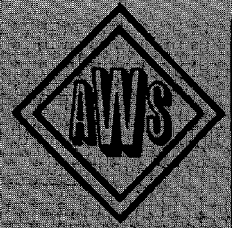


CHAPTER 3:

CODES, STANDARDS AND SPECIFICATIONS



Introduction

The responsibility associated with inspection is quite large. People who inspect for a living must have a critical eye, knowledge of their field, and know how to exercise judgment.

Some welding applications are more critical than others; however, all welding inspections are important, no matter how critical the weld or the application. The importance of welding inspection activities is underscored by the array of codes and specifications that inspectors must use.

In addition to covering the various codes and specifications, this chapter tells how different kinds of weldments are inspected, and also discusses the administrative side of welding inspection.....

There are many approaches to inspection. Today's growing technical demands by purchasers and the cost of product liability rule out casual or sloppy inspection. However, there are still areas of interpretation—for instance, where choices of the level of sensitivity are to be selected.

Where life and safety are involved, the quantity and quality of welding inspection usually must conform to a code, standard, or specification. The code may come from a government agency or a private agency such as an engineering society. A code is a body of rules for construction or fabrication of some product. For example, cities have "building codes" which describe the construction requirements for structures in that municipality. Codes are made mandatory by laws or regulations and may be used along with other referenced standards or specifications.

A standard is any document or object used as a basis of comparison. So, once a "standard" has been defined, you as an inspector must then judge the adequacy of product based upon how it compares with that established standard. "Standard" is a general term which could be used to describe a number of documents, including: codes, specifications, procedures, recommended practices, and groups of graphic symbols. Standards can be considered mandatory, such as a code, or nonmandatory, as is the case for a recommended practice.

The third type of document important to the welding inspector is the specification. The specification differs from the code in that it describes the requirements for a particular object, material, service, etc., while the code describes a much larger scope of construction or fabrication. You might more easily remember this difference by realizing that a specification describes a specific part or material that may become an integral part of a product fabricated in accordance with some code. Almost all codes and standards require written welding procedure specifications (WPS's). These specifications provide the welder and inspector with valuable details about the welding processes to be applied. The WPS is a "recipe" for a welded joint.

During the execution of any inspection, the welding inspector must constantly refer to the codes, standards, specifications, or a combination of the three to learn many important requirements for the fabrication or construction taking place. A number of these documents exist that relate to some aspect of weld quality. They are primarily produced by national professional organizations or

government agencies. Depending on the type of weldment being constructed, different requirements will be enforced.

The following discussion includes descriptions of these various welding codes, standards and specifications and their areas of coverage.

Structural Welding Code - Steel (AWS D1.1)

AWS D1.1, *Structural Welding Code- Steel*, is published by the American Welding Society, with new editions being scheduled for publication every other year. It describes the welding requirements for steel structures, including statically loaded, dynamically loaded and tubular structures. Sections 1 through 7 contain topics applicable to all structures, while Sections 8, 9 and 10 refer to requirements specific to statically loaded structures, dynamically loaded structures and tubular structures, respectively.

Below is a listing of the various Sections of AWS D1.1 and their areas of coverage:

- (1) General Provisions
- (2) Design of Welded Connections
- (3) Workmanship
- (4) Technique
- (5) Qualification
- (6) Inspection
- (7) Stud Welding
- (8) Statically Loaded Structures
- (9) Dynamically Loaded Structures
- (10) Tubular Structures
- (11) Strengthening and Repairing Existing Structures
- (12) Appendices & Commentaries

In AWS D1.1, section 6 there are two definitions of welding inspectors: fabrication/erection and verification. The fabrication/ erection inspection and testing is the responsibility of the contractor unless otherwise provided in contract documents. However, the

verification inspection and testing is the responsibility of the owner or engineer. While AWS does make this distinction, the requirements of the Code are intended to apply equally to the work of both parties.

Sections 6.1 through 6.5 describe the duties and responsibilities of the welding inspector, and Section 6.6 details the responsibilities of the contractor in satisfying the wishes of the inspection personnel. Sections 6.7 and 10.17.2 describe the methods to be used for nondestructive examination in accordance with AWS D1.1. For information pertaining to the various NDT methods, refer to Table 3-1, page 3-3.

Other AWS Structural Welding Codes (D1.2, D1.3, D1.4, and D1.5)

In addition to D1.1, AWS is also responsible for the development of four other codes dealing with structural welding requirements. They include:

- D1.2, *Structural Welding Code- Aluminum*;
- D1.3, *Structural Welding Code- Sheet Steel*;
- D1.4, *Structural Welding Code- Reinforcing Steel*;
- D1.5, *Bridge Welding Code*.

All four follow the general format of AWS D1.1; however, as the names imply, they each refer to a specific type of structure. As such, the welding requirements differ slightly.

The newest of these four codes, AWS D1.5 *Bridge Welding Code*, was prepared under the joint guidance of the AWS Structural Welding Committee and AASHTO (American Association of State Highway and Transportation Officials).

ASME Boiler and Pressure Vessel Code

The ASME Boiler and Pressure Vessel Code prescribes those requirements for design and construction of pressure-containing components, as well as the care and operation of heating and

Table 3-1
Nondestructive Testing Methods - D1.1 Code Reference

<u>Test Method</u>	<u>Applicable Code References</u>
Radiographic	Section 6, Part B and Section 10.18
Ultrasonic	Section 6, Part C and Section 10.19
Magnetic Particle	6.7.5 (ASTM E709)
Liquid Penetrant	6.7.6 (ASTM E165)
NDT Personnel Qualification	6.7.7 (SNT-TC-1A)

The acceptance criteria for both the visual inspection and nondestructive examination are found in the following Code locations, depending upon the type of structure being constructed:

<u>Type of Structure</u>	<u>Weld Acceptance Criteria Reference</u>
Statically Loaded	8.15
Dynamically Loaded	9.25
Tubular	10.17

power boilers. Different sections of this Code refer to both fossil and nuclear power equipment. Due to the wide range of coverage offered by the ASME Code, it is contained in several different sections. Table 3-2, page 3-4 describes the various areas of coverage for these Code sections.

Definition of Inspector

Under the ASME Code, the term *Inspector* refers only to an *Authorized Inspector* who is employed by:

- 1) A state or municipality of the U.S. or a province of Canada;
- 2) An insurance company authorized to write boiler and pressure vessel insurance
- 3) A company having vessels made for use by that company exclusively and not for sale (applies to Section VIII, Division I, only)

An Authorized Inspector is not an inspector hired by the fabricator. Qualification of a National Board commissioned Authorized Inspector is by written examination prepared by the National Board of Boiler and Pressure Vessel Inspectors and administered by a city, state or province. The CWI is not an Authorized Inspector. The position of Authorized Inspector is a separate certification.

General Inspection Requirements

General inspection requirements concerning materials, procedures, and personnel are covered in paragraph UG90 of ASME Section VIII, Division I.

Materials

The welding inspector must be sure that the specified materials are used and verify that suitable test examinations proved that filler materials were correct.

**Table 3-2 -
ASME Boiler and Pressure Vessel - Code Reference**

ASME Section	Topic
I	Power Boilers
II	Material Specifications
	Part A: Ferrous Materials
	Part B: Nonferrous Materials
	Part C: Welding Filler Materials
	Part D: Properties
III	Nuclear Components
IV	Heating Boilers
V	Nondestructive Examination
VI	Care and Operation of Heating Boilers
VII	Care of Power Boilers
VIII	Unfired Pressure Vessels
IX	Welding and Brazing Qualification
X	Fiberglass-Reinforced Plastic Pressure Vessels
XI	Inservice Inspection of Nuclear Components

When performing inspection in accordance with the ASME Code, several of the different sections must be referenced, because they contain different types of requirements. As an example, for an unfired pressure vessel constructed from steel in accordance with the ASME Code, the various sections which apply are:

Section	Information Provided
II, Part A	Description, including chemical and mechanical properties, of the steel base metals to be used.
II, Part C	Description, including chemical and mechanical properties, of the welding filler materials.
II, Part D	Material properties
V	Methods for performing various required nondestructive examinations.
VIII	Design, fabrication and inspection requirements for unfired pressure vessels, including weld acceptance criteria.
IX	Requirements for the qualification of welding procedures and welders.

Procedures

It must be verified that the welding procedures have been qualified. Evidence of this qualification can be found by reviewing a written *Welding Procedure Specification (WPS)* and a *Procedure Qualification Record (PQR)*.

Personnel

All welders, welding operators, brazers, and brazing operators must be qualified.

Nondestructive Examination

You must ensure that nondestructive examinations and tests are carried out as needed.

ASTM Standards

Numerous standards of the American Society for Testing and Materials are referenced in the ASME, AWS, and other codes. Most common are the specifications for materials. However, for ASME Code fabrication, the designations for

ASTM Standards are assigned the prefix “S”. Hence, ASTM A285 steel is specified as SA285 for ASME applications. However, when accepted by ASME, the information found in both is identical.

API Standards

The American Petroleum Institute publishes three important standards which deal with welded pipelines and vessels. They include:

<u>API Standard</u>	<u>Title</u>
1104	<i>“Standard for Welding Pipeline and Related Facilities”</i>
620	<i>“Recommended Rules for Design and Construction of Large Welded Low-Pressure Storage Tanks”</i>
650	<i>“Standard for Welded Steel Tank for Oil Storage”</i>

API Standard 1104 contains requirements for qualification of procedures and welders, qualification of radiographers, radiographic techniques, as well as weld quality requirements for production welding.

For procedure and welder qualification, test coupons are subjected to various destructive tests, including: tensile, nick break, root bend, face bend, and side bend. Fillet welds are examined by the nick break test. However, as in AWS D1.1 and ASME Section IX, API 1104 permits the qualification of welders using radiographic testing in lieu of destructive tests. (see specific code for requirements)

Requirements for the qualification of radiographers are given in Paragraph 8.0, but no limitations are placed on the qualification of destructive test personnel. Fractured test specimens speak for themselves, presuming that the welding inspector can verify their source or application.

API Standard 620 is intended to apply to the design and construction of large, welded, low-pressure, carbon steel, above-ground storage tanks that have a single vertical axis of revolution. These tanks may be operated at temperatures up to 200° F and pressures up to 15 psi.

API Standard 650 applies to the material, design, fabrication, erection, and testing requirements for vertical cylindrical aboveground, closed and open-top, welded steel storage tanks in various sizes and capacities for internal pressures approximating atmospheric pressures, except that a small internal pressure is permitted when the additional requirements of Appendix F are met. API 650 applies only to nonrefrigerated service.

Military Standards

The United States Department of Defense produces a staggering quantity of military standards. For a complete list of all military specifications, refer to the *Index to Military Specifications and Standards* that may be available at companies producing products under a military contract. Here are a few examples of the military standards.

Welding electrode specifications have the identifying letter “E” and a multi-digit number, such as MIL-E-22200/1 for “Electrodes, covered low alloy steel”; MIL-E-22200/2 for covered stainless steel electrodes; MIL-E-19933D for bare stainless steel electrode wires; and MIL-E-16053L for bare aluminum electrode wires. Other important filler metal specifications include MIL-R-17131B for “Rods, bare hard surfacing alloys for GTA welding” and MIL-I-2341B for “Inserts, consumable.”

ANSI Standards

The American National Standards Institute has either developed or adopted other codes and standards which are referred to as “American National Standards.” Many of these documents carry identification referring to both organizations responsible for its development and maintenance.

Two common ANSI standards are ASME B31.1, "Power Piping" and ASME B31.3, "Chemical Plant and Petroleum Refinery Piping." Although developed by the American Society of Mechanical Engineers (ASME), they are best known by their ANSI designation. Both refer to ASME Section IX for welding and brazing qualification requirements.

Many of the AWS standards are also considered to be American National Standards, and can be correctly referred to by the designation prefix ANSI/AWS. A few of the many examples are: ANSI/AWS D1.1, ANSI/AWS B1.10, ANSI/AWS D14.3, etc.

AWS Filler Metal Specifications

Thirty different specifications for filler materials are published by the American Welding Society. Reference is made in ASME, ANSI, and AWS Codes, and indirectly in the API Standards to the AWS filler metal specifications. Certain of these are reviewed and adopted by ASME, adding the letters "SF" preceding the AWS designation. The AWS Filler metal specifications are listed as follows:

- A5.1** Carbon Steel Covered Arc Welding Electrodes
- A5.2** Iron and Steel Gas Welding Rods
- A5.3** Aluminum and Aluminum Alloy Arc Welding Electrodes
- A5.4** Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Electrodes
- A5.5** Low Alloy Steel Covered Arc Welding Electrodes
- A5.6** Copper and Copper Alloy Covered Electrodes
- A5.7** Copper and Copper Alloy Bare Welding Rods and Electrodes

A5.8 Brazing Filler Metal

A5.9 Corrosion Resisting Chromium and Chromium-Nickel Steel Bare and Composite Metal Cored and Stranded Arc Welding Electrodes and Welding Rods

A5.10 Aluminum and Aluminum Alloy Welding Rods and Bare Electrodes

A5.11 Nickel and Nickel Alloy Covered Welding Electrodes

A5.12 Tungsten Arc Welding Electrodes

A5.13 Surfacing Welding Rods and Electrodes

A5.14 Nickel and Nickel Alloy Bare Welding Rods and Electrodes

A5.15 Welding Rods and Covered Electrodes for Welding Cast Iron

A5.16 Titanium and Titanium Alloy Bare Welding Rods and Electrodes

A5.17 Bare Carbon Steel Electrodes and Fluxes for Submerged Arc Welding

A5.18 Carbon Steel Filler Metals for Gas Shielded Arc Welding

A5.19 Magnesium Alloy Welding Rods and Bare Electrodes

A5.20 Carbon Steel Electrodes for Flux Cored Arc Welding

A5.21 Composite Surfacing Welding Rods and Electrodes

A5.22 Flux Cored Corrosion-Resisting Chromium and Chromium-Nickel Steel Electrodes

A5.23 Bare Low Alloy Steel Electrodes and Fluxes for Submerged Arc Welding

A5.24 Zirconium and Zirconium Alloy Bare Welding Rods and Electrodes

- A5.25** Consumables Used for Electroslag Welding of Carbon and High Strength Low Alloy Steels
- A5.26** Consumables Used for Electrogas Welding of Carbon and High Strength Low Alloy Steels
- A5.27** Copper and Copper Alloy Gas Welding Rods
- A5.28** Low Alloy Steel Filler Metals for Gas Shielded Arc Welding
- A5.29** Low Alloy Steel Electrodes for Flux Cored Arc Welding
- A5.30** Consumable Inserts
- A5.31** Specification for Fluxes for Brazing and Braze Welding

Alphabetic Index to AWS Filler Metal Specifications

Aluminum	A5.3, A5.10
Brazing	A5.8, A5.31
Carbon Steel	A5.1, A5.17, A5.18, A5.20, A5.25, A5.26
Cast Iron	A5.15
Consumable Inserts	A5.20
Copper	A5.6, A5.7, A5.27
Corrosion Resistance	A5.4, A5.9, A5.22
Electrogas	A5.26
Electroslag	A5.25
Flux Cored	A5.20, A5.22, A5.29
Gas Shielded Arc	A5.18, A5.28
Low Alloy Steel	A5.5, A5.23, A5.25, A5.26, A5.28

Magnesium	A5.19
Nickel	A5.11, A5.14
Stainless Steel	A5.4, A5.9, A5.22
Submerged Arc	A5.17, A5.23
Surfacing	A5.13, A5.21
Titanium	A5.16
Tungsten	A5.12
Zirconium	A5.24

Summary

As a welding inspector, it will be necessary to work under the guidance and requirements of certain codes, standards and specifications. These documents should describe all of the necessary information, including:

- what to inspect,
- where to inspect,
- how to inspect,
- the extent of inspection, and
- the acceptance criteria to be used during these evaluations.

Various organizations are responsible for the development and maintenance of these codes, standards and specifications. As required by contract documents, the welding inspector will refer to those documents which will be in effect for his portion of the inspection.

A number of different codes, standards and specifications exist for different types of fabrication and construction. Their requirements differ depending on the specific needs of that particular industry.

REVIEW - CHAPTER 3 CODES, STANDARDS AND SPECIFICATIONS

- Q3-1** Job quality requirements can be found in all but which of the following?
- a. codes
 - b. standards
 - c. specifications
 - d. text books
 - e. a&b only
- Q3-2** Of the following, which may be considered either mandatory or non-mandatory?
- a. codes
 - b. specifications
 - c. standards
 - d. a and b above
 - e. all of the above
- Q3-3** The type of document which has legal status is:
- a. code
 - b. standard
 - c. specification
 - d. both a and b above
 - e. all of the above
- Q3-4** That type of document which describes the requirements for a particular object or component is referred to as:
- a. code
 - b. standard
 - c. specification
 - d. a and b above
 - e. b and c above

- Q3-5** Of the following types of documents, which is the more general type. In fact, the other documents could be considered as more specific types of this classification.
- a. codes
 - b. standards
 - c. specifications
 - d. drawings
 - e. none of the above
- Q3-6** The code which covers the welding of steel structures is:
- a. ASME Section IX
 - b. ANSI B31.1
 - c. API 1104
 - d. AWS D1.1
 - e. none of the above
- Q3-7** The code which covers the design and fabrication of unfired pressure vessels is:
- a. ASME Section IX
 - b. ASME Section VIII
 - c. ASME Section III
 - d. API 1104
 - e. AWS D1.1
- Q3-8** The specification covering the requirements for welding electrodes are designated as:
- a. AWS D1.X
 - b. AWS D14.X
 - c. AWS A5.X
 - d. ASTM A53
 - e. ASTM A36
- Q3-9** The standard describing the requirements for welding of crosscountry pipelines is:
- a. AWS D1.1
 - b. ASME Section VIII
 - c. ASME Section IX
 - d. API 1104
 - e. none of the above