

## SECTION 18100 GENERAL WELDING REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES:

- A. Welding fabrication and construction activities occurring both on-site and off-site. These requirements apply to structural welding, pipe welding, and ductwork welding when invoked by other technical sections or when drawings require fabrication to codes referenced in this document.
- B. Approval of a Subcontractor's welding procedures and welders for on-site welding may be granted for either of the following:
  - 1. The Subcontractor wishes to use a welding process not included in Division 18.
  - 2. The majority of the fabrication is off-site, and the Subcontractor will use the welding procedures and welders approved for off-site welding for the on-site installation welding.
- C. Special Qualification Requirements for Welding:
  - 1. If conditions of access for welding require the use of a mirror, the welder shall demonstrate his/her ability to weld using a mirror on a welder qualification test under access conditions, which simulate the production conditions.
  - 2. If conditions of access for any weld are such that the welder and/or the welder's supervisor/foreman determines that it is doubtful that the weld can be successfully made, the supervisor/foreman shall either:
    - a. Have the welder weld a mockup duplicating the conditions that make the success of the weld questionable. The weld mockup shall be examined in the same manner and meet the same requirements as required for the production weld, or;
    - b. Request that the designer evaluate the connection for redesign to provide for adequate access for welding.
  - 3. Contractor shall include in spot checks an evaluation of the adequacy of conditions for making acceptable welds.
  - 4. The Subcontractor shall conduct a pre-job briefing with the welders and supervisors to review special welding requirements resulting from the materials, personal protective equipment, or accessibility restrictions.

#### 1.2 REFERENCES

- A. AWS D.1, Structural Welding Code, 1988 Edition.
- B. AWS D9.1/D1.3, Sheet Metal Welding Code, 2000 Edition.
- C. AWS QC-1, Specification for Qualification and Certification of Welding Inspectors, 1996 Edition
- D. ASME Boiler and Pressure Vessel Code, Section V, Non-Destructive Examination, 1998 Edition.
- E. ASME Boiler and Pressure Vessel, Sect. IX, Welding and Brazing Qualifications, 1998 Edition

- F. ASME Boiler and Pressure Vessel Code, Sect. II, Part C, Material Specification, 1998 Edition.
- G. Technical Specification Div. 18B, On-Site Welding, January 1999 Edition (available on request).
- H. ASME B31.3, Process Piping, 1999 Edition.
- I. ASME B31.9, Building Service Piping, 1996 Edition.
- J. ASNT, Recommended Practice SNT-TC-1A, December 1996 Edition.

### 1.3 DEFINITIONS

- A. Engineer: The design engineering organization or representative responsible for the design of the system, component, or structure.
- B. Examination: Nondestructive examination performed on a weld to determine its compliance with established acceptance standards. A visual examination evaluates specifically listed attributes to established acceptance criteria. Only certified examiners perform examinations.
- C. Examiner: A qualified and certified individual who performs examinations and inspections.
- D. Faying Surface: The mating surface of a member which is in contact with or in close proximity to another member to which it is to be joined.
- E. Inspection: Oversight function of welding provided by the CM to verify that specified requirements applicable to the welding program are satisfied.
- F. Spot Check: Random observation performed by the subcontractor's examiner and the CM oversight inspector to verify conformance to the welding program requirements of this specification.
- G. On-Site: Welding activities, which occur within the boundaries of the ORNL site.
- H. Off-Site: Welding activities, which occur outside the boundaries of the ORNL site.
- I. Procedure Qualification Record (PQR): Written documentation of the qualification of a welding procedure specification (WPS) by examination and testing of physical weld specimens made using the WPS.
- J. Performance Qualification Test (PQT): Standard performance test(s) which a welder must successfully pass in order to be qualified to weld. Requirements for these tests are based on a qualified WPS and establish a specific range of essential variables the welder is qualified for.
- K. Shared WPS: A welding procedure specification that, when qualified by one company, may be used by another company without additional testing after accepting it in writing.
- L. Welder Performance Qualification (WPQ): The record, which documents a welder's successful completion of a performance qualification test (PQT) and establishes the range of variables the welder is qualified for.

- M. Welding Procedure Specification (WPS): A written document, which establishes the essential, nonessential, and supplementary essential (when required) variables for welding and provides direction to the welder for making production welds to ensure compliance with requirements.
- N. Weld Maps: A map that shows the location of welds in a system so that documentation such as certified material test reports, welder identification, and weld examination records can be traced to the weld it represents.

#### 1.4 SUBMITTALS

- A. Off-Site Welding – The following summarizes submittals required from the Vendor, Supplier or Subcontractor for performing off-site welding activities. Approval of the following are required prior to welding.
  - 1. WPQ records, including evidence of updates.
  - 2. WPSs and PQRs (unless prequalified per AWS D-1.1).
  - 3. Non-Destructive testing procedures with Examiner certification records.
- B. On-Site Welding
  - 1. Submit “For Approval” copies of PQRs for those WPSs that the Contractor or its Subcontractor are required to qualify per Paragraph 3.2.
  - 2. Submit “For Approval” copies of the following when the CM or its Subcontractor requests approval to use their own procedures on-site.
    - a. WPQ records, including evidence of updates. Continuity updates shall be documented on Attachment A or equivalent.
    - b. WPSs and PQRs (unless prequalified per AWS D-1.1).
  - 3. The Contractor and its Subcontractors submit “For Information” copies of Attachment B, “Contractor and Subcontractor Notification of Planned Welding Activities.”

#### 1.5 QUALITY ASSURANCE

- A. Welding by this specification requires that welders, welding procedures, examiners, and examination procedures meet the requirements specified in Part 2 and Part 3. For both on-site and off-site welding, the Subcontractor performs examinations using personnel and procedures approved by the CM.
- B. The subcontractor, vendor, supplier, or seller is the examiner and performs all examinations of welding activities and provides documented reports. The CM is the inspector, on behalf of the owner, and performs oversight inspections of the subcontractor’s examinations and welding activities.

### PART 2 - PRODUCTS

#### 2.1 MATERIAL REQUIREMENTS

- A. Welding Rods and Electrodes for On-Site and Off-Site Welding.
  - 1. Verify filler materials delivered are legibly marked in accordance with the General Requirements for each specification listed in AWS or the ASME Boiler and Pressure Vessel Code, Sect. II, Part C, Material Specifications.
  - 2. Verify bare filler material is identified with the applicable classification and/or specification numbers.
  - 3. Control, handle, and identify welding rods and electrodes at all times to avoid material degradation or inappropriate usage and to ensure they are identifiable as acceptable material until the material is consumed in the welding process.

- a. Unless otherwise specified by the CM, store and handle low-hydrogen electrodes in accordance with AWS D-1.1.
4. Technical Specification 15128 requires Certified Material Test Reports for stainless steel and Nickel alloy filler materials. Submit CMTRs for each heat of material reporting chemical analysis for those elements prescribed for that classification in the ASME/AWS specification. Heat number traceability to the time of consumption is required by these technical specifications for these materials.
  - a. Use ASME SFA5.9 or AWS A5.9, classification ER308L filler materials with a minimum delta ferrite of 5 ferrite number for Section 15128 or 15898 stainless steel welds. Use the type of filler material specified in the WPS.
  - b. Use ASME SFA 5.14 or AWS A5.14, filler materials for Nickel alloy welds. Use the type of filler material specified in the WPS.

## 2.2 OFF-SITE WELDING REQUIREMENTS

### A. Welding Procedures

1. For welding procedures other than those in Section 18350 prepare written welding procedures and qualify them for the scope of welding required in accordance with the applicable code in Paragraph 3.1 below.
2. Written approval of the WPS and PQR is required prior to welding.

### B. Qualification of Welders

1. Qualify welders and welding operators using the appropriate approved and qualified welding procedure specification. Submit records of welder qualification, including updates, required by the applicable code for the procedure. The welder performance qualification requirements and limits of qualification are those of the code for which the procedure is qualified.
2. Written approval of the welder performance qualification records is required prior to welding.

## 2.3 INSPECTION/EXAMINATION OF WELDS MADE OFF-SITE

- A. The Contractor or Subcontractor is responsible for the performance and documentation of specified weld examinations. These examinations shall be performed by qualified personnel or by an outside qualified examination service. The following applies for examination of welds made off-site:
  1. Certify examination personnel per the requirements in Part 3 of this specification.
  2. Submit weld examination procedures for approval in accordance with the applicable construction code in Part 3 of this specification prior to welding.
  3. Examine welds in accordance with Part 3 of this specification.
- B. Welds and weld records are subject to inspection by the CM. The CM may request additional welding examinations on any weld to establish the quality of the weld. The CM reserves the right to accept, reject, or demand removal of welds which are interpreted by the CM to be in violation of this specification.

## PART 3 - EXECUTION

### 3.1 GENERAL WELDING REQUIREMENTS

- A. Make groove and butt welds complete joint penetration and continuous unless specified otherwise by documentation. Backwelding of groove welds is acceptable. Weld size and

length shall comply with design tolerances as indicated in the specifications, drawings, and referenced codes. Do not change the location of welds without the approval of the CM.

B. Pipe Welding

1. Weld piping systems in accordance with ASME B31.9 for pipe sizes up to 30-inch and in accordance with ASME B31.3 for larger pipe sizes for Category D Fluid Service. Weld piping systems in accordance with ASME B31.3 for Category M Fluid Service.
  - a. Use the gas tungsten arc process for welds in the following materials:
    - 1) Butt welds in piping 1 1/2-in. outside diameter and smaller,
    - 2) The root pass of stainless steel piping,
    - 3) Copper and copper-base alloy piping, and
    - 4) The root pass of nickel and nickel-base alloy piping.
  - b. Purge the backside of the weld with Argon for the following materials until a minimum of 3/16-in. material thickness separates the weld from the backside of the weld. Analyze the purge with an oxygen analyzer to assure that oxygen does not exceed 1%.
    - 1) Stainless steel and
    - 2) Nickel and nickel-base alloys.
  - c. Do not use copper or aluminum as temporary backing for pipe welding.
  - d. Do not use backing rings unless permitted on the drawing or in the piping specification.
  - e. Do not use the SMAW, FCAW, or SAW process for root pass welding of stainless steel piping welds.
  - f. The GTAW, SMAW, GMAW, or FCAW process may be used for fillet welds or groove welds in pipe, fittings, and branch connections larger than 1 1/2 inch outside diameter.
  - g. GMAW with short circuiting transfer is prohibited for pipe welding.

3.2 ON-SITE WELDING

A. Operational Control

1. Division 18, Welding, implements the method of accomplishment for welding and, therefore, is the Government's welding specification which applies unless otherwise approved by the CM. To be in full compliance with the references in Part 1, welding must be within the operational control of each subcontractor performing it. This may be achieved by the Contractor describing in the quality control program or adopting by reference to this section, the following elements.
  - a. Each subcontractor using Div. 18, Welding, may request the CM to make changes. Identify the section number and the suggested change. General comments that the specification is unacceptable will be returned for specific comments.
  - b. The CM and its Subcontractor records acceptance of Division 18 and each WPS to be used by signing a copy of the example form included in Attachment D.
2. Construction Manager (CM)
  - a. The CM performs oversight inspection of welding activities performed by the subcontractor to verify that requirements of the welding program are complied with.
  - b. The CM is responsible for approving Welding WPSs when the applicable code does not permit shared WPSs.
  - c. Performs documented surveillance of welding activities to verify compliance with this specification and the WPSs.
3. Contractor

- a. The Contractor or Subcontractor is responsible for providing welding services and examinations in full compliance with the applicable code, contract, technical specifications, design drawings, and all other specified design documents.
  - b. Performs documented surveillance of welding activities to verify compliance with this specification and the WPSs.
- B. Welding Procedures
1. The elements necessary to achieve qualified welding procedure specifications are summarized below. Comprehensive sets of piping WPSs are provided in other sections as follows:
    - a. 18100, General Welding Requirements.
    - b. 18350, Pipe Welding Procedure Specifications.
  2. General
    - a. Use Division 18 WPSs for welding unless otherwise approved by the CM.
    - b. The following documents located in Division 18, used together, constitute a qualified welding procedure.
      - 1) WPS Section 18250.
      - 2) WPS Section 18350.
      - 3) Piping Welding Requirements referenced by Section 18310.
      - 4) Ductwork Welding Requirements referenced by Section 18410
      - 5) Structural Steel Section 015120.
      - 6) The PQRs referenced on the WPS.
  3. Contractor
    - a. Accomplish welding using Division 18 weld procedures. These procedures have been or will be qualified in advance by the CM as required to be compliant with the applicable construction/welding codes. The Contractor will provide copies of these procedures to its personnel and/or its Subcontractor as is necessary for their acceptance of the WPS.
  4. Subcontractor
    - a. When possible, use the prequalified (shared) welding procedures as allowed by ASME B31.3 and B31.9 prequalified per AWS D1.1; or Procedures qualified by the CM per AWS D9.1 or D1.3. The Subcontractor representative's signature on Attachment F attests that the Subcontractor accepts the procedure without requalification.
    - b. If a weld is identified that is not covered by this specification, notify the CM so that procedures can be provided.
  5. Exception
    - a. When specifically authorized by the CM, the Subcontractor may submit their own written weld procedures and PQRs through the Contractor for approval to be used for on-site welding.
    - b. The following welding programs, PQRs, WPSs and WPQs have been approved by the CM for On-site welding: Ironworkers local Union #384, Plumbers and Steamfitters Local Union #102 and Sheet Metal Workers Union #5 (CM approval pending).
- C. Weld Joint Details
1. Use the piping and weld joint details specified on the WPS and detailed in Section 18370 (available from the CM upon request) unless otherwise specified by the construction drawings.
- D. Welder Qualifications

1. Each organization performing welding is responsible for instructing their welders in the appropriate general welding requirements in Sections 18100 and 18310.
2. Subcontractor is responsible for qualification of welders and welding operator in accordance with the applicable code.

E. Weld Execution

1. Each organization performing welding on-site is responsible for the following:
  - a. Providing welding services in full compliance with the applicable code, contract, technical specifications, design drawings, and other specified design documents.
    - 1) Each organization's examiner performs and documents a random surveillance of welding activities to ensure compliance with this specification. Include the following activities in spot checks: base materials; weld joint fit-up; alignment of parts; surface cleanliness; welder qualification; adequate access to weld; filler material; WPS followed; purge; and workmanship. As a minimum, surveillance shall be performed weekly.
    - 2) Each organization is responsible to correct deficiencies found during surveillance, inspections, and examinations.
  - b. Ensuring that the specified weld procedure is qualified for the application and that the welder(s) is currently qualified for the procedure and for the specific range of welds to be made.
    - 1) The CM will specify a WPS to be used or a group of WPSs to select from. Notify the CM to resolve any situations in which weld procedures are not qualified for the full range of welding, or if welding of materials is required for which a procedure does not currently exist.
  - c. Notifying the CM prior to the start of any welding activities. The Subcontractor fills out the form in Attachment B, "Subcontractors Notification of Planned Welding Activities" and submits "For Information" to CM before 2:00 PM each Friday.
  - d. Maintaining project records required by the specification for base materials procured by that organization filler materials used and examination records until completion of the project, at which time the records will be submitted to the CM.
  - e. Repairing welds that fail acceptance standards.

F. Pipe WPSs

1. The CM and its subcontractors selects one of the WPSs from Specification Section 18350. The piping WPSs are included in Section 18350.
2. SM11-1(PP), SM11-2(PP), GT11-1(PP), GT88-1(PP), GT88-2(PP), and SM88-1(PP) may be used (shared) by the CM or its Subcontractor, without requalification, as allowed by ASME B31.3 or B31.9. The remaining WPSs in Section 18350 require qualification prior to use. Once qualified by a Subcontractor, the procedure may be used on-site by that Subcontractor indefinitely without further requalification. Submit for approval copies of the PQR to the CM prior to using WPSs that may not be shared.
3. Weld pipe supports using one of the pipe welding WPSs from Section 18350 for the materials specified in the technical specification.

G. Inspection/Examination

1. The subcontractor will provide the following:
  - a. Weld inspection/examination services required by the specifications. This does not relieve the Subcontractor from complying with other requirements of the code.

- b. Inspect welding activities as necessary to assure compliance with this specification. As a minimum, at least 5% of all welding activities shall be randomly examined for compliance with the specification. This does not relieve or replace the responsibility for each organization to monitor their own work as described in 3.2.
- c. Prepare, file, and transmit copies to CM QA or all inspection/examination reports weekly.

3.3 PERSONNEL CERTIFICATION REQUIREMENTS FOR WELD EXAMINATIONS

- A. Personnel performing visual examination of welds shall be currently certified either as an AWS CWI or as a visual testing Level II per the employers written practice in accordance with SNT-TC-1A. If certified in accordance with SNT-TC-1A, the training and experience requirements shall be satisfied entirely by time spent in weld examination related work. Personnel performing other Non-Destructive testing methods shall be certified in accordance with SNT-TC-1A.

3.4 EXAMINATION OF PIPING WELDS

- A. Required Examinations
  - 1. Examination Required for Category D Fluid Service Pipe Welding

<b>Section</b>	
15050	Piping Systems
15146	Stainless Steel Piping System (Non-certified Materials)
15104	Technical Equipment Cooling Water Piping
15106	Chilled Water, Condenser Water, Cooling Tower Water, Heating Hot Water, Condensate and Process Water Piping, including Hydronic Specialties

- a. The inspector shall randomly select a sufficient number of welds (5% min) for examination in order to be satisfied that they conform to the specification. Include welds made by each welder or welder operator in those examined. Perform a final visual examination of these welds in accordance with ASME B31.9 and/or the acceptance standards provided in the applicable site specification.

- 2. Examination required for Category M Fluid Service Piping Welding

<b>Section</b>	
15067	Special Piping Materials
15128	Stainless Steel Piping System (Certified Materials)

- a. Examinations shall be in accordance with pipe material schedules included on the drawings.





ATTACHMENT B (continued)

<b>Welding Inspection Service Request</b>	
<b>To:</b> <i>Construction Manager</i>	<b>Request No.:</b>
<b>Requester's Name:</b>	<b>Date of Request:</b>
<b>Requestor's Mailing Address:</b>	<b>Requestor's Phone and Pager No.</b>
<b>Division / Department / Organization:</b>	<b>Work Order No.:</b>
<b>Building / Location of Fabrication and Installation:</b>	<b>Labor / Materials Charge No.:</b>
<b>Project / System:</b>	<b>Technical Specification:</b>
<b>Welding Category:</b> <input type="checkbox"/> Piping <input type="checkbox"/> Structural <input type="checkbox"/> Ductwork <input type="checkbox"/> Incidental	<b>Drawing No.:</b>
<b>Welding Specification:</b> <input type="checkbox"/> DIVISION 18 <input type="checkbox"/> ASME B31.3 <input type="checkbox"/> AWS D.1.1 <input type="checkbox"/> Other	
<b>Type of Examination or Inspection Required</b>	
Procedure / Specification for Examination	
<input type="checkbox"/> Visual Weld Examination <input type="checkbox"/> Liquid Penetrant Examination <input type="checkbox"/> Magnetic Particle Examination <input type="checkbox"/> Other Test/Examination Requested	
<b>24 hour advanced notification of needed service will be issued by:</b>	
Name / Phone	
<b>Special Instructions:</b>	
<b>Distribute Inspection Reports To:</b>	
Name/Bldg./MS/Phone	

Disposition By: \_\_\_\_\_ Date: \_\_\_\_\_ ETI-109 (3 3/99)

ATTACHMENT C

**WELD AND INSPECTION REQUIREMENTS FOR STRUCTURAL WELDS**

WELD PLANNING DATA		INSPECTION REQUIRED			REMARKS
Specification or Drawing No.	WPS	Spot Check	Spot Inspection	VT-F 100%	
05120 Structural Steel	SM11-1(ST), FC11-1(ST), GM11-1(ST)	Req'd.	Req'd.	Req'd.	N/A
05210 Steel Joists	SM11-1(ST), FC11-1(ST), GM11-1(ST)	Req'd.	Req'd.	Req'd.	
05310 Steel Deck	SMASW-1(ST)	Req'd.	Req'd.	Req'd.	
05505 Miscellaneous Metals	SM11-1(ST), FC11-1(ST), GM11-1(ST)	Req'd.	Req'd.	Req'd.	

VT-FU = Fit-up visual      VT-F = Final Visual      PT-R = Liquid penetrant of root pass  
 PT-F = Liquid penetrant of final weld      PT-ID = Liquid penetrant of final inside root surface  
 Spot Check = Spot observation of welding activities for compliance with the specification by a person designated by the welder's employer other than the welder.  
 Spot Inspection = Oversight to verify conformance to the welding program. Include at least 5% of functions not included in the required examinations.



ATTACHMENT D

FORM FOR CONTRACTOR ACCEPTANCE OF WPS

WELDING PROCEDURE SPECIFICATION (WPS)		NUMBER:	
STRUCTURAL	PIPE	DUCTWORK	REVISION:
CONTRACTOR	AUTHORIZED SIGNATURE	DATE	PQR(S)

NOTE 1: For shared procedures as allowed by ASME B31.3, para. 328.2.2; procedures prequalified per AWS D1.1; or procedures qualified by the Owner per AWS D9.1, the PQRs are those listed on the WPS. The contractor's signature asserts that he has reviewed and approves the WPS, the PQRs listed on the WPS, and the specifications referenced on the WPS. For ASME B31.3 shared procedures, the contractor must identify at all times one welder whose qualification was tested by bend tests.

**END OF SECTION 18100**