

Welding Codes and How They're Used

Almost all design, welding, fabrication, material, repair, testing, and inspection requirements are covered under three main governing organizations. Even the Department of Defense (**DOD**) has either adopted many of these codes, or used them as a basis to develop their own codes known as Mil-Specs. These codes are recognized by the American National Standards Institute (**ANSI**). The following list of codes just barely "scratches the surface" of all existing codes and code organizations. These are the most common codes being used, but there are many others. Many complex jobs fall under multiple codes.

These main organizations are the American Welding Society (**AWS**), the American Society of Mechanical Engineers (**ASME**), and the American Petroleum Institute (**API**). All of these organizations have multiple specific codes for various types of construction, processes, and/or materials. Design specifications and approved materials are included in these codes. What I am about to list is only the major codes from these organizations that control metal construction with a brief overview and is **not** a comprehensive list of every single code that these organizations have available. This information is taken from the latest codes that are available to me and not necessarily the latest editions of these codes. If you need a comprehensive up to date list of any or all of their codes, then you should visit the respective organizations. Think you just landed a contract that doesn't fall under a code? Think again-and read on!

American Welding Society

- **AWS D1.1** This code contains the requirements for fabricating and erecting welded steel structures. This code applies to steels with a thickness of 1/8 inch (3.2mm) or more. When this code is specified in a contract, most of the provisions are mandatory. Optional provisions and examples are shown in an annex included within this code.
- **AWS D1.2** This is the Structural Welding Code-Aluminum. The welding requirements are applicable to any type of welded aluminum alloy structure. This code is appropriate for use in fabrication of supporting structures and appurtenances. It is not intended to supplant codes developed for use in specialized fabrication such as the ASME Boiler and Pressure Vessel Code, aerospace codes, or military codes.
- **AWS D1.3** This is the Structural Welding Code-Sheet Steel. This code covers the arc welding of structural steel sheet/strip steels including cold formed members which are equal to or less than 3/16 inch (.188 in./4.8mm) in nominal thickness. Three weld types unique to sheet steel, arc spot, arc seam, and arc plug welds are included in this code.
- **AWS D1.4** This is the Structural Welding Code-Reinforcing Steel. This code shall apply to the welding of reinforcing steel to reinforcing steel and of reinforcing steel to carbon or low-alloy structural steel. This code shall be used in conjunction with the prescribed general building code specifications and is applicable to all welding of reinforcing steel using the processes listed in Section 1.4, and performed as a part of reinforced concrete construction. When reinforcing steel is welded to structural steel, the provisions of AWS D1.1 shall apply to the structural steel component.
- **AWS D1.5** This is the Bridge Welding Code. This code covers welding fabrication requirements applicable to welded highway bridges. It is to be used in conjunction with the AASHTO Standard Specification for Highway Bridges or the AASHTO LRFD Bridge Design Specifications. This code is not intended to be used for the following: steels with a minimum specified yield strength greater than 690 MPa (100ksi), pressure vessels or pressure piping, base metals other than carbon or low alloy steels, or structures composed of structural tubing.

- **AWS D1.6** Structural Welding Code-Stainless Steel. This code covers welding requirements applicable to stainless steel weldments subject to design stress. It shall be used in conjunction with any complementary code or specification for the design or construction of stainless steel weldments.
- **AWS D3.5-93R** Guide for Steel Hull Welding. This guide is referenced in many contract specifications for building vessels from barges to tugboats.
- **AWS D3.6M** Specification for Under-Water Welding.
- **AWS D3.7** Guide for Aluminum Hull Welding. Similar to the Steel Hull Welding Guide, but with a special emphasis on the unique properties of aluminum.
- **AWS D8.8-97** Specification for Automotive and Light Truck Weld Quality: Arc Welding.
- **AWS D14.1** Specification for Welding Earth Moving and Construction Equipment. Applies to all structural welds used in the manufacture of earthmoving and construction equipment. This specification reflects the welding practices employed by manufacturers within the industry and incorporates various methods which have been proven successful by individual manufacturers.
- **AWS D14.5** Specification for Welding Presses and Press Components. The purpose of this specification is to establish minimum acceptable requirements for weld joint design and the fabrication by welding of presses and press components, and is not intended to apply to material feed mechanisms and tooling. It shall also apply to the modification or repair by welding of new or existing presses or press components.

American Society of Mechanical Engineers

- **ASME Section I** Requirements for Power boilers. Part PW lists the Requirements for Boilers Fabricated By Welding. The rules in Part PW are applicable to boilers and component parts thereof, including piping constructed under the provisions of this Section that are fabricated by welding and shall be used in conjunction with the general requirements of Part PG as well as with the specific requirements in the applicable Parts of this Section that pertain to the type of boiler under consideration.
- **ASME Section II** Material Specifications-4 Subparts(A,B,C,D). Subpart A-Ferrous Material Specifications. Subpart B-Non-Ferrous Material Specifications-Materials. Subpart C-Specifications for Welding Rods, Electrodes, and Filler Metals. Subpart D- Properties-divided into three subparts- 1 Stress Tables. 2 Physical Properties Tables. 3 Charts and Tables for Determining Shell Thickness of Components Under External Pressure.
- **ASME Section III** Nuclear-There are Three Subdivisions- Division 1-Rules For Construction of Nuclear Facility Components. Subsection NB lists Class 1 Components. Subsection NC lists Class 2 Components. Subsection ND lists Class 3 Components. Subsection NE lists Class MC Components. Subsection NF covers Supports. Subsection NG deals with Core Support Structures. Subsection NH covers Class 1 Components in Elevated Temperature Service. Division 2-Code For Concrete Reactor Vessels and Containment. Division 3-Containment Systems for Storage and Transport Packaging of Spent Nuclear Fuel and High Level Radioactive Material and Waste.
- **ASME Section IV** Rules For Construction of Heating Boilers. The rules to Part HG apply to steam heating boilers, hot water heating boilers, hot water supply boilers, and appurtenances thereto. They shall be used in conjunction with the specific requirements of Parts HF and HC whichever is applicable. The forward provides the basis for these rules. Part HG is not intended to apply to potable water heaters except as provided for in Part HLW.
- **ASME Section V** Non-Destructive Examination. Unless otherwise specified by the referencing

Code Section, or other referencing documents, this Section of the Code contains requirements and methods for nondestructive examination which are Code requirements to the extent they are specifically referenced and required by other Code Sections. These nondestructive examination methods are intended to detect surface and internal discontinuities in materials, welds, and fabricated parts and components. They include radiographic examination, ultrasonic examination, liquid penetrant examination, magnetic particle examination, eddy current examination, visual examination, leak testing, and acoustic emission examination.

- **ASME Section VI** Recommended Rules For the Care and Operation of Heating Boilers. This is divided into nine subsections. 1-General, covers scope and terminology. 2-Types of Boilers. 3-Accessories and Installation. 4-Fuels. 5-Fuel Burning Equipment and Fuel Burning Controls. 6-Boiler Room Facilities. 7-Operation, Maintenance, and Repair-Steam Boilers. 8-Operation, Maintenance, and Repair-Hot Water Boilers and Hot Water Heating Boilers. 9-Water Treatment
- **ASME Section VII** Recommended Guidelines for the Care of Power Boilers
- **ASME Section VIII** Pressure Vessel and Tank Code. This is divided into three sub-divisions. Division 1-Subsection A is general pressure vessel information. Subsection B covers the Requirements Pertaining to Methods of Fabrication of Pressure Vessels. Subsection C lists the Requirements Pertaining to Classes of Materials. Division 2 covers Alternative Rules for Construction of Pressure Vessels. Division 3 lists Alternative Rules for Construction of High Pressure Boilers.
- **ASME Section IX** Welding and Brazing Qualifications. This section covers the requirements for Weld Procedure Specifications (WPS), Procedure Qualification Records (PQR), and certification requirements for tackers, welders, welding operators, and brazing personnel.
- **ASME Section X** Fiber-Reinforced Plastic Pressure Vessels.
- **ASME Section XI** Rules for In-service Inspection of Nuclear Power Plant Components.
- **ASME B31.1** Power Piping-This Code prescribes requirements for the design, materials, fabrication, erection, test, and inspection of power and auxiliary service piping systems for electrical generation stations, industrial and institutional plants, central and district heating plants, and district heating systems, except as limited by para. 100.1.3. These systems are not limited by plant or property lines unless they are specifically limited by para. 100.1. Piping as used in this Code includes pipe, flanges, bolting, gaskets, valves, relief devices, fittings, and the pressure containing portions of other piping components. It also includes hangers and supports and other equipment items necessary to prevent overstressing the pressure containing components. The users of this Code are advised that in some areas legislation may establish governmental jurisdiction over the subject matter covered in this Code. However, any such legal requirement shall not relieve the owner of his inspection responsibilities specified in para. 136.1.
- **ASME B31.2** Fuel Gas Piping-Material, This Code covers the design, fabrication, installation, and testing of piping systems for fuel gases such as natural gas, manufactured gas, liquefied petroleum gas-air mixtures above the upper combustible limit, liquefied petroleum gas in the gaseous phase, or a mixture of these gases. Included within the scope of this Code are fuel gas piping systems both in buildings and between buildings, from the outlet of the consumer's meter set assembly (or point of delivery) to and including the first pressure containing valve upstream of the gas utilization device. Piping systems within the scope of this Code include all components such as pipe, valves, fittings, flanges (except inlet and outlet flanges that are a part of equipment or apparatus described in para. 200.1.4), bolting and gaskets. Also included are the pressure containing parts of other components such as expansion joints, strainer and metering devices, and piping supporting fixtures and structural attachments.

- **ASME B31.3** Process Piping- Rules for the Process Piping Code have been developed considering piping typically found in chemical, petroleum refineries, pharmaceutical, textile, paper, semiconductor, and cryogenic plants; and related processing plants and terminals. This Code prescribes requirements for materials and components, design, fabrication, erection, assembly, examination, inspection, and testing of piping. this Code applies to all fluids, including: raw, intermediate, and finished chemicals; petroleum products; gas, steam, air, and water; fluidized solids; refrigerants; and cryogenic fluids.
- **ASME B31.4** Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohol. This Code prescribes requirements for the design, materials, construction, assembly, inspection, and testing of piping transporting liquids such as crude oil, condensate, natural gasoline, natural gas liquids, liquefied petroleum gas, carbon dioxide, liquid alcohol, liquid anhydrous ammonia, and liquid petroleum products between producers' lease facilities, tank farms, natural gas processing plants, refineries, stations, ammonia plants, terminals (marine, rail, truck), and other delivery and receiving points. Piping consists of pipe, flanges, bolting, gaskets, valves, relief devices, fittings, and the pressure containing parts of other piping components. It also includes hangers and supports, and other equipment items necessary to prevent overstressing the pressure containing parts.
- **ASME B31.5** Piping Refrigeration-This Code prescribes requirements for the materials, design, fabrication, assembly, erection, test, and inspection of refrigerant and secondary coolant piping for temperatures as low as -320°F except as specifically excluded.
- **ASME B31.8** Gas Transmission and Distribution-This code covers the design, fabrication, installation, inspection, testing and safety aspects of operation and maintenance of gas transmission and distribution systems, including gas pipelines, gas compressor stations, gas metering and regulation stations, gas mains, and service lines up to the outlet of the customer's meter set assembly. Included within this Code are gas transmission and gathering pipelines, including appurtenances, that are installed offshore for the purpose of transporting gas from production facilities to onshore locations. Much more is also covered in this code.
- **ASME B31.9** Building Services Piping-This Code Section has rules for the piping in industrial, institutional, commercial and public buildings, and multi-unit residences which does not require the range of sizes, pressures, and temperatures covered in B31.1.
- **ASME B31.11** Slurry Transportation Piping Systems-This code prescribes minimum requirements for the design, materials, construction, assembly, inspection, testing, operation, and maintenance of piping transporting aqueous slurries of non-hazardous materials, such as coal, mineral ore, concentrates, and other solid material, between a slurry processing plant or terminal, and a receiving plant or terminal.

American Petroleum Institute

- **API 570** Piping Inspection Code- This code covers the inspection, repair, alteration, and re-rating of in-service piping systems. API 570 was developed for the petroleum refining and chemical process industries but may be used, where practical, for any piping system. It is intended for use by organizations that maintain or have access to an authorized inspection agency, a repair organization, and technically qualified piping engineers, inspectors, and examiners, all as defined in Section 3.

- **API 620** This code lists the requirements for Design and Construction of Large, Welded, Low-Pressure Tanks. This code applies to carbon steel above ground, including flat bottom tanks, that have a single vertical axis of revolution. The tanks described in this standard are designed for metal temperatures not greater than 250°F and with pressures in their gas or vapor spaces not more than 15 psi.
- **API 650** Welded Steel Tanks for Oil Storage. This standard covers 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 pressure (internal pressure not exceeding the weight of the roof plates), but a higher internal pressure is permitted when additional requirements are met. This standard applies only to tanks whose entire bottom is uniformly supported and to tanks in non-refrigerated service that have a maximum operating temperature of 90°C (200°F).
- **API 653** Tank Inspection, Repair, Alteration, and Reconstruction. This standard covers carbon and low alloy steel tanks built to API Standard 650 and its predecessor API Specification 12C. API 653 provides minimum requirements for maintaining the integrity of welded or riveted, atmospheric pressure, aboveground storage tanks after they have been placed in service. It covers the maintenance inspection, repair, alteration, relocation, and reconstruction of such tanks. The scope of this publication is limited to the tank foundation, bottom, shell, structure, roof, attached appurtenances, and nozzles to the face of the first flange, first threaded joint, or first welding-end connection. This standard employs the principles of API 650; however, storage tank owner/operators may apply this standard to any steel tank constructed in accordance with a tank specification.
- **API 1104** Welding of Pipelines and Related Facilities. This standard covers the gas and arc welding of butt, fillet, and socket welds in carbon and low-alloy steel piping used in the compression, pumping, and transmission of crude petroleum, petroleum products, fuel gases, carbon dioxide, and nitrogen, and where applicable, covers welding on distribution systems. It applies to both new construction and in-service welding. The welding may be done by a shielded metal-arc welding, submerged arc welding, gas tungsten-arc welding, gas metal-arc welding, flux-cored arc welding, plasma arc welding, oxyacetylene welding, or flash butt welding process or by a combination of these processes using a manual, semi-automatic, or automatic welding technique or a combination of these techniques. The welds may be produced by position or roll welding or by a combination of position and roll welding. This standard also covers the procedures for radiographic, magnetic particle, liquid penetrant, and ultrasonic testing as well as the acceptance standards to be applied to production welds tested to destruction or inspected by radiographic, magnetic particle, liquid penetrant, ultrasonic, and visual testing methods.