

NRC INSPECTION MANUAL

DQASIP

INSPECTION PROCEDURE 55100

STRUCTURAL WELDING GENERAL INSPECTION PROCEDURE

PROGRAM APPLICABILITY: 2512, 2515, 2730, 2630

55100-01 INSPECTION OBJECTIVES

- 01.01 To determine, through direct observation whether the structural welding activities performed at the site are done in accordance with Safety Analysis Report (SAR) commitments to the American Welding Society (AWS) Code.
- 01.02 To determine whether the licensee's structural welding practices, specification, and procedures meet the requirements of the AWS Code and contract requirements.
- 01.03 To review a sample of records to determine whether they are prepared, evaluated, and maintained in accordance with applicable commitments and/or requirements.
- 01.04 To determine that welding practices, specifications, procedures, production equipment, and existing licensee quality control systems are adequate for the production of sound welds.

Inspection Schedule

<u>Inspection</u>	<u>Must Be Started</u>	<u>Must Be Completed</u>
1st inspection:	After work is 5% complete	Before work is 15% complete
Subsequent inspections:	Periodically, until startup of the plant.	

The schedule listed above applies to inspection of nuclear construction site and other long-term inspection efforts. For short-duration projects and vendor inspections, a different schedule may be more practical.

55100-02 INSPECTION REQUIREMENTS

The inspection requirements contained in this section may be fulfilled during a single inspection or several inspections, depending on type and scope of inspected welding activity. For short-duration projects and vendor inspections, the completion of all requirements listed below may not be practical.

02.01 Base-Material and Filler-Metal Compatibility for Welding

- a. Verify that base metals and welding filler-materials combinations are those listed in Table 4.1.1 of the AWS D1.1 Code.
- b. Evaluate base-material/filler-metal combinations other than those listed in Table 4.1.1, to determine the suitability of application.
- c. Verify that welding materials are clearly identified at all times and that contractor/licensee has established adequate controls to assure proper dispersion and handling of welding materials.
- d. Verify that the contractor/licensee has effective procedures, or his practice adequately controls moisture pickup of low-hydrogen electrodes. The maximum out-of-oven exposure time should conform to the requirements stated in Table 4.5.2 of the AWS Code.
- e. If the contractor/licensee uses a single system for welding material control, verify that this system is conservative and meets the requirements for the most restrictive application.

02.02 Welding Procedures

- a. Verify that the contractor/licensee or fabricator has established procedures or instruction for preparation, qualification approval/certification, distribution, and revision of welding procedure specifications (WPS').
- b. If the contractor/licensee uses AWS pre-qualified welding procedures, verify that those procedures meet all requirements stated in Table E1 of the AWS D1.1 Code.
- c. For welding procedures other than those being prequalified, in accordance with the requirements stated in Appendix E of the AWS D1.1 Code, verify that the procedure qualifications meet the requirements of Section 5, Part B, of the AWS Code.
- d. Review two WPS' from each welding process used in production welding and verify conformance with items b or c above, as applicable.
- e. Verify that each of the procedures mentioned in d, above, has been qualified in accordance with Section 5 of the AWS Code, and that the supporting procedure qualification records (PQRs) are on file.
- f. Review PQRs for the above procedures and verify that each PQR lists the essential variables for the specific welding process or processes covered, and that the values or ranges of these variables are consistent with those permitted by the WPS, and within the limits of Section 5 of the AWS Code.
- g. Verify that all mechanical tests required by Section 5 of the AWS Code (including notch toughness when applicable) have been completed and are properly documented in the PQR.
- h. Verify that the PQR has been certified by the contractor/licensee and that the mechanical test results meet or exceed the minimum AWS Code requirement.
- i. Verify that any changes or revisions of the WPS essential variables are supported by requalification of the original WPS, or a new WPS.

- j. Verify that any changes in the WPS nonessential variables are properly identified and documented either as revisions to the original WPS or a new WPS.

02.03 Welder Qualifications

- a. Verify that the manufacturer has established procedures for qualification of welders and welding operators in accordance with Section 5, Parts C and D, of the AWS Code. These procedures should include adequate provisions to preclude falsification of welder and welding operator qualifications.
- b. If practical, sample adequate number of welders taking the qualification tests and confirm, by positive identification, that the person welding the test weldment is indeed the person being qualified.
- c. Verify that the manufacturer has a workable system for maintaining a continuous record of the qualification status of all welders and welding operators and that this system is effectively used and accurate.
- d. Verify, by review of the qualification status records, that welders and welding operators performing production welding have been and are currently, qualified to weld, under the respective procedures. This review shall include all welder and welding operators performing work on the welds selected for inspection under paragraph 02.04, "Production Welding".

02.04 Production Welding. Survey ongoing welding activities and select typical in-process operations representing different welding process procedures and joint configurations for detailed review. Perform the following verifications.

- a. Verify that welding procedures, detailed drawings and instructions, if applicable, and weld data sheets are at the work station or readily available.
- b. Verify that the WPS assignment is in accordance with the applicable AWS Code requirements. This is accomplished by comparing the essential variables of the WPS to the production weld.
- c. Verify that the welding technique and sequence requirements are specified.
- d. Verify that the base metals, welding filler materials, fluxes, gases, and backing materials are of the specified type and grade; have been properly inspected, tested, and identified; and are traceable to test reports or certifications.
- e. Verify that weld joint geometry is as specified and that surfaces to be welded have been prepared, cleaned, and inspected, in accordance with applicable procedures of instructions.
- f. Verify that parts to be welded are assembled and held in place within specified gap and alignment tolerances and verify that the alignment is within limits allowed by the AWS Code.
- g. Verify that gas purging, if specified, is used in accordance with the applicable procedure, and that protection is provided to shield the welding operation from adverse environmental conditions.
- h. Verify that preheat, if specified, is in accordance with applicable procedures requirements.

- i. Verify that the technique of each welder is in accordance with the welding procedure.
- j. Verify that welding electrodes are used only in the positions and with the electrical characteristics specified in the welding procedure.
- k. Verify that shielding gas flow and composition are as specified in the WPS.
- l. Verify that shielding gas flowmeters indicate the gas type for which they are applicable and have appropriate conversion factors if a different gas or gas mixture is used for the work under review.
- m. Verify that welding equipment, including power cables and gas lines, are in good condition, and that ammeters and voltmeters used for automatic welding have been calibrated in accordance with applicable procedure requirements.
- n. Verify that interpass temperature is controlled in accordance with specified requirements.
- o. Verify that interpass cleaning, grinding (especially starts and stops), and peening are conducted in accordance with the applicable procedure.
- p. Verify that backgouging, if applicable, is performed as specified.
- q. Verify that temporary attachments, arc strikes and weld splatter are removed and inspected.
- r. Verify, by direct observation and/or record review, that repairs are conducted in accordance with specified procedures.
- s. Identify all welders and welding operators involved in joint fitup, welding, and weld repair, for qualification review, per 02.03, above.
- t. Verify that all production-welding equipment is in such condition as to enable qualified welders to follow the production-welding procedures and be able to duplicate the results obtained in the procedure qualification.

02.05 Preheat and Post-Weld Heat Treatment

- a. Verify that approved procedures are available for weld joint preheating when required by a WPS. These procedures should specify acceptable preheating methods and provide requirements for monitoring and recording preheat temperature before, during, and if specified, after, welding, until post-weld stress relief.
- b. Sample sufficient number of in-process preheating to verify that preheat control procedures are being followed in production welding.
- c. Verify that the preheat used in production welding is within the limits specified by the welding procedure, and in accordance with Table 4.2 of the AWS Code.
- d. Verify that approved procedures are available for the conduct of post-weld heat treatment (PWHT), and that the fabricator has a system capable of meeting the heating and cooling rates, metal temperature, temperature uniformity, and control limits specified in paragraph 4.4 of the AWS Code.

- e. If furnace heating is used, verify that furnace atmosphere is controlled, as specified in the approved procedure.
- f. Review a sufficient sampling of PWHT operations (in-process and records) to assure that the stress-relief heat treatment meets the requirements stated in Section 4 of the AWS Code.
- g. Verify that temperature control is exercised on in-process components that are required to be maintained at preheat or other specified temperature, for extended time periods, while awaiting further processing.
- h. Examine cumulative stress-relief records for typical welds and verify that the total time and temperatures meet the AWS Code requirements.

02.06 Examination and Inspection of Welds

- a. Select welds produced by different welding processes, procedures, and combination of procedures, and verify, by visual examination, that the following characteristics conform to the applicable AWS Code and fabricator welding-procedure requirements:
 1. Weld surface finish and appearance.
 2. Transitions between welds of different diameters and wall thicknesses.
 3. Weld reinforcement.
 4. Shape and size of fillet and socket welds.
 5. Joint configurations of structural supports.
 6. Removal of temporary fabrication aids, arc strikes, and weld splatter.
 7. Finish-grinding or machining of weld surface.
 8. Absence of surface defects, including cracks, laps, lack of penetration, lack of fusion, porosity, slag, oxide film, and under-cut exceeding prescribed limits.
- b. Verify that approved procedures are available for the nondestructive examination of the weld when required by the AWS Code and/or contract requirements.
- c. Verify that the fabricator's nondestructive procedures meet the AWS Code and/or contract requirements. To accomplish this, select the applicable nondestructive examination method and inspect per Inspection Procedures 57050, 57060, 57070, 57080, or 57090, as required.
- d. Verify that the fabricator's welding inspectors are certified in accordance with the requirements of the AWS Code.
- e. Verify that the fabricator's inspections of welds meet the requirements stated in Section 6 of the AWS Code.

55100-03 INSPECTION GUIDANCE

General Guidance. The inspector performing the inspection under this procedure should be thoroughly familiar with the requirements contained in the AWS Structural Welding Code. The knowledge of welding, welding operations, their applications, limitations, and evaluations is essential for this inspection. The intent of this procedure is to achieve an in-depth review of the overall AWS Code welding activities taking place at the construction site. It is intended that early in the construction phase of the plant, a cognizant inspector will perform this inspection, to advise the regional management about potentially troublesome areas and to identify any significant deficiencies that need correction.

Periodic assessments of the structural welding activities will be performed by cognizant inspection personnel who will be required to access structural welding activities throughout the construction phase of the plant. This procedure should be used also in cases when the regional management has reasons to believe that the AWS welding performed on the site does not meet established practices and standards; (e.g., serious allegations related to welding, discovery of significant welding problems that will lead to degradation of hardware, etc.).

This inspection of the structural welding activities, performed on the site, as outlined in this procedure, can be described as a four-phase progressive review: Before performing an inspection, the inspector familiarizes himself with the requirements pertaining to the particular site scheduled for inspection. Second, the licensee's/contractor's procedures and practices are reviewed. Third, the work is observed to determine that the work is accomplished in accordance with these procedures and practices. Finally, records and drawings are reviewed to verify that they are complete and accurate. For long-duration projects, it is estimated that at least 3 weeks of actual site inspection will be needed to perform the required in-depth review of items b. through d; below. The complete inspection of welding activities at the site can be accomplished during a single inspection, or by the completion of each phase of the procedure, during several inspections. Additional guidance concerning each phase of inspection is provided below:

- a. Preparation for Inspection. Before performing an inspection, in accordance with the requirements of this procedure the inspector should review the following:
 1. U.S. Nuclear Regulatory Commission, requirements.
 2. Licensees' commitments relative to Code editions; (e.g., which Code edition applies to this site.)
 3. Applicable portions of the SAR.
 4. Licensee special requirements contained in their welding and purchasing specifications.
 5. The number and scope of each welding contractor performing work at the site.
 6. Licensee programs and procedures pertaining to the subject.
 7. Applicable portions of the Quality Assurance Manual.
 8. Licensee commitments relative to welding and associated activities.
- b. Review of Welding Specification and Procedures. The inspector should perform the following reviews:
 1. Identify contractors or fabricators performing AWS welding at the site.

2. Identify which welding processes are used at the site and perform a review of all welding procedures used in production welding, in accordance with the applicable paragraphs of Section 02 of this procedure.
 3. Determine whether the welding procedures being used meet all AWS Code and additional contract requirements (if any). Establish whether the use of these procedures will result in the production of sound weld suitable for the intended application.
- c. **Work Observations**. The inspector should select, for work observation, a sample of welds, comprising a combination of structures and AWS welding contractors associated with the work. The selected welds should also represent a good cross-section of the production activities, in terms of welding processes used (SMA, TIG, etc.,) and materials to be welded (high-strength steel, carbon steel, etc.). Considerations such as physical location, difficulties to weld, and limited accessibility should also be incorporated in the sample selection. The total number of sampled welds selected for work observation should be at least thirty (30), but need not be greater than sixty (60), since statistically, a greater sample size will not significantly increase the confidence interval of the sampled production welding. However, it is very important that the inspected sample is representative of all ongoing production welding.
- d. **Record Review**. The Inspector should review all the relevant documentation related to a sample thirty (30) randomly selected welds for each welding process used at the site (e.g., SMA, TIG, MIG, etc.). Same considerations as those stated in c above are applicable. It is preferable that the welds identified for record review are not the same welds identified for work observation. However, certain circumstances may necessitate the use of some of the welds sampled in c, above (e.g., a contractor/licensee has completed only three welds to date and all three welds need to be included in the sample to provide meaningful statistical representation).

55100-04 REFERENCES

Safety Analysis Report, Chapters 1, 3, 5, 6, and 17, including pertinent Codes and Standards referenced in these chapters.

American Welding Society, "Structural Welding Code".

U.S. Nuclear Regulatory Commission, "Regulatory Guide 1.26, Quality Group Classifications and Standards for Water-, Steam- and Radio-Waste Containing Components of Nuclear Power Plants".

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.29, "Seismic Design Classification".

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.38, "Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage and Handling of Items for Water-Cooled Nuclear Power Plants".

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.50, "Control of Pre-Heat Temperature for Welding of Low-Alloy Steel".

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.58, "Qualification of Nuclear Power Plant Inspection, Examination, and Testing Personnel".

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.71, "Welder Qualification for Areas of Limited Accessibility".

American Welding Society, Welding Handbook, Volume 1, "Fundamentals of Welding".

American Welding Society, "Welding Inspection."

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