4.1.1)
- The welding position used for qualification (flat, horizontal, vertical, or overhead) conform to the requirements of AWS D1.1-96, Table 4.1. (AWS D1.1-96, Section 4.3)
- The qualification tests performed are of the type and number required to qualify the WPSs for a given thickness, diameter, or both and conform with the requirements of AWS D1.1-96, Tables 4.2, 4.3, or 4.4, as appropriate, for joint type. (AWS D1.1-96, Section 4.4)

- The weld conditions conform to all the applicable essential variables referenced in AWS D1.1-96, Section 4.7. The specific value of these WPS variables are recorded in the PQR, which serves as a written confirmation record of a successful WPS qualification. (AWS D1.1-96, Section 4.6)
- The two welds selected meet the following AWS D1.1 acceptance criteria:
  - The visual inspection requirements in Section 4.8.1 (AWS D1.1-96, Section 4.8.1)
  - The UT or RT requirements of Section 6, Part C (AWS D1.1-96, Section 4.8.2.2)
  - The mechanical testing requirements of Sections 4.8.3.3, 4.8.3.5, and 4.8.4.1, as applicable. (AWS D1.1-96, Sections 4.8.3.3, 4.8.3.5, and 4.8.4.1)

4.2.2.2 The inspector should select four WPS for which changes have been made to the PQR essential variables. Verify the changes were not beyond those allowed by AWS D1.1-96, Tables 4.5 or 4.6. (AWS D1.1-96, Section 4.7)

### **4.2.3 Qualification of Welding Personnel**

The major activities for qualifying welding personnel are listed below.

4.2.3.1 For the welds selected in 4.2.4, the inspector should review the qualifications of at least two welders, two welding operators, and two tack welders and, as applicable, verify the following. (Observation of other welding activities may be necessary to obtain a representative sample size for each type of welding personnel.)

- Welders, welding operators, and tack welders using welding processes covered by AWS D1.1 are qualified by the applicable test described in AWS D1.1, Section 4, Part C. (AWS D1.1-96, Section 4.1.2)
- The welders or welding operators are continuously engaged in the welding process for which they are qualified, with no break periods exceeding six months. If a break period exceeds six months, the welders or welding operators are requalified before engaging in the welding process. (AWS D1.1-96, Section 4.1.3.1)
- The welding positions being used are qualified and conform to the requirements of AWS D1.1-96, Table 4.8. (AWS D1.1-96, Section 4.18.1.1)
- The welds examined are in the range of welding thickness and diameters for which the selected welder or welding operator was qualified and conform to the requirements of AWS D1.1-96, Table 4.9. (AWS D1.1-96, Section 4.18.2.1)

- The type and number of qualification tests required for the qualification of the welders and welding operators conform to the requirements of AWS D1.1-96, Table 4.9. (AWS D1.1-96, Section 4.19.1)
- The acceptance criteria for the welder and welding operator qualifications conform to the requirements of AWS D1.1-96, Section 4.30. (AWS D1.1-96, Section 4.30)

4.2.3.2 The inspector should select four PQRs that have changes to the process essential variables. If the changes are beyond the limitations shown in AWS D1.1-96, Table 4.10, verify that the welders, welding operators, and tack welders, as applicable, were requalified. (AWS D1.1-96, Section 4.22.)

#### **4.2.4 Fabrication**

The major activities for verifying fabrication are listed below.

4.2.4.1 The inspector should select a completed or in-progress fabrication activity for a Quality Level 1 or 2 steel structure. For the selected fabrication activity, select eight welds (select different processes and work in progress, if possible) and, as applicable for each weld, verify the following:

- The classification and size of electrode, arc length, voltage, and amperage used are suited to the thickness of material, type of groove, welding position, and other circumstances of the work. Welding current used is within the range recommended by the electrode manufacturer. (AWS D1.1-96, Section 5.3.1.2)
- SMAW electrodes used, as applicable, are purchased and stored according to the requirements of AWS D1.1-96, Section 5.3.2. (AWS D1.1-96, Section 5.3.2)
- SMAW electrodes with low-hydrogen coverings that have been exposed to the atmosphere for periods longer than allowed are rebaked according to AWS D1.1-96, Section 5.3.2.4. The allowable exposure time for low-hydrogen electrodes conforming to ANSI/AWS A5.1 or A5.5 is specified in Table 5.1. (AWS D1.1-96, Section 5.3.2.4)
- SAW electrodes and fluxes are purchased and stored according to the requirements of AWS D1.1-96, Section 5.3.3. (AWS D1.1-96, Section 5.3.3)
- The electrodes and shielding gas used for GMAW or FCAW conform to the latest edition of ANSI/AWS A5.18 or ANSI/AWS A5.20, as applicable. (AWS D1.1-96, Section 5.3.4)
- Electroslag and electrogas welding processes are not used for welding quenched and tempered steel nor for welding cyclically loaded structural members subject to tensile stress or reversal stress. (AWS D1.1-96, Section 5.4.1)



- Welding variables conform to the applicable written WPS. (AWS D1.1-96, Section 5.5)
- Base metals were heated, if required, to a temperature not less than the minimum value listed on the WPS. (AWS D1.1-96, Section 5.6)
- Backings, if used to prevent melting through, conform to the requirements of AWS D1.1-96, Section 5.10. (AWS D1.1-96, Section 5.10)
- The welding environment (e.g., temperature, wind, rain, and snow) conforms with AWS D1.1-96, Section 5.12. (AWS D1.1-96, Section 5.12)
- Temporary and tack welds are subject to the same welding procedure requirements as are the final welds. (AWS D1.1-96, Section 5.18)

4.2.4.2 The inspector should visually inspect ten completed welds and verify there are no arc strikes. Review two repair procedures for arc strike repairs and verify cracks or blemishes caused by arc strikes are ground to a smooth contour and checked to ensure soundness. (AWS D1.1-96, Section 5.29)

#### **4.2.5 Inspection Activities**

The major activities for verifying inspection activities are listed below.

4.2.5.1 The inspector should select a completed or in-progress fabrication activity for a Quality Level 1 or 2 steel structure. For the selected fabrication activity, select four welds (select different processes and work in progress, if possible) and, as applicable for each weld, verify the following:

- The QC inspectors inspect the weld to verify that the size, length, and location of the welds conform to the requirements of the AWS D1.1 Code. (AWS D1.1-96, Section 6.5.1)
- The QC inspectors inspect the weld to verify that electrodes are used only in the positions and with the type of welding current and polarity for which the welder is qualified. (AWS D1.1-96, Section 6.5.3)
- The QC inspectors identify with a distinguishing mark or other recording method all parts or joints they inspect and accept. (AWS D1.1-96, Section 6.5.6)

4.2.5.2 The inspector should select five QC inspectors and/or assistant inspectors and verify they have passed an eye examination with or without corrective lenses to prove (1) near vision acuity of Snellen English, or equivalent, at 12 inches; and (2) far vision acuity of 20/40, or better. (AWS D1.1-96, Section 6.1.3.4)

### 4.3 Adequacy and Effectiveness of the Training and Qualification of Personnel

During the observation of work activities (Section 4.2 above), the inspector should carry a copy of the procedures specifying the Contractor's requirements for education and experience levels, training, and certification. The inspector should interview four craft and four QA/QC personnel involved in performing structural steel welding activities and record which jobs they were performing. Verify that the personnel are sufficiently knowledgeable of procedure requirements. Review the training and qualification records for those individuals to determine if they meet the requirements.

### 4.4 Adequacy and Effectiveness of the System of Records

The inspector should select a sample of ten (10) records generated during the conduct of structural steel welding activities and records of qualification for those craft and QA/QC personnel selected during the performance of Section 4.3 above. Verify that the records selected for examination are approved by proper authority and stored and maintained in such a manner as to demonstrate conformance with procedure requirements.

## 5.0 REFERENCES

ANS/AISC Standard N690-1994, *Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities*, American National Standard/American Institute for Steel Construction, 1994.

AWS D1.1-1996, *Structural Welding Code*, American Welding Society, 1996.

*Integrated Safety Management Plan*, BNFL-5193-ISP-01, Rev. 5, 2000.

*Quality Assurance Manual*, 24590-WTP-QAM-QA-01-001, Revision 0, 2001.

*Safety Requirements Document*, BNFL-5193-SRD-01-02, Rev. 3, 2000.

## 6.0 LIST OF TERMS

AISC	American Institute of Steel Construction
ANS	American National Standards
AWS	American Welding Society
FCAW	flux cored arc welding
GMAW	gas metal arc welding
ISMP	Integrated Safety Management Plan
PQR	Procedure qualification record
QA	quality assurance
QAP	Quality Assurance Program
QC	quality control
RT	radiographic test

RPP	River Protection Project
SAW	submerged arc welding
SC	safety criterion
SMAW	shielded metal arc welding
SRD	Safety Requirements Document
UT	ultrasonic test
WPS	weld procedure specification
WTP	Waste Treatment Plant

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