CHAPTER A4
PIPING CODES AND STANDARDS

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Codes usually set forth requirements for design, materials, fabrication, erection, test, and inspection of piping systems, whereas standards contain design and construction rules and requirements for individual piping components such as elbows, tees, returns, flanges, valves, and other in-line items. Compliance to code is generally mandated by regulations imposed by regulatory and enforcement agencies. At times, the insurance carrier for the facility leaves hardly any choice for the owner but to comply with the requirements of a code or codes to ensure safety of the workers and the general public. Compliance to standards is normally required by the rules of the applicable code or the purchaser's specification.

Each code has limits on its jurisdiction, which are precisely defined in the code. Similarly, the scope of application for each standard is defined in the standard. Therefore, users must become familiar with limits of application of a code or standard before invoking their requirements in design and construction documents of a piping system.

The codes and standards which relate to piping systems and piping components are published by various organizations. These organizations have committees made up of representatives from industry associations, manufacturers, professional groups, users, government agencies, insurance companies, and other interest groups. The committees are responsible for maintaining, updating, and revising the codes and standards in view of technological developments, research, experience feedback, problems, and changes in referenced codes, standards, specifications, and regulations. The revisions to various codes and standards are published periodically. Therefore, it is important that engineers, designers, and other professional and technical personnel stay informed with the latest editions, addenda, or revisions of the codes and standards affecting their work.

While designing a piping system in accordance with a code or a standard, the designer must comply with the most restrictive requirements which apply to any of the piping elements.

In regard to applicability of a particular edition, issue, addendum, or revision of a code or standard, one must be aware of the national, state, provincial, and local laws and regulations governing its applicability in addition to the commitments made by the owner and the limitations delineated in the code or standard. This

chapter covers major codes and standards related to piping. Some of these codes and standards are discussed briefly, whereas others are listed for convenience of reference.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The American Society of Mechanical Engineers (ASME) is one of the leading organizations in the world which develops and publishes codes and standards. The ASME established a committee in 1911 to formulate rules for the construction of steam boilers and other pressure vessels. This committee is now known as the ASME Boiler and Pressure Vessel Committee, and it is responsible for the ASME Boiler and Pressure Vessel Code. In addition, the ASME has established other committees which develop many other codes and standards, such as the ASME B31, Code for Pressure Piping. These committees follow the procedures accredited by the American National Standards Institute (ANSI).

ASME BOILER AND PRESSURE VESSEL CODE

The ASME Boiler and Pressure Vessel Code contains 11 sections:

Section I Power Boilers

Section II Material Specifications

Section III Rules for Construction of Nuclear Power Plant Components

- Division 1 Nuclear Power Plant Components
- Division 2 Concrete Reactor Vessel and Containments
- Division 3 Containment Systems and Transport Packaging for Spent Nuclear Fuel and High-Level Radioactive Waste

Section IV Heating Boilers

Section V Nondestructive Examination

Section VI Recommended Rules for Care and Operation of Heating Boilers

Section VII Recommended Rules for Care of Power Boilers

Section VIII Pressure Vessels

- Division 1 Pressure Vessels
- Division 2 Pressure Vessels (Alternative Rules)
- Division 3 Alternative Rules for Construction of High-Pressure Vessels

Section IX Welding and Brazing Qualifications

Section X Fiber-Reinforced Plastic Pressure Vessels

Section XI Rules for In-Service Inspection of Nuclear Power Plant Components

Code Cases: Boilers and Pressure Vessels

Code Cases: Nuclear Components

Primarily, Sections, I, II, III, IV, V, VIII, IX, and XI specify rules and requirements for piping. Section II, V, and IX are supplementary sections of the code because they have no jurisdiction of their own unless invoked by reference in the code of record for construction, such as Section I or III.

Editions and Addenda

Code editions are published every three years and incorporate the additions and revisions made to the code during the preceding three years.

Colored-sheet addenda, which include additions and revisions to individual sections of the code, are published annually. Before the 1986 edition of the code, addenda were published semiannually as summer and winter addenda.

Interpretations

ASME issues written replies to inquiries concerning interpretation of technical aspects of the code. The interpretations for each individual section are published separately as part of the update service to that section. They are issued semiannually up to the publication of the next edition of the code. Interpretations are not part of the code edition or the addenda.

Code Cases

The Boiler and Pressure Vessel Committee meets regularly to consider proposed additions and revisions to the code; to formulate cases to clarify the intent of the existing requirements; and/or to provide, when the need is urgent, rules for materials or construction not covered by existing code rules. The code cases are published in the appropriate code casebook: (1) *Boiler and Pressure Vessel* and (2) *Nuclear Components*. Supplements are published and issued to the code holders or buyers up to the publication of the next edition of the code.

Code case(s) can be reaffirmed or annulled by the ASME Council. Reaffirmed code case(s) can be used after approval by the council. However, the use of code case(s) is subject to acceptance by the regulatory and enforcement authorities having jurisdiction. A code case once used for construction may continue to be used even if it expires later or becomes annulled. An annulled code case may become a part of the addenda or edition of the code or just disappear after its annulment because there may not be any need for it.

ASME SECTION I: POWER BOILERS

Scope

ASME Section I has total administrative jurisdiction and technical responsibility for boiler proper; refer to Fig. A4.1. The piping defined as boiler external piping (BEP) is required to comply with the mandatory certification by code symbol stamping, ASME data forms, and authorized inspection requirements, called Administrative Jurisdiction, of ASME Section I; however, it must satisfy the technical

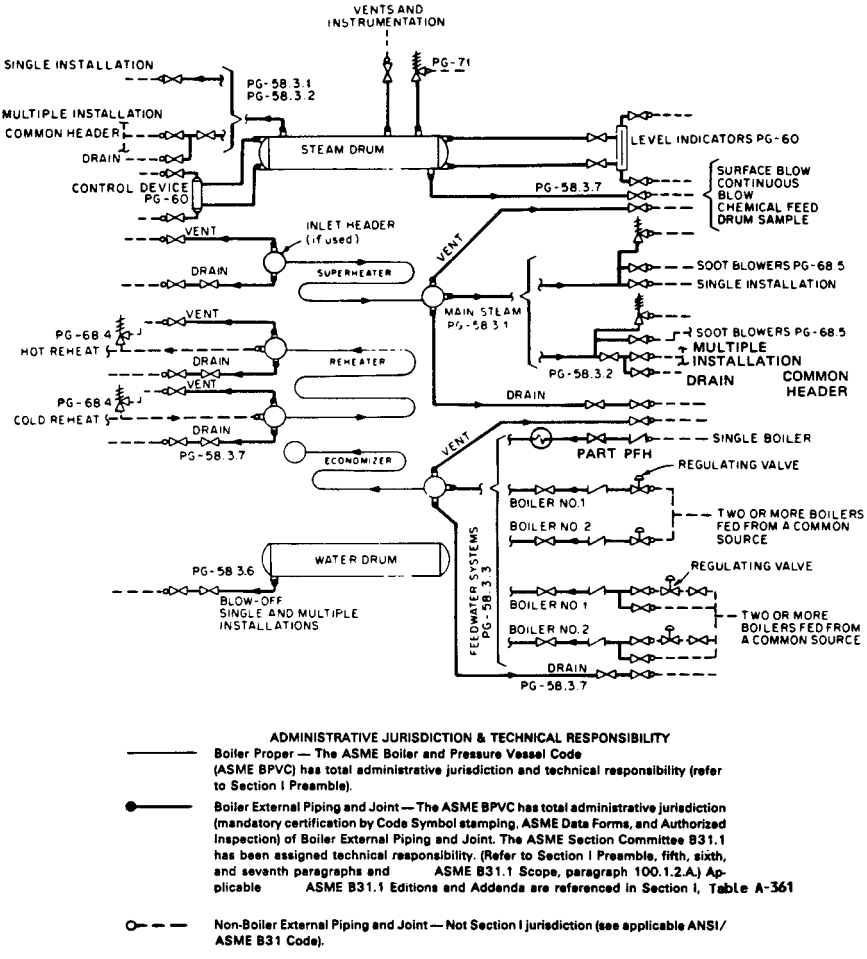

FIGURE A4.1 ASME Section I jurisdictional limits and clarifications for jurisdiction over boiler external piping (BEP) and nonboiler external piping (NBEP). *(Figure PG-58.3.1, ASME Section I).*

requirements (design, materials, fabrication, installation, nondestructive examination, etc.) of ASME B31.1, Power Piping Code.[1]

Effective Edition, Addenda, and Code Cases

Code editions are effective on—and may be used on or after—the date of publication printed on the title page. Code addenda are effective on—and may be used on or after—the date of issue. Revisions become mandatory as minimum requirements six months after such date of issuance, except for boilers (or pressure vessels) contracted for before the end of the six-month period.

Use of revisions and code cases that are less restrictive than former requirements of the applicable edition and addenda shall not be made without assurance that they have been accepted by the proper authorities in the jurisdiction in which the power boiler (component) is to be installed. Use of code cases is permissible beginning with the ASME council approval date published on the code case.

ASME SECTION II: MATERIALS

Scope

ASME Section II consists of four parts, three of which contain material specifications and the fourth the properties of materials which are invoked for construction of items within the scope of the various sections of the ASME Boiler and Pressure Vessel Code and ASME B31, Code for Pressure Piping. Therefore, ASME Section II is considered a supplementary section of the code.

Part A: Ferrous Material Specifications. Part A contains material specifications for steel pipe, flanges, plates, bolting materials, and castings and wrought, cast, and malleable iron. These specifications are identified by the prefix SA followed by a number such as SA-53 or SA-106.

Part B: Nonferrous Material Specifications. Part B contains materials specifications for aluminum, copper, nickel, titanium, zirconium, and their alloys. These specifications are identified by the prefix SB followed by a number such as SB-61 or SB-88.

Part C: Specifications for Welding Rods, Electrodes, and Filler Metals. Part C contains material specifications for welding rods, electrodes and filler materials, brazing materials, and so on. These specifications are identified by the prefix SFA followed by a number such as SFA-5.1 or SFA-5.27.

Part D: Properties. Part D covers material properties of all those materials that are permitted per Sections I, III, and VIII of the ASME Boiler and Pressure Vessel Code.

Subpart 1 contains allowable stress and design stress intensity tables for ferrous and nonferrous materials for pipe, fittings, plates, bolts, and so forth. In addition, it provides tensile strength and yield strength values for ferrous and nonferrous materials, and lists factors for limiting permanent strain in nickel, high-nickel alloys, and high-alloy steels.

Subpart 2 of Part D has tables and charts providing physical properties, such as coefficient of thermal expansion, moduli of elasticity, and other technical data needed for design and construction of pressure-containing components and their supports made from ferrous and nonferrous materials.

Effective Edition, Addenda, and Code Cases

The application of ASME Section II is mandatory only when referenced by other sections of the ASME Boiler and Pressure Vessel Code, ASME B31, Code for Pressure Piping, and various other industry codes and standards.[2]

The applicable edition and addenda of ASME Section II shall correspond to the edition and addenda of the referencing code or standard.

Use of a later or the latest edition and addenda of ASME Section II is permissible provided it is acceptable to the enforcement authorities having jurisdiction over the site where the component is to be installed.

For items within the scope of ASME Section XI, the effective edition and addenda of ASME Section II shall be in accordance with the requirements of ASME Section XI.

In case of nonnuclear items or applications, the effective edition addenda and code case shall be determined as described for ASME Section I.

Use of code cases related to materials for ASME Section III applications may be made in accordance with the recommendations of Regulatory Guide 1.85, Materials Code Case Acceptability, ASME Section III, Division 1. The code cases, as approved with or without limitations and listed in Regulatory Guide 1.85, may be used. The code case(s) not listed as approved in Regulatory Guide 1.85 by the U.S. Nuclear Regulatory Commission (NRC) may only be used after seeking approval from the NRC.

ASME SECTION III: NUCLEAR POWER PLANT COMPONENTS

Scope

Division 1 of ASME Section III contains requirements for piping classified as ASME Class 1, Class 2, and Class 3. ASME Section III does not delineate the criteria for classifying piping into Class 1, Class 2, or Class 3; it specifies the requirements for design, materials, fabrication, installation, examination, testing, inspection, certification, and stamping of piping systems after they have been classified Class 1, Class 2, or Class 3 based upon the applicable design criteria and Regulatory Guide 1.26, Quality Group Classifications and Standards for Water-Steam, and Radio-Waste-Containing Components of Nuclear Power Plants. Subsections NB, NC, and ND of ASME III specify the construction requirements for Class 1, Class 2, and Class 3 components, including piping, respectively. Subsection NF contains construction requirements for component supports, and a newly added Subsection NH contains requirements for 1 Class 1 Components in Elevated-Temperature Service. Subsection NCA, which is common to Divisions 1 and 2, specifies general requirements for all components within the scope of ASME Section III.

Division 3 of ASME Section III is a new addition to the code and contains requirements for containment systems and transport packaging for spent nuclear fuel and high–level radioactive waste.

The construction requirements for ASME Class 1, Class 2, and Class 3 piping are based on their degree of importance to safety, with Class 1 piping being subjected to the most stringent requirements and Class 3 to the least stringent requirements. It is noted that a nuclear power plant does have piping systems other than ASME Class 1, Class 2, and Class 3, which are constructed to codes other than ASME Section III. For example, the fire protection piping systems are constructed to National Fire Protection Association (NFPA) standards, and most of the nonnuclear piping systems are constructed to ASME B31.1, Power Piping Code.

When joining piping systems or components of different classifications, the more restrictive requirements shall govern, except that connections between piping and

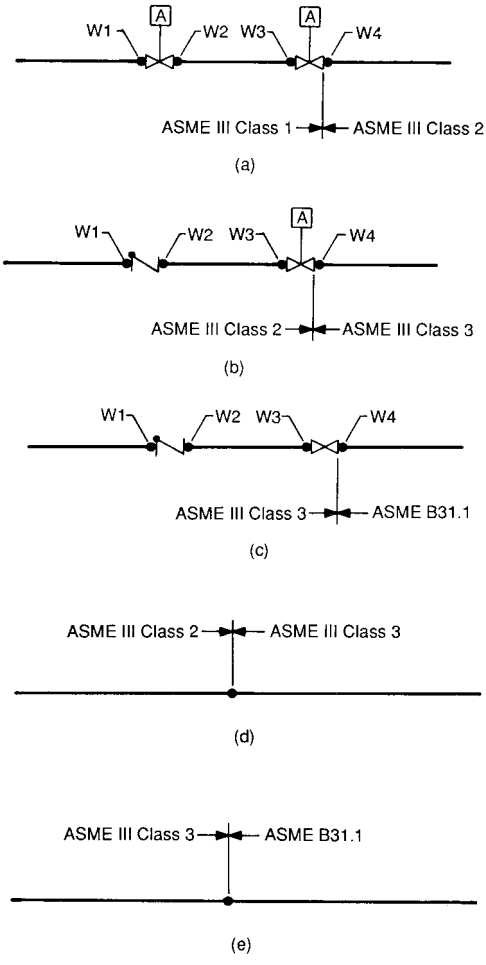

FIGURE A4.2 Code jurisdiction at interface welds between ASME III piping and components, and ASME/ANSI B31.1 piping. (*a*) Welds W1, W2, and W3 are between ASME III Class 1 piping and ASME III Class 1 valves/components. These welds shall comply with the requirements for ASME III Class 1 components. Weld W4 is between ASME III Class 1 valve and ASME III Class 2 piping. This weld shall comply with the requirements for ASME III Class 2 components; (*b*) Welds W1, W2, and W3 are between ASME III Class 2 piping and ASME III Class 2 valves/components. These welds shall comply with the requirements for ASME III Class 2 components. Weld W4 is between ASME Class 2 valve/component and ASME III Class 3 piping. This weld shall comply with the requirements for ASME III Class 3 components; (*c*) Welds W1, W2, and W3 are between ASME III Class 3 piping and ASME III Class 3 valves/components. These welds shall comply with the requirements for ASME III Class 3 components. Weld W4 is between ASME III Class 3 valve/component and ASME B31.1 piping. This weld shall comply with the requirements of ASME B31.1; (*d*) The connecting weld between two different ASME III classes of piping shall comply with more stringent requirements of the connecting classes of piping. In this case, the weld shall meet the requirements for ASME III Class 2 components; (*e*) The connecting weld between ASME III Class 3 and ASME B31.1 piping shall comply with more stringent requirements of ASME III Class 3 piping.

other components such as vessels, tanks, heat exchangers, and valves shall be considered part of the piping. For example, a weld between an ASME Class 1 valve and ASME Class 2 piping shall be made in compliance with the requirements of Subsection NC, which contains rules for ASME Class 2 components, including piping (refer to Fig. A4.2).

Effective Edition, Addenda, and Code Cases

Selection of effective editions and addenda of ASME Section III shall be based upon the following guidelines:

Only the approved edition(s) and addenda of ASME Section III, incorporated by reference in 10 CFR 50.55a, Paragraph (b) (1) are to be used for construction of items within the scope of ASME Section III.

The latest published edition and addenda of ASME Section III may not be approved by the U.S. NRC; therefore, their use can only be made after seeking special permission from the U.S. NRC. Refer to 10 CFR 50.55a, Codes and Standards from time to time to find which edition and addenda of ASME Section III have been approved by the U.S. NRC.

As per Subsubarticle NCA-1140, in no case shall the code edition and addenda dates established in the design specifications be earlier than three years prior to the date the nuclear power plant construction permit application is docketed. In addition, the guidelines of preceding paragraphs shall apply[3]:

Code editions and addenda later than those established in the design specification and documents per the above-delineated approach may be used provided they are approved for use. Also, specific provisions within an edition or addenda later than those established in the design specifications and documents may be used provided all related requirements are met.

All code items, including piping systems, may be constructed to a single code edition and addenda, or each item may be constructed to individually specified code editions and addenda.

The use of code case(s) is optional. Only the U.S. NRC–approved code cases with or without limitations or additional requirements published in the following regulatory guides may be used without a specific request to the U.S. NRC for approval:

Regulatory Guide 1.84: Design and Fabrication Code Case Acceptability ASME Section III, Division 1.

Regulatory Guide 1.85: Materials Code Case Acceptability ASME Section III, Division 1.

The code cases not listed as approved in Regulatory Guides 1.84 and 1.85 may be used only after seeking permission from the U.S. NRC for the specific application.

ASME SECTION V: NONDESTRUCTIVE EXAMINATION

Scope

ASME Section V comprises Subsection A, Subsection B, and mandatory and nonmandatory appendixes. Subsection A delineates the methods of nondestructive examination, and Subsection B contains various ASTM standards covering nondestructive examination methods that have been adopted as standards. The standards contained in Subsection B are for information only and are nonmandatory unless specifically referenced in whole or in part in Subsection A or referenced in other code sections and other codes, such as ASME B31, Pressure Piping Code.

The nondestructive examination requirements and methods included in ASME Section V are mandatory to the extent they are invoked by other codes and standards or by the purchaser's specifications. For example, ASME Section III requires radiographic examination of some welds to be performed in accordance with Article 2 of ASME Section V.[5]

ASME Section V does not contain acceptance standards for the nondestructive examination methods covered in Subsection A. The acceptance criteria or standards shall be those contained in the referencing code or standard.

Effective Edition, Addenda, and Code Cases

The applicable edition and addenda of ASME Section V shall correspond to the edition and addenda of the referencing code.

ASME SECTION VIII: PRESSURE VESSELS

Scope

The rules of ASME Section VIII constitute construction requirements for pressure vessels. Division 2 of ASME Section VIII delineates alternative rules of construction to Division 1 requirements. However, there are some differences between the scopes of the two divisions. Recently added Division 3 provides Alternative Rules for Construction of High-Pressure Vessels.

The rules of ASME Section VIII apply to flanges, bolts, closures, and pressure-relieving devices of a piping system when and where required by the code governing the construction of the piping. For example, ASME B31.1 requires that the safety and relief valves on nonboiler external piping, except for reheat safety valves, shall be in accordance with the requirements of ASME Section VIII, Division 1, UG-126 through UG-133.

Effective Edition, Addenda, and Code Cases

Editions are effective on—and may be used on or after—the date of publication printed on the title page.

Addenda are effective on—and may be used on or after—the date of issue. Addenda and revisions become mandatory as minimum requirements six months after date of issuance, except for pressure vessels contracted for prior to the end of the six-month period.

Code cases may be used beginning with the date of their approval by the ASME. Use of revisions and addenda and code cases that are less restrictive than former requirements must not be made without assurance that they have been accepted by the proper authorities in the jurisdiction where the pressure vessel is to be installed.

ASME SECTION IX: WELDING AND BRAZING QUALIFICATIONS

Scope

ASME Section IX consists of two parts—Part QW and Part QB—which deal with welding and brazing, respectively. In addition, ASME Section IX contains mandatory and nonmandatory appendixes.

ASME Section IX requirements relate to the qualification of welders, welding operators, brazers, and brazing operators and the procedures used in welding and brazing. They establish the basic criteria for welding and brazing observed in the preparation of welding and brazing requirements that affect procedure and performance.

ASME Section IX is a supplemental code. The requirements of ASME Section IX apply when referenced by the governing code or standard or when specified in purchaser's specification. It is usually referenced in other sections of the ASME Boiler and Pressure Vessel Code and the ASME B31, Pressure Piping Code.

Effective Edition, Addenda, and Code Cases

The applicable edition and addenda of ASME Section IX shall correspond to the edition and addenda of the referencing code. However, the later or the latest edition or addenda of ASME Section IX may be used, provided it is acceptable to the enforcement authorities having jurisdiction.

For safety-related items of an operating nuclear power plant, application of ASME Section IX will be in accordance with the requirements of ASME Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components.

For nonsafety-related items, the following guidelines apply:

- Editions are effective and may be used on or after the date of publication on the title page.
- Addenda are effective and may be used on or after the date of issue.
- Addenda and revisions become mandatory as minimum requirements six months after the date of issue, except for pressure vessels or boilers contracted for prior to the end of the six-month period.
- Code cases may be used beginning with the date of their approval by the ASME.
- Use of revisions and addenda and code cases that are less restrictive than former requirements must not be made without assurance they have been accepted by the proper authorities in the jurisdiction where the item is to be installed.

ASME SECTION XI: RULES FOR IN-SERVICE INSPECTION OF NUCLEAR POWER PLANT COMPONENTS

Scope

ASME Section XI comprises three divisions, each covering rules for inspection and testing of components of different types of nuclear power plants. These three divisions are as follows:

ASME Section XI, Division 1: Rules for Inspection and Testing of Components of Light-Water-Cooled Plants

ASME Section XI, Division 2: Rules for Inspection and Testing of Components of Gas-Cooled Plants

ASME Section XI, Division 3: Rules for Inspection and Testing of Components of Liquid-Metal-Cooled Plants.

Since the publication of the first edition of ASME Section XI in 1971, significant changes and additions have been incorporated, and as such, the organization of the later versions of ASME Section XI, Division 1, is considerably different from that of the first edition.

ASME Section XI, Division 1, provides the rules and requirements for in-service inspection and testing of light-water-cooled nuclear power plants. The rules and requirements identify, as a minimum, the areas subject to inspection, responsibilities, provisions for accessibility and inspectability, examination methods and procedures, personnel qualifications, frequency of inspection, record-keeping and report requirements, procedures for evaluating inspection results, subsequent disposition of results of evaluations, and repair requirements.

Division 1 also provides for the design, fabrication, installation, and inspection of replacements. The jurisdiction of Division 1 of ASME Section XI covers individual components and complete power plants that have met all the requirements of the construction code, commencing at that time when the construction code requirements have been met, irrespective of physical location.

When portions of systems or plants are completed at different times, the jurisdiction of Division 1 shall cover only those portions on which all of the construction code requirements have been met. Rules of ASME Section XI apply to ASME Classes 1, 2, 3, and MC components and their supports, core support structures, pumps, and valves.

Rules of ASME Section XI, Division 1, apply to modifications made to ASME III components and their supports after all of the original construction code requirements have been met.

Rules of ASME Section XI, Division 1, apply to systems, portions of systems, components, and their supports not originally constructed to ASME Section III requirements but based on their importance to safety if they were classified as ASME Classes 1, 2, 3, and MC.

Effective Edition, Addenda, and Code Cases

Section 10 CFR 50.55a, Codes and Standards, of the Code of Federal Regulations requires compliance with ASME Section XI for operating nuclear power plants. In addition, 10 CFR 50.55a, Paragraph (b)(2) delineates the editions and addenda of ASME Section XI that are approved for use. Only the approved editions and addenda of ASME Section XI are to be used. The latest published edition and addenda may not be approved by the U.S. NRC; therefore, they can only be used after seeking special permission from the U.S. NRC.

It is recommended that one refer to 10 CFR 50.55a from time to time to determine which edition and addenda of ASME Section XI have been approved by the U.S. NRC and which edition and addenda may be applicable to a nuclear power plant at a particular time.

The requirements of 10 CFR 50.55a are based on the construction permit (CP) docket date and the operating license (OL) date of the nuclear plant.

Code editions and addenda later than those established for a particular application in conformance with the requirements of 10 CFR 50.55a may be used provided they are approved and all related requirements of respective editions or addenda are met.

While establishing a particular edition and addenda of ASME Section XI, consider the limitations and modifications to the specific editions and addenda delineated in Paragraph (b)(2) of 10 CFR 50.55a, and ensure compliance to those limitations and modifications, as applicable.

For repairs and replacements, the applicable edition and addenda shall be the one in effect for that in-service inspection (ISI) interval during which the repairs

and replacements are to be made. Refer to articles IWA-4000 and IWA-7000 of ASME Section XI.

Applicable Code Cases

Like the code edition and addenda, code cases are regularly reviewed by the U.S. NRC. The U.S. NRC–approved code cases with or without limitations or additional requirements are published in the Regulatory Guide 1.147, In-Service Inspection Code Case Acceptability of ASME Section XI, Division 1.[4]

Acceptance or endorsement by the U.S. NRC staff applies only to those code cases or code case revisions with the date of ASME Council approval, as shown in the Regulatory Guide 1.147.

ASME B31: CODE FOR PRESSURE PIPING

Starting with Project B31 in March 1926, the first edition of American tentative Standard Code for Pressure Piping was published in 1935. In view of continuous industry developments and increases in diversified needs over the years, decisions were made to publish several sections of the Code for Pressure Piping. Since December 1978, the American National Standards Committee B31 was reorganized as the ASME Code for Pressure Piping B31 Committee under procedures developed by the ASME and accredited by ANSI.

Presently, the following sections of ASME B31, Code for Pressure Piping are published:*

ASME B31.1	Power Piping
USAS B31.2	Fuel Gas Piping
ASME B31.3	Process Piping
ASME B31.4	Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohol
ASME B31.5	Refrigeration Piping
ASME B31.8	Gas Transmission and Distribution Piping Systems
ASME B31.9	Building Services Piping
ASME B31.11	Slurry Transportation Piping Systems

ASME B31.1: POWER PIPING CODE

Scope

ASME B31.1, Power Piping Code, prescribes requirements for the design, material, fabrication, erection, test, and inspection of power and auxiliary service piping

* USAS B31.2 was withdrawn in 1988, but it is available for historical and reference purposes.

systems for electric generation stations, industrial and institutional plants, central and district heating plants, and district heating systems. It does not apply to piping systems covered by other sections of the Code for Pressure Piping, and other piping which is specifically excluded from the scope of this code.[7]

As explained earlier, the BEP is required to meet administrative jurisdictional requirements of ASME Section I; however, pipe connections meeting all other requirements of ASME B31.1 but not exceeding nominal pipe size (NPS) ½ may be welded to boiler external pipe or boiler headers without inspection and stamping required by ASME Section I.

Nonboiler external piping is defined as all the piping covered by ASME B31.1 with the exception of BEP. The nonboiler external piping must be constructed in accordance with the requirements of this code.

In addition to the piping systems covered by other sections of ASME B31, Pressure Piping Code, ASME B31.1 does not cover the following:

- Economizers, heaters, pressure vessels, and components covered by the ASME Boiler and Pressure Vessel Code (except the connecting piping not covered by the ASME Boiler and Pressure Vessel Code shall meet the requirements of ASME B31.1)
- Building heating and distribution steam piping designed for 15 psig (100 kPa gauge) or less, or hot-water heating systems piping designed for 30 psig (200 kPa gauge) or less
- Piping for roof and floor drains, plumbing, sewers, and sprinkler and other fire-protection systems
- Piping for hydraulic or pneumatic tools and their components downstream of the first stop valve off the system distribution header
- Piping for marine or other installations under federal control
- Piping covered by other sections of ASME B31 and ASME Section III
- Fuel gas piping within the scope of ANSI Z 223.1, National Fuel Gas Code
- Pulverized fuel piping within the scope of NFPA

The requirements of this code apply to central and district heating systems for distribution of steam and hot water away from the plants whether underground or elsewhere, and geothermal steam and hot water piping both to and from wellheads.

The construction of fuel gas or fuel oil piping brought to plant site from a distribution system inside the plant property line is governed by the requirements of ASME B31.1 when the meter assembly is located outside the plant property line. In cases where the meter assembly is located within the plant property line, the requirements of this code shall apply to the fuel gas and fuel oil piping downstream from the outlet of the meter assembly (see Fig. A4.3).

This code also applies to gas and oil systems piping other than that shown in Fig. A4.3. It covers air systems, hydraulic fluid systems piping, and the steam-jet cooling systems piping which are part of the power plant cycle. In addition, building services within the scope of ASME B31.9 but outside the limits of Paragraph 900.1.2 of B31.9 are required to be designed in accordance with ASME B31.1.

Effective Edition, Addenda, and Code Cases

Prior to the publication and implementation of ASME Section III for construction of nuclear power plant components, in some nuclear power plants the safety-related

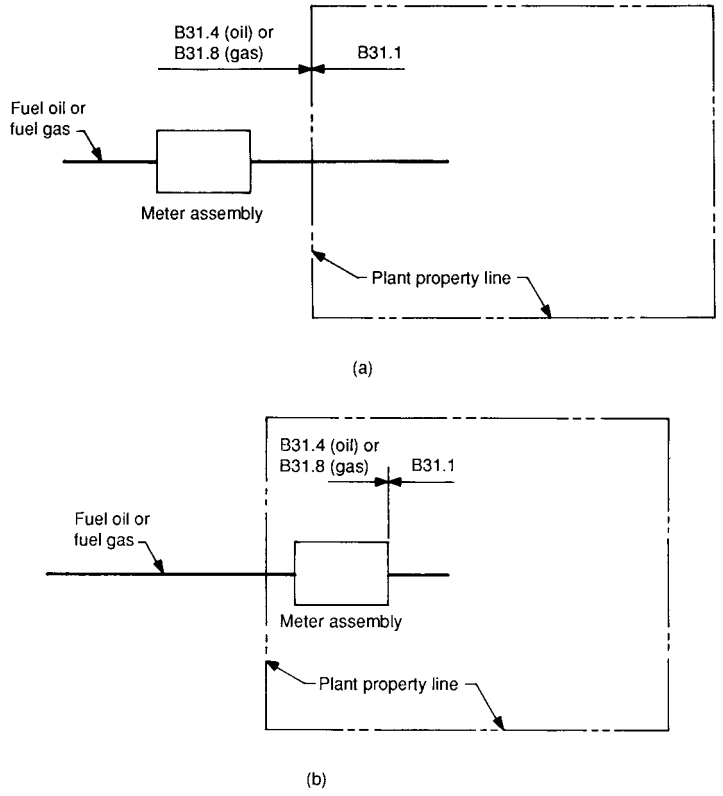

FIGURE A4.3 Jurisdiction of ASME B31.1, B31.4, and B31.8 Over Fuel Gas and Fuel Oil Piping.

piping systems now classified as ASME Classes 1, 2, and 3 were constructed to earlier versions of AMSE B31.1. Therefore, the repairs and replacements of those safety-related piping systems may be made in accordance with the edition and addenda of ANSI B31.1 used for the original construction or the later edition and addenda of ANSI B31.1. Refer to Article IWA-4000 and Article IWA7000 of ASME Section XI for requirements related to repairs and replacements, respectively.

For power piping systems other than the nuclear safety-related piping systems constructed and new piping systems to be constructed to ASME B31.1, the following guidelines shall be used to determine the effective edition and addenda of ASME B31.1:

> Editions are effective and may be used on or after the date of publication printed on the title page. Addenda are effective and may be used on or after the date of publication printed on the title page

The latest edition and addenda, issued six months prior to the original contract date for the first phase of the activity covering a piping system(s) shall be the governing document for design, materials, fabrication, erection, examination, and

testing activities for the piping system(s) until the completion of the work and initial operation.[7] Unless agreement is specifically reached between the contracting parties, no code edition and/or addenda shall be retroactive.

Code cases may be used after they have been approved by the ASME Council. The provisions of a code case may be used even after its expiration or withdrawal, provided the code case was effective on the original contract date and it was used for original construction or was adopted prior to completion of work and the contracting parties agreed to its use.

Do not use revisions and code cases that are less restrictive than former requirements without having assurance that they have been accepted by the proper authorities in the jurisdictions where the piping is to be installed.

USAS B31.2: FUEL GAS PIPING

In 1955 a decision was made to publish separate code sections of B31, Code for Pressure Piping. Consequently, Section 2 of B31.1-1955 was updated and revised to publish as USAS B31.2—1968, Fuel Gas Piping. No edition of this code section was published after 1968. This code was withdrawn in 1988.

Scope

USAS B31.2 covers the design, fabrication, installation, and testing of piping systems for fuel gases such as natural gas, manufactured gas, and liquefied petroleum gas (LPG); air mixtures above the upper combustible limit; LPG in the gaseous phase; or mixtures of these gases.

This code applies to fuel gas piping systems both within and between the buildings, from the outlet of the consumer meter assembly, and to and including the first pressure-containing valve upstream of the gas utilization device.

This code does not apply to:

- Vacuum piping systems
- Fuel gas piping systems with metal temperatures above 450°F or below −20°F
- Fuel gas piping systems within petroleum refineries, loading terminals, natural gas processing plants, bulk plants, compounding plants, or refinery tank farms, and so forth within the scope of USAS B31.3
- Fuel gas piping systems in power and atomic energy plants within the scope of USAS B31.1
- Fuel gas piping systems within the scope of USAS B31.8
- Fuel gas piping systems within the scope of USAS Z21.30
- Piping systems within the scope of USAS Z106.1
- Proprietary items of equipment, apparatus, or instruments, such as compressors, gas-generating sets, and calorimeters
- Design and fabrication of pressure vessels covered by the ASME Boiler and Pressure Vessel Code
- Support structures and equipment such as stanchions, towers, building frames, pressure vessels, mechanical equipment, and foundations

- Piping systems for conveying premixed fuel gas-air mixtures which are in the combustible or inflammable limits or range

Effective Edition, Addenda, and Code Cases

USAS B31.2 is no longer used. It can be used for installations which were constructed in compliance with 1968 edition of this code, if permitted by the authorities having the jurisdiction.

ASME B31.3: PROCESS PIPING

Scope

This code prescribes requirements for the materials, design, fabrication, assembly, erection, examination, inspection, and testing of piping within the property limits of facilities engaged in the processing or handling of chemical petroleum or related products. Figure A4.4 provides an illustration of the scope of ASME B31.3. The requirements of ASME B31.3 apply to piping for all fluids, including raw, intermediate, and finished chemicals; petroleum products, gas, steam, air, and water; fluidized solids; and refrigerants.

In case of packaged equipment, the interconnecting piping with the exception of refrigeration piping shall be in compliance with the requirements of ASME B31.3. The refrigeration piping may conform to either ASME B31.3 or ASME B31.5.

The requirements of ASME B31.3 do not apply to piping systems designed for internal gauge pressures at or above 0 but less than 15 (100 kPa gauge) psig provided the fluid handled is nonflammable, nontoxic, and not damaging to human tissue and its design temperature is from −29°C (−20°F) through 180°C (366°F).

The following piping and equipment are not required to comply with the requirements of ASME B31.3:

- Power boiler and the boiler external piping
- Piping covered by ASME B31.4, B31.8, or B31.11, although located on the company property
- Piping covered by applicable governmental regulations
- Piping for fire-protection systems
- Plumbing, sanitary sewers, and storm sewers
- Tubes, tube headers, crossovers, and manifolds of fired heaters which are internal to the heater enclosures
- Pressure vessels, heat exchangers, pumps, compressors, and other fluid-handling or processing equipment, including internal piping and connections for external piping

Effective Edition, Addenda, and Code Cases

The effective edition, addenda, and code cases shall be determined similarly to the approach delineated for ASME B31.1 for piping systems other than the nuclear safety-related piping systems.

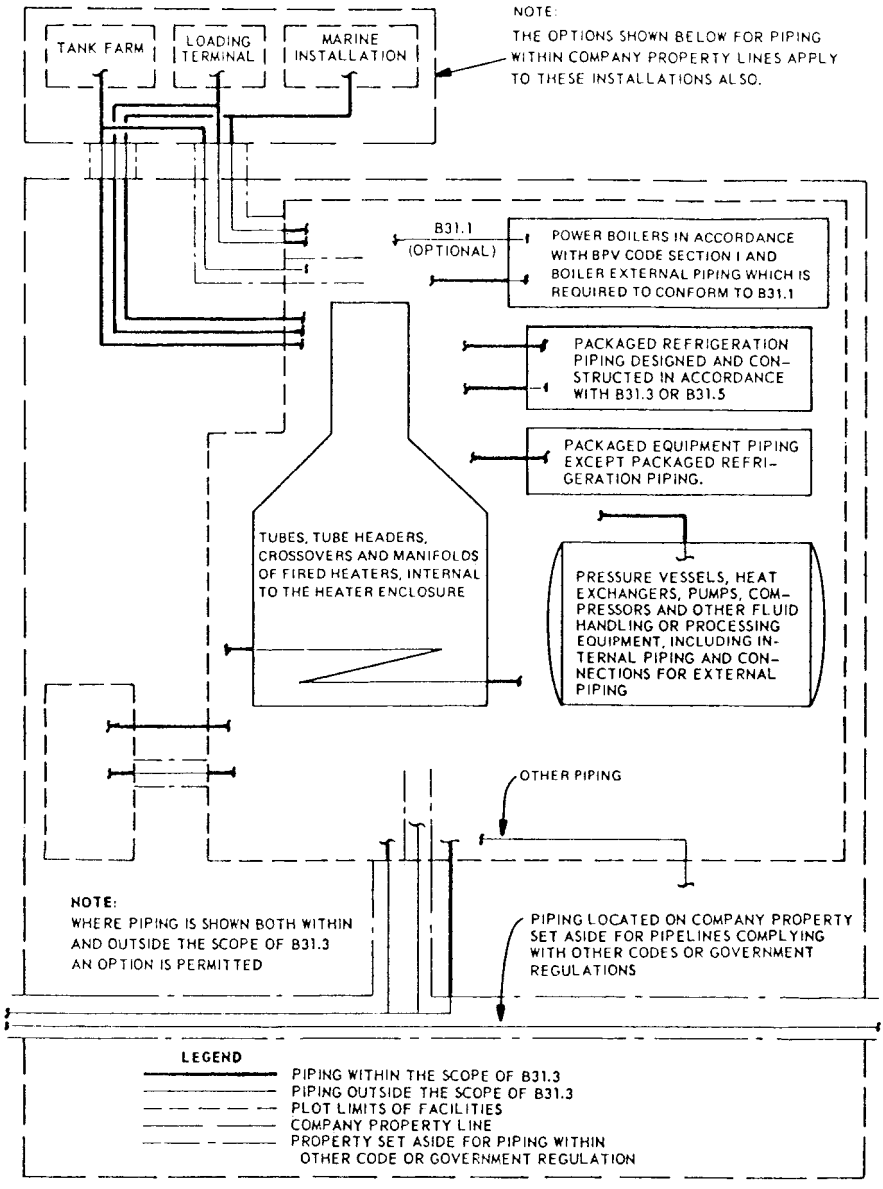

FIGURE A4.4 B31.3 Jurisdictional Limits and Options. *(Source: ASME B31.3).*

ASME B31.4: LIQUID TRANSPORTATION SYSTEMS FOR HYDROCARBONS, LIQUID PETROLEUM GAS, ANHYDROUS AMMONIA, AND ALCOHOLS

Scope

Section B31.4 of the ASME Pressure Piping 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, liquid alcohol, liquid anhydrous ammonia, and liquid petroleum products between producers' lease facilities, tank farms, natural-gas processing plants, refineries, stations, ammonia plants, terminals, and other delivery and receiving points.

The scope of ASME B31.4 also includes the following:

- Primary and associated auxiliary liquid petroleum and liquid anhydrous ammonia piping at pipeline terminals (marine, rail, and truck), tank farms, pump stations, pressure-reducing stations, and metering stations, including scraper traps, strainers, and prover loops
- Storage and working tanks, including pipe-type storage fabricated from pipe and fittings, and piping interconnecting these facilities
- Liquid pertroleum and liquid anhydrous ammonia piping located on property which has been set aside for such piping within petroleum refinery, natural gasoline, gas processing, ammonia, and bulk plants
- Those aspects of operation and maintenance of liquid pipeline systems relating to the safety and protection of the general public, operating company personnel, environment, property, and the piping systems

ASME B31.4 does not apply to

- Auxiliary piping such as water, air, steam, lubricating oil, gas, and fuel
- Pressure vessels, heat exchangers, pumps, meters, and other such equipment, including internal piping and connections for piping except as limited by Paragraph 423.2.4 (b) of ASME B31.4
- Piping designed for internal pressures:
  a. At or below 15 psi (100 kPa) gauge pressure regardless of temperature
  b. Above 15 psi (100 kPa) gauge pressure if design temperature is below −20°F (−29°C) or above 250°F (120°C)
- Casing, tubing, or pipe used in oil wells, wellhead assemblies, oil and gas separators, crude oil production tanks, other producing facilities, and pipelines interconnecting these facilities
- Petroleum refinery, natural gasoline, gas processing, ammonia, and bulk plant piping, except as covered within the scope of the code
- Gas transmission and distribution piping
- The design and fabrication of proprietary items of equipment, apparatus, or instruments, except as limited by this code

- Ammonia refrigeration piping systems provided for in ASME B31.5, Refrigeration Piping Code
- Carbon dioxide gathering and field distribution systems

The rules of this code provide for protection of the general public and operating company personnel, for reasonable protection of the piping system against vandalism and accidental damage by others, and for reasonable protection of the environment.

Effective Edition, Addenda, and Code Cases

To determine the effective edition, addenda, and code cases for an application within the jurisdiction of ASME B31.4, follow the requirements delineated for ASME B31.1 for piping systems other than nuclear safety-related piping systems.

ASME B31.5: REFRIGERATION PIPING

Scope

This section of ASME B31, Pressure Piping Code, contains requirements for the materials, design, fabrication, assembly, erection, testing, and inspection of refrigerant and secondary coolant piping for temperatures as low as −320°F (−195.5°C), except when other sections of the code cover requirements for refrigeration piping.

ASME B31.5 does not apply to the following:

- Self-contained or unit systems subject to the requirements of Underwriters' Laboratories (UL) or other nationally recognized testing laboratories
- Water piping
- Piping designed for external or internal gauge pressure not exceeding 15 psig (100 kPa)

Effective Edition, Addenda, and Code Cases

To determine the effective edition, addenda, and code cases for piping systems within the jurisdiction of ASME B31.5, follow the guidelines delineated for nonnuclear piping systems within the jurisdiction of ASME B31.1.

ASME B31.8: GAS TRANSMISSION AND DISTRIBUTION PIPING SYSTEMS

Scope

A pipeline or transmission line is defined as that pipe which transmits gas from a source or sources of supply to one or more large-volume customers or to a pipe used to interconnect sources of supply. ASME B31.8 prescribes requirements for

the design, fabrication, installation, testing, and safety aspects of operation and maintenance of gas transmission and distribution piping 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.

Also included within the scope of ASME B31.8 are gas storage equipment of the closed-pipe type, fabricated or forged from pipe or fabricated from pipe and fittings, and gas storage lines.

The requirements of ASME B31.8 also apply to the use of elements of piping systems, including but not limited to pipe, valves, fittings, flanges, bolting, gaskets, regulators, pressure vessels, pulsation dampeners, and relief valves.

The requirements of ASME B31.8 are applicable to operating and maintenance procedures of existing installations and to the update of existing installations.

ASME B31.8 does not apply to the following:

- Design and manufacture of pressure vessels covered by the ASME Boiler and Pressure Vessel Code
- Piping with metal temperatures above 450°F (232°C) or below −20°F (−29°C)
- Piping beyond the outlet of the customer's meter set assembly (refer to ANSI Z223.1 and NFPA 54)
- Piping in oil refineries or natural gasoline extraction plants, gas-treating plant piping other than the main gas stream piping in dehydration, and all other processing plants installed as part of a gas transmission system, gas manufacturing plants, industrial plants, or mines (see other applicable sections of the ASME Code for Pressure Piping, B31)
- Vent piping to operate at substantially atmospheric pressures for waste gases of any kind
- Wellhead assemblies, including control valves, flow lines between wellhead and trap or separator, or casing and tubing in gas or oil wells
- The design and manufacture of proprietary items of equipment, apparatus, or instruments
- The design and manufacture of heat exchangers
- Liquid petroleum transportation piping systems (refer to ANSI/ASME B31.4)
- Liquid slurry transportation piping systems (refer to ASME B31.11)
- Carbon dioxide transportation piping systems
- Liquefied natural gas piping systems (refer to NFPA 59 and ASME B31.3)

Effective Code Edition, Addenda, and Code Cases

To determine the effective edition, addenda, and code cases to be invoked for an application or piping systems within the jurisdiction of ASME B31.8, follow the criteria delineated for piping systems within the scope of ASME B3 1.1:

No edition and addenda shall be applied retroactively to existing installations insofar as design, fabrication, installation, and testing at the time of construction are concerned. Further, no edition and addenda shall be applied retroactively to established operating pressures of existing installations, except as provided for in Chapter V of ASME B31.8.

ASME B31.9: BUILDING SERVICES PIPING

Scope

ASME B31.9 applies to the following building services:

- Water for heating and cooling
- Condensing water
- Steam or other condensate
- Steam
- Vacuum
- Compressed air and other nontoxic and nonflammable gases

The requirements of this code also apply to boiler external piping for steam boilers with 15 psig (103.5 kPa) maximum pressure and for water heating units having 160 psig (1104 kPa) maximum pressure and 250°F (121°C) maximum temperatures. It is noted that the boiler external piping exceeding the above limits of pressure and temperature fall within the scope of ASME B31.1 and ASME Section I.

This code places size and thickness limitations on the piping made of different materials. The requirements of this code shall apply to the piping of up to and including those sizes and thicknesses. These limitations are as follows:

- *Carbon steel:* NPS 30 (DN 750) in O.D. and 0.500 in (12.7 mm) wall
- *Stainless steel:* NPS 12 (DN 300) and 0.500 in (12.7 mm) wall
- *Aluminum:* NPS 12 (DN 300)
- *Brass and copper:* NPS 12 (DN 300) (12.125 in or 308 mm O.D. for copper tubing)
- *Thermoplastics:* NPS 14 (DN 350)
- *Ductile iron:* NPS 18 (DN 450)
- *Reinforced thermosetting resin:* NPS 14 (DN 350)

Piping made of other materials permitted by this code may also be used for building services.

The piping within the working pressure or temperature limits shown in Table A4.1 shall be designed and constructed in compliance with the requirements of ASME B31.9.

TABLE A4.1 Working Pressure and Temperature Limits of ASME B31.9

Pressure limit		Temperature limit	
Service	Pressure	Service	Temperature
Steam and condensate	150 psig (1000 kPa)	Steam and condensate	366°F (186°C)
Air and gas	150 psig (1000 kPa)		
Liquids	350 psig (2300 kPa)	Gases and vapors	200°F (93°C)
		Nonflammable liquids	250°F (121°C)
Vacuum	1 atm external pressure (100 kPa)	Minimum temperature (all services)	0°F (−18°C)

ASME B31.9 does not cover requirements for economizers, heaters, pumps, tanks, heat exchangers, and other equipment within the scope of ASME Boiler and Pressure Vessel Code.

Effective Code Edition, Addenda, and Code Cases

For any specific application, the effective edition, addenda, and code cases of ASME B31.9 shall be determined in accordance with the approach followed for ASME B31.1.

ANSI/ASME B31.11: SLURRY TRANSPORTATION PIPING SYSTEMS

Scope

Like ASME B31.4, this section of ASME B31, Pressure Piping Code, specifies minimum requirements for the design, materials, construction, assembly, inspection,

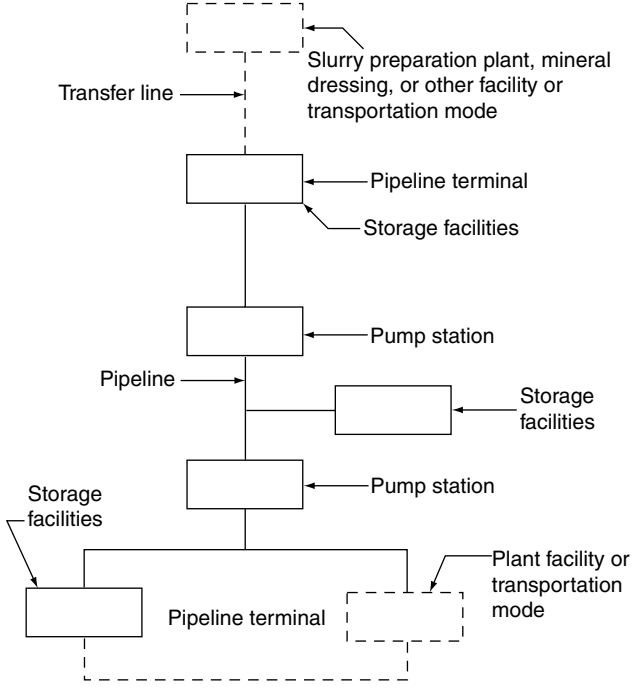

FIGURE A4.5 Scope of ANSI/ASME B31.11 Facilities Indicated by Solid Lines are within the Scope of ANSI/ASME B31.11. *(Source Figure 1100.11, ANSI/ASME B31.11).*

testing, operation, and maintenance of piping transporting aqueous slurries of nonhazardous materials, such as oil, mineral ores, and concentrates, between a slurry processing plant or terminal and a receiving plant or terminal. The requirements of ASME B31.11 also apply to the following:

1. Primary and auxiliary slurry piping at storage facilities, pipeline terminals, pump stations, and pressure-reducing stations, including piping up to the first valve of attached auxiliary water lines
2. Slurry piping storage facilities and other equipment located on property which has been set aside for the slurry transportation system
3. Those aspects of operation and maintenance of slurry transportation piping systems which relate to the safety and protection of the general public, operating company personnel, environment, property, and the piping systems.

Refer to Fig. A4.5 for facilities within the scope of ANSI/ASME B31.11.

Effective Code Edition, Addenda, and Code Cases

The effective edition, addenda, and code cases applicable for piping within the scope of ANSI/ASME B31.11 shall be determined in accordance with the guidelines delineated for ASME B31.

ASME PERFORMANCE TEST CODES

The ASME Performance Test Codes (PTC) were originally known as Power Test Codes. These codes provide standard directions and rules for conducting and reporting tests of specific materials such as fuels, equipment, and processes or functions related to power plants. Listed here are some Performance Test Codes which may be of interest in regard to piping:

PTC 1-91	General Instructions
PTC 2-80	Definitions and Values (R 1985)
PTC 4.1-64	Steam Generating Units (R 1991)
PTC 4.3-68	Air Heaters (R 1991)
PTC 4.4-81	Gas Turbine Heat Recovery Steam Generators (R 1992)
PTC 6A-82	Appendix A to Test Code for Steam Turbine (R 1995)
PTC 7-49	Reciprocating Steam-Driven Displacement Pumps (R 1969)
PTC 7.1-62	Displacement Compressors, Vacuum Pumps, and Blowers (R 1969)
PTC 10-65	Compressors and Exhaustors (R 1992)
PTC 12.2-83	Code on Steam Condensing Apparatus (R 1988)
PTC 12.3-77	Deaerators (R 1995)

PTC 12.4-92	Moisture Separator Reheaters
PTC 14-70	Evaporating Apparatus (R 1991)
PTC 16-58	Gas Producers and Continuous Gas Generators (R 1991)
PTC 18-92	Hydraulic Turbines
PTC 19.2-87	Pressure Measurement Instruments and Apparatus
PTC 19.3-74	Temperature Measurement Instruments and Apparatus (R 1986)
PTC 19.5-72	Application Part II of Fluid Meters
PTC 19.16-65	Density Determination of Solids and Liquids
PTC 19.17-65	Determination of the Viscosity of Liquids Instruments and Apparatus
PTC 22-85	Gas Turbine Power Plants
PTC 25-94	Pressure Relief Services
PTC 32.1-69	Nuclear Steam Supply Systems (R 1992)

AMERICAN NATIONAL STANDARDS INSTITUTE

The American National Standards Institute (ANSI) was earlier known as the American Standards Association (ASA). For a short period of time, from 1967 to 1969, it was called the United States of America Standards Institute (USASI).

ANSI provides a forum for development or obtaining a consensus for approval of standards having national impact and serves as a focal point for distribution of national and other standards, including those developed and issued by the International Organization for Standardization (ISO) and foreign governments. Development and approval functions are performed by committees representing a cross section of affected interests, such as engineering societies, manufacturers, trade institutes, fabricators, builders, universities, unions, insurance companies, and government agencies. Many of the committees are chaired or sponsored by engineering societies, such as ASME and the Institute of Electrical and Electronics Engineers (IEEE).

Safety is the basic objective of the engineering design and construction requirements contained in standards developed, approved, and distributed by ANSI. The ANSI standards include prohibition for practices considered unsafe and cautions where advisory warnings, instead of prohibitions, are deemed necessary.

This chapter provides a brief discussion of various sections of ASME B31, Pressure Piping Code, which was earlier known as ANSI B31, Pressure Piping Code. It is envisioned that other ANSI standards may eventually become known as ASME standards; however, they shall be subjected to approval of the ANSI. The following ANSI standards contain provisions related to piping.

ANSI Standards

A13.1-96	Scheme for the Identification of Piping Systems
A112.1.2-91	Air Gaps in Plumbing Systems

A112.6.1M-88	Supports for Off-the-Floor Plumbing Fixtures for Public Use
A112.18.1M-96	Plumbing Fixture Fittings
A112.19.IM-94	Enameled Cast Iron Plumbing Fixtures
A112.19.3M-87	Stainless Steel Plumbing Fixtures (designed for residential use) (R1996)
A112.21.1M-91	Floor Drains
A112.21.2M-83	Roof Drains (revision of ANSI A112.21.2-1971)
A112.36.2M-91	Cleanouts (revision of ANSI A112.36.2-1983)
AG-1-94	Code on Nuclear Air and Gas Treatment
B1.1	Unified Inch Screw Threads
B1.20.1-83	Pipe Threads General Purpose (Inch) (revision and redesignation of ASME/ANSI B2.1-1968) (R1992)
B1.20.3-76	Dryseal Pipe Threads (Inch) (revision and redesignation of B2.2-1968) (R1991)
B16.1-89	Cast Iron Pipe Flanges and Flanged Fittings
B16.3-92	Malleable Iron Threaded Fittings; Classes 150 and 300
B16.4.92	Cast Iron Threaded Fittings; Classes 125 and 250
B16.5-96	Pipe Flanges and Flanged Fittings
B16.9-93	Factory-Made Wrought Steel Butt-Welding Fittings
B16.10-92	Face-To-Face and End-To-End Dimensions of Valves
B16.11-96	Forged Steel Fittings, Socket-Welding and Threaded
B16.12-91	Cast Iron Threaded Drainage Fittings
B16.14-91	Ferrous Pipe Plugs, Bushings, and Locknuts with Pipe Threads
B16.15-85	Cast Bronze Threaded Fittings; Classes 125 and 250
B16.18-84	Cast Copper Alloy Solder Joint Pressure Fittings (R1994)
B16.22-95	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
B16.23-92	Cast Copper Alloy Solder Joint Drainage Fittings

B16.24-91	Bronze Pipe Flanges and Flanged Fittings; Classes 150 and 300
B16.25-97	Butt-Welding Ends
B16.26-88	Cast Copper Alloy Fittings for Flared Copper Tubes
B16.28-94	Wrought Steel Butt-Welding Short Radius Elbows and Returns
B16.29-94	Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings
B16.32-92	Cast Copper Alloy Solder Joint Fittings for Solvent Drainage Systems
B16.33-90	Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psig (sizes ½ through 2)
B16.34-96	Valves—Flanged, Threaded, and Welding End
B16.36-96	Orifice Flanges
B16.38-85	Large Metallic Valves for Gas Distribution (manually operated, NPS 2 ½ to 12, 125 psig maximum) (R1994)
B16.39-86	Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300 (R1994)
B16.40-85	Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems (R1994)
B16.41-83	Functional Qualification Requirements for Power-Operated Active Valve Assemblies for Nuclear Power Plants (R1989)
B16.42-87	Ductile Iron Pipe Flanges and Flanged Fittings; Classes 150 and 300 (R1997)
B16.44-95	Manually Operated Metallic Gas Valves for Use in House Piping Systems
B16.45-87	Cast Iron Fittings for Sovent Drainage Systems
B16.47-96	Large Diameter Steel Flanges NPS 26 through NPS 60
B18.2.1-96	Square and Hex Bolts and Screws (Inch Series) Including Hex Cap Screws and Lag Screws; Supplement 1318.2.1
B18.2.2-87	Square and Hex Nuts (Inch Series)
B18.2.3.1M-79	Metric Hex Cap Screws (R1995)
B18.2.3.2M-79	Metric Formed Hex Screws (R1995)
B18.2.3.3M-79	Metric Heavy Hex Screws (R1995)
B18.2.3.4M-84	Metric Hex Flange Screws (R1995)

B18.2.3.5M-79	Metric Hex Bolts; Errata-May 1981 (R1995)
B18.2.3.6M-79	Metric Heavy Hex Bolts (R1995)
B18.2.4.1M-79	Metric Hex Nuts, Style 1 (R1995)
B18.2.4.2M-79	Metric Hex Nuts, Style 2 (R1995)
B18.2.4.3M-79	Metric Slotted Hex Nuts (R1995)
B18.2.4.4M-82	Metric Hex Flange Nuts (R1993)
B18.2.4.5M-79	Metric Hex Jam Nuts (R1990)
B18.2.4.6M-79	Metric Heavy Hex Nuts (R1990)
B18.5-90	Round Head Bolts (Inch Series)
B18.5.2.1M-81	Metric Round Head Short Square Neck Bolts (R1995)
B18.5.2.2M-82	Metric Round Head Square Neck Bolts (R1993)
B18.15-85	Forged Eyebolts (R1995)
B18.18.1M-87	Inspection and Quality Assurance for General Purpose Fasteners (R1994)
B18.18.3M-87	Inspection and Quality Assurance for Special Purpose Fasteners (R1993)
B18.18.4M-87	Inspection and Quality Assurance for Fasteners for Highly Specialized Engineered Applications (R1993)
B18.21.1-72	Lock Washers (Inch Series)
B18.21.2M-94	Lock Washers (Metric Series)
B18.22M-81	Metric Plain Washers (R1990)
B18.22.1-65	Plain Washers (reaffirmation and redesignation of ASA 1327.2-1965) (R1990)
B32.5-77	Preferred Metric Sizes for Tubular Metal Products Other than Pipe (R1988)
B32.6M-84	Preferred Metric Equivalents of Inch Sizes for Tubular Products Other than Pipe (revision of ANSI B32.6-1977) (R1994)
B36.10M-96	Welded and Seamless Wrought Steel Pipe (revision of ANSI B36.10)
B36.19M-85	Stainless Steel Pipe (revision of ANSI B36.19)
MFC-1M-91	Glossary of Terms Used in the Measurement of Fluid Flow in Pipes
MFC-6M-87	Measurement of Fluid Flow in Pipes Using Vortex Flow Meters

MFC-7M-87	Measurement of Gas Flow by Means of Critical Flow Venturi Nozzles (R1992)
N45.2.1-80	Cleaning of Fluid Systems and Associated Components for Nuclear Power Plants
N278.1-75	Self-Operated and Power-Operated Safety-Related Valves Functional Specification Standard, Reactor Plants and Their Maintenance (R 1992)
NQA-1-1997	Quality Assurance Program Requirements for Nuclear Facilities
TDP-1-85	Recommended Practices for the Prevention of Water Damage to Steam Turbines Used for Electric Power Generation (Fossil)
TDP-2-85	Recommended Practices for the Prevention of Water Damage to Steam Turbines Used for Electric Power Generation (Revision of ASME Standard No. TWDPS-1-1973, Part 2) (Nuclear)

ANSI Guides/Manuals

1986	Guide for Gas Transmission and Distribution Piping Systems-1986; Addenda 1-1986, Addenda 2-1987, Addenda 3-1987
B31 Guide-77	Corrosion Control for ANSI B31.1, Power Piping Systems
B31 Guide-91	Manual for Determining the Remaining Strength of Corroded Pipelines (a supplement to ASME B31 Code for Pressure Piping)
1001-88	Performance Requirements for Pipe Applied Atmospheric Type Vacuum Breakers
1003-93	Performance Requirements for Water Pressure Reducing Valves
1037-90	Performance Requirements for Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures
1045-87	Performance Standard and Installation Procedures for Aluminum Drain, Waste, and Vent Pipe with End Cap Components

Other ASME/ANSI Publications

The following is a list of additional ASME/ANSI publications which are of interest to people engaged in piping design, construction, operation, and maintenance activities:

B16.20-93	Metallic Gaskets for Pipe Flanges—Ring Joint, Spiral-Wound and Jacketed
B16.21-92	Nonmetallic Flat Gaskets for Pipe Flanges

AMERICAN SOCIETY FOR TESTING AND MATERIALS

The American Society for Testing and Materials (ASTM) is a scientific and technical organization that develops and publishes voluntary standards on the characteristics and performance of materials, products, systems, and services. The standards published by the ASTM include test procedures for determining or verifying characteristics, such as chemical composition, and measuring performance, such as tensile strength and bending properties. The standards cover refined materials, such as steel, and basic products, such as machinery and fabricated equipment. The standards are developed by committees drawn from a broad spectrum of professional, industrial, and commercial interests. Many of the standards are made mandatory by reference in applicable piping codes.

The ASTM standards are published in a set of 67 volumes. Each volume is published annually to incorporate new standards and revisions to existing standards and to delete obsolete standards. Listed here are the 67 volumes, divided among 16 sections, published by the ASTM.

Section 1: Iron and Steel Products

Volume 01.01	Steel—Piping, Tubing, Fittings
Volume 01.02	Ferrous Castings; Ferroalloys
Volume 01.03	Steel—Plate, Sheet, Strip, Wire
Volume 01.04	Steel—Structural, Reinforcing, Pressure Vessel, Railway
Volume 01.05	Steel—Bars, Forgings, Bearing, Chain, Springs
Volume 01.06	Coated Steel Products
Volume 01.07	Shipbuilding

Section 2: Nonferrous Metal Products

Volume 02.01	Copper and Copper Alloys
Volume 02.02	Aluminum and Magnesium Alloys

Volume 02.03	Electrical Conductors
Volume 02.04	Nonferrous Metals—Nickel, Cobalt, Lead, Tin, Zinc, Cadmium, Precious, Reactive, Refractory, Metals, and Alloys
Volume 02.05	Metallic and Inorganic Coatings; Metal Powders, Sintered P/M Structural Parts

Section 3: Metals Test Methods and Analytical Procedures

Volume 03.01	Metals—Mechanical Testing: Elevated and Low-Temperature Tests, Metallography
Volume 03.02	Wear and Erosion, Metal Corrosion
Volume 03.03	Nondestructive Testing
Volume 03.04	Magnetic Properties; Metallic Materials for Thermostats, Electrical Heating and Resistance, Heating, Contacts, and Connectors
Volume 03.05	Analytical Chemistry of Metals, Ores, and Related Materials (I)
Volume 03.06	Analytical Chemistry of Metals, Ores, and Related Materials (II)

Section 4: Construction

Volume 04.01	Cement, Lime, Gypsum
Volume 04.02	Concrete and Aggregates
Volume 04.03	Road and Paving Materials, Pavement Management Technologies
Volume 04.04	Roofing, Waterproofing, and Bituminous Materials
Volume 04.05	Chemical-Resistant Materials; Vitrified Clay, Concrete, Fiber-Cement Products; Mortars; Masonry
Volume 04.06	Thermal Insulation; Environmental Acoustics
Volume 04.07	Building Seals and Sealants; Fire Standards; Building Constructions
Volume 04.08	Soil and Rock; Dimension Stones; Geosynthetics
Volume 04.09	Wood

Section 5: Petroleum Products, Lubricants, and Fossil Fuels

Volume 05.01	Petroleum Products and Lubricants (1): D 56-D 1947
Volume 05.02	Petroleum Products and Lubricants (II): D 1949-D 3601
Volume 05.03	Petroleum Products and Lubricants (III): D 3602-latest; Catalysts
Volume 05.04	Test Methods for Rating Motor, Diesel, and Aviation Fuels
Volume 05.05	Gaseous Fuels; Coal and Coke

Section 6: Paints, Related Coatings, and Aromatic

Volume 06.01	Paint—Tests for Formulated Products and Applied Coatings
Volume 06.02	Paint—Pigments, Resins, and Polymers; Cellulose
Volume 06.03	Paint—Fatty Oils and Acids, Solvents, Miscellaneous; Aromatic Hydrocarbons

Section 7: Textiles

Volume 07.01	Textiles (I): D76-D3219
Volume 07.02	Textiles (II): D3333-latest

Section 8: Plastics

Volume 08.01	Plastics (I): C 177-D 1600
Volume 08.02	Plastics (II): D 1601-D 3099
Volume 08.03	Plastics (III): D 3100-latest
Volume 08.04	Plastic Pipe and Building Products

Section 9: Rubber

Volume 09.01	Rubber, Natural, and Synthetic—General Test Methods; Carbon Black
Volume 09.02	Rubber Products, Industrial—Specifications and Related Test Methods; Gaskets; Tires

Section 10: Electrical Insulation and Electronics

Volume 10.01	Electrical Insulation (I) D69-D2484
Volume 10.02	Electrical Insulation (II) D2518-latest

Volume 10.03	Electrical Insulating Liquids and Gas; Electrical Protective Equipment
Volume 10.04	Electronics (I)
Volume 10.05	Electronics (II)

Section 11: Water and Environmental Technology

Volume 11.01	Water (I)
Volume 11.02	Water (II)
Volume 11.03	Atmospheric Analysis; Occupational Health and Safety
Volume 11.04	Pesticides; Resource Recovery; Hazardous Substances and Oil Spill Responses; Waste Management; Biological Effects

Section 12: Nuclear, Solar, and Geothermal Energy

Volume 12.01	Nuclear Energy (I)
Volume 12.02	Nuclear, Solar, and Geothermal Energy

Section 13: Medical Devices and Services

Volume 13.01	Medical Devices, Emergency Medical Services

Section 14: General Methods and Instrumentation

Volume 14.01	Analytical Methods—Spectroscopy; Chromatography; Computerized Systems
Volume 14.02	General Test Methods, Nonmetal; Laboratory Apparatus; Statistical Methods; Appearance of Materials; Durability of Nonmetallic Materials
Volume 14.03	Temperature Measurement

Section 15: General Products, Chemical Specialties, and End Use Products

Volume 15.01	Refractures; Carbon and Graphite Products; Activated Carbon
Volume 15.02	Glass; Ceramic Whitewares
Volume 15.03	Space Simulation; Aerospace and Aircraft; High Modulus Fibers and Composites

Volume 15.04	Soap; Polishes; Leather; Resilient Floor Coverings
Volume 15.05	Engine Coolants; Halogenated Organic Solvents; Industrial Chemicals
Volume 15.06	Adhesives
Volume 15.07	End Use Products
Volume 15.08	Fasteners
Volume 15.09	Paper; Packaging; Flexible Barrier Materials; Business Copy Products

Section 00: Index

Volume 00.01	Subject Index and Alphanumeric List

AMERICAN GAS ASSOCIATION

The following publications of the American Gas Association (AGA) are of interest to people associated with the design, construction, operation, and maintenance of gas systems piping.

Z223.1-92	National Fuel Gas Code, Fifth Edition
Z22.3-92	National Fuel Gas Code Handbook, Second Edition

AMERICAN PETROLEUM INSTITUTE

The American Petroleum Institute (API) publishes specifications (Spec.), bulletins (Bull.), recommended practices (RP), standards (Std.), and other publications (Publ.) as an aid to procurement of standardized equipment and materials. These publications are primarily intended for use by the petroleum industry. However, they can be and are used by others in that they are referenced in a code or invoked in the purchase order/specification governing the design and construction of piping systems. For example API Specification 5L and the API Standard 605 are referenced in ASME B31.1, Power Piping Code.

The following documents, which relate to piping, are published by the API.

Specifications (Spec.)

Spec. 2B-96	Specification for the Fabrication of Structural Steel Pipe
Spec. 6D-94	Specification for Pipeline Valves (Gate, Plugs, Ball, and Check Valves)

Spec. 5L-95	Specification for Line Pipe
Spec. 5LC-91	Specification for CRA Line Pipe
Spec. 6FA-94	Specification for Fire Test for Valves
Spec. 6FC-94	Specification for Fire Test for Valves with Automatic Backseats
Spec. 15HR-95	Specification for High Pressure Fiberglass Line Pipe
Spec. 15LE-95	Specification for Polyethylene Line Pipe (PE)
Spec. 15LR-90	Specification for Low Pressure Fiberglass Line Pipe
Spec. 5B-88	Specification for Threading, Gauging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads; Thirteenth Edition, Supplement 1, July 1990
Spec. 6FA-94	Specification for Fire Test for Valves
Spec. 6B-92	API specification for Fire Test for End connections
Spec. 6FC-94	Specification for Fire Test for Valves with Automatic Backseats
Spec. 6FD-95	Specification for Fire Test for Check Valves
Spec. 14A-94	Specification for Subsurface Safety Valve Equipment
Spec. 14D-94	Specification for Wellhead Surface Safety Valves and Underwater Safety Valves for Offshore Service

Bulletins (Bull.)

Bull. 5C3-94	Bulletin on Formulas and Calculations for Casing, Tubing, Drill Pipe, and Line Pipe Properties
Bull. 6AF-95	Bulletin on Capabilities of API Flanges Under Combinations of Load
Bull. 6F2-94	Bulletin on Fire Resistance Improvements for API Flanges

Recommended Practices (RP)

RP 5A3	Recommended Practice on Threaded Compounds for Casing, Tubing, and Line Pipe
RP 5A5-97	Recommended Practice for Field Inspection of New Casing, Tubing, and Plain-End Drill Pipe
RP 5B1-96	Recommended Practice for Gauging and Inspection of Casing, Tubing, and Line Pipe Threads

RP 5L1-96	Recommended Practice for Railroad Transportation of Line Pipe
RP 5L2-87	Recommended Practice for Internal Coating of Line Pipe for Noncorrosive Gas Transmission Service
RP 5L3-96	Recommended Practice for Conducting Drop-Weight Tear Tests on Line Pipe
RP 51-5-75	Recommended Practice for Marine Transportation of Line Pipe; First Edition
RP 5L6-79	Recommended Practice for Transportation of Line Pipe on Inland Waterways; First Edition
RP 5L7-88	Recommended Practices for Unprimed Internal Fusion Bonded Epoxy Coating of Line Pipe
RP 5L8-96	Recommended Practice for Field Inspection of New Line Pipe
RP 6G-82	Recommended Practice for Through Flowline (TFL) Pump Down Systems
Bull 6AF-95	Technical Report on Capabilities of API Flanges under Combinations of Load
Bull 6AF1-91	Bulletin on Temperature Derating of API Flanges Under Combinations of Loading
Bull 6RS-90	Standardization of Valves and Wellhead Equipment
RP 1OE-94	Recommended Practice for Application of Cement Lining to Steel Tubular Goods, Handling, Installation, and Joining; Third Edition ISO 10409
RP 11V7-90	Recommended Practice for Repair, Testing, and Setting Gas Lift Valves; First Edition
RP 15TL4-93	Recommended Practice for Care and Use Fiberglass Tubulars
RP 17B-88	Recommended Practice for Flexible Pipe
RP 520 PTI-93	Recommended Practice for Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries, Part I—Sizing and Selection
RP 520 PT II 94	Recommended Practice Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries, Part II—Installation
RP 574-90	Inspection of Piping, Tubing, Valves, and Fittings; First Edition (Replaces Guide for Inspection of Refinery Equipment Chapter XI)

RP 1102-93	Recommended Practice for Liquid Petroleum Pipelines Crossing Railroads and Highways
RP 1107-91	Recommended Pipe Line Maintenance Welding Practices
RP 1109-93	Recommended Practice for Marking Liquid Petroleum Line Facilities
RP 1110-97	Recommended Practice for Pressure Testing of Liquid Petroleum Pipelines

Standards (Std.)

Std. 526-95	Flanged Steel Pressure-Relief Valves Seat
Std. 527-91	Seat Tightness of Pressure Relief Valves
Std. 594-91	Wafer and Wafer-Lug Check Valves
Std. 598-90	Valve Inspection and Testing
Std. 599-94	Metal Plug Valves—Flanged and Welding End
Std. 600-91	Steel Gate Valves—Flanged and Butt-Welding Ends
Std. 602-93	Compact Steel Gate Valves—Flanged, Threaded, Welding, and Extended Body Ends
Std. 603-91	Class 150, Cast, Corrosion-Resistant, Flanged-End Gate Valves
Std. 607-93	Fire Test for Soft-Seated Quarter Turn Valves
Std. 608-95	Metal Ball Valves—Flanged, Threaded and Welding Ends
Std. 609-91	Lug and Wafer Type Butterfly Valves
Std. 1104-94	Welding of Pipelines and Related Facilities; Seventeenth Edition

Publications (Publ.)

Publ. 1113-93	Developing a Pipeline Supervisory Control Center

AMERICAN WATER WORKS ASSOCIATION

The American Water Works Association (AWWA) publishes standards that cover requirements for pipe and piping components used in water treatment and distribution systems, including specialty items such as fire hydrants. It also publishes several

AWWA manuals relative to design, installation, operation, management, and training. The AWWA standards are used for design, fabrication, and installation of large-diameter piping for water systems not covered by ASME Boiler and Pressure Vessel Code, ASME B31, Code for Pressure Piping, and other codes. Conformance to AWWA standards is required either by being referenced in the codes governing the construction of water systems piping or by the enforcement authorities having jurisdiction over the water systems piping.

Refer to Table C1.2 of Chapter C1, Part C of this handbook for a comprehensive listing of AWWA publications and standards dealing with piping.

AMERICAN WELDING SOCIETY

The American Welding Society (AWS) publishes handbooks, manuals, guides, recommended practices, specifications, and codes. The specifications for filler metals are in the AWS A5 series. The filler metal specifications are usually cited in design documents. The welding procedures are in the D10 series. The AWS handbook is published in five volumes and is intended to be an aid to the user and producer of welded products.

The following is a list of AWS publications directly related to piping. The AWS A5 series filler metal specifications are not included in the list since they can be used for a multitude of items other than piping.

AWS Welding Handbook

Volume 1	Fundamentals of Welding
Volume 2	Welding Processes
Volume 3	Welding Processes
Volume 4	Engineering Applications—Materials
Volume 5	Engineering Applications—Design Brazing Manual, Soldering Manual
AWS A3.0	Soldering Manual, Brazing Handbook, Welding Terms and Definitions, including Terms for Brazing, Soldering, Thermal Spraying, and Thermal Cutting
AWS A5.01	Filler Metal Procurement Guidelines
AWS D10.4	Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing
AWS D10.6	Recommended Practices for Gas Tungsten Arc Welding of Titanium Pipe and Tubing
AWS D10.7	Recommended Practices for Gas Shielded Arc Welding of Aluminum and Aluminum Alloy Pipe
AWS D10.8	Recommended Practices for Welding of Chromium-Molybdenum Steel Piping and Tubing

AWS D10.10	Recommended Practices for Local Heating of Welds in Piping and Tubing
AWS D10.11	Recommended Practices for Root Pass Welding of Pipe Without Backing
AWS D10.12	Recommended Practices for Procedures for Welding Low Carbon Steel Pipe

AIR-CONDITIONING AND REFRIGERATION INSTITUTE

The Air-Conditioning and Refrigeration Institute (ARI) publishes standards, guidelines, and directories of certification. Some of these standards and guidelines, listed here, may be used for design and construction of refrigeration piping systems.

Standards

720-88	Refrigerant Access Valves and Hose Connectors
750-87	Thermostatic Refrigerant Expansion Valves
760-87	Solenoid Valves for Use with Volatile Refrigerants
770-84	Refrigerant Pressure Regulating Valves

Guidelines

C-95	Guideline for ARI Recommended Dimensions of Steel Solder/Braze Fittings

AMERICAN SOCIETY OF HEATING REFRIGERATING AND AIR-CONDITIONING ENGINEERS

The following standards, guidelines, and handbooks published by the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) relate to piping:

Standards

41.3-89	Standard Method for Pressure Measurement
41.4-84	Standard Method for Measurement of Proportion of Oil in Liquid Refrigerant

41.6-94	Standard Method for Measurement of Moist Air Properties
41.7-84	Standard Method for Measurement of Flow of Gas
41.8-89	Standard Methods of Measurement of Flow of Liquids in Pipes Using Orifice Flowmeters

Guidelines

1-89	Guidelines for Commissioning of HVAC Systems
2-86	Guidelines for Engineering Analysis of Experimental Data

Handbooks

1993 ASHRAE Handbook Fundamentals I-P Edition
1993 ASHRAE Handbook Fundamentals SI Edition
1995 ASHRAE Handbook HVAC Applications IP Edition
1995 ASHRAE Handbook HVAC Applications SI Edition
1992 ASHRAE Handbook HVAC Systems and Equipment IP Edition
1992 ASHRAE Handbook HVAC Systems and Equipment SI Edition
1994 ASHRAE Handbook Refrigeration Systems and Applications I-P Edition
1994 ASHRAE Handbook Refrigeration Systems and Applications SI Edition

AMERICAN SOCIETY OF SANITARY ENGINEERS

The American Society of Sanitary Engineers (ASSE) publishes many standards, some of which are ANSI approved. The following is a list of standards which contain requirements related to sanitary piping.

Standards

1001-88	Performance Requirements for Pipe Applied Atmospheric Type Vacuum Breakers
1003-93	Performance Requirements for Water Pressure Reducing Valves
1005-86	Performance Requirements for Water Heaters Drain Valves 3″ IPS
1029-94	Performance Requirements for Dual Check Valve Type Backflow Preventers

1032-80	Performance Requirements for Dual Check Valve Type Backflow Preventers for Carbonated Beverage Dispensers
1037-90	Performance Requirements for Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures
1045-87	Performance Standard and Installation Procedures for Aluminum Drain, Waste, and Vent Pipe with End Cap Components
1046-90	Performance Requirements for Thermal Expansion Relief Valve
1048-93	Performance Requirements for Double Check Detector Assembly Backflow Preventer
1047-93	Performance Requirement for Reduced Pressure Detector Backflow Preventer
1050-91	Performance Requirements for Air Admittance Valves for Plumbing DWV Systems Stack Type Devices
1051-90	Performance Requirements for Air Admittance Valves for Plumbing Drainage Systems Fixture and Branch Devices
1052-93	Performance Requirements for Hose Connection Backflow Preventers
1056-93	Performance Requirements for Back Siphonage Backflow Vacuum Breakers

AMERICAN SOCIETY OF CIVIL ENGINEERS

The following documents, which are published by the American Society of Civil Engineers (ASCE), contain information related to piping. The contents of these documents can be used in design and construction of appropriate piping systems.

12-92.1.1	Standard Guidelines for the Design of Urban Subsurface Drainage
13-93.1.1	Standard Guidelines for Installation of Urban Subsurface Drainage
14-94.1.1	Standard Guidelines for Operation and Maintenance of Urban Subsurface Drainage
15-93.1.1	Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations

Publications Guideline for the Seismic Design of Oil and Gas Pipeline Systems (1984)

Report on Pipeline Location, 1965 Edition

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING

The American Society for Nondestructive Testing (ASNT) publishes recommended practices concerning procedures, equipment, and qualification of personnel for nondestructive testing. The following practice is cited in several codes and standards which contain requirements for piping:

SNT-TC-1A-92	Recommended Practice for Nondestructive Testing Personnel Qualification

AMERICAN IRON AND STEEL INSTITUTE

The following publications of the American Iron and Steel Institute (AISI) provide design guidelines for use of stainless steel in piping systems.

E-3-89	Welded Steel Pipe Steel Plate Engineering Data
E-6-84	Handbook of Steel Pipe
SG-862-90	Modern Sewer Design

AMERICAN NUCLEAR SOCIETY

The following American Nuclear Society (ANS) standards contain requirements for nuclear power plant piping systems:

8.9-87	Nuclear Criticality Safety Criteria for Steel Pipe Intersection Containing Aqueous Solutions of Fissile Materials
51.10-91	Auxiliary Feedwater System for Pressurized Water Reactor
56.2-84	Containment Isolation Provisions for Fluid Systems after a LOCA
56.3-77	Overpressure Protection of Low Pressure Systems Connected to the Reactor Coolant Pressure Boundary
56.4-83	Pressure and Temperature Transient Analysis for Light Water Reactor Containment

56.8-94	Containment System Leakage Testing Requirements
58.2-88	Design Basis for Protection of Light Water Nuclear Power Plants Against Effects of Postulated Pipe Rupture
59.51-89	Fuel Oil Systems for Emergency Diesel Generators

BUILDING OFFICIALS CONFERENCE OF AMERICA

The Building Officials Conference of America (BOCA) publishes a series of national codes, manuals, training aids, and other documents which contain technical requirements and other information related to piping. The following is a partial list of these publications:

National Codes

National Building Code
National Mechanical Code
National Plumbing Code
National Private Sewage Disposal Code
National Fire Prevention Code
National Energy Conservation Code

Manuals

BOCA National Code Interpretations
Fire Protection Systems Workbook
Plumbing Materials and Sizing Selector

DUCTILE IRON PIPE RESEARCH ASSOCIATION

The following documents published by the Ductile Iron Pipe Research Association contain guidelines, requirements, and other technical information related to ductile iron piping systems:

Pipe Material Comparison Booklet
Ductile Iron Pipe Characteristics/Applications
Design of Ductile Iron Pipe on Supports
Ductile Iron Pipe for Wastewater Applications
Cement-Mortar Linings for Ductile Iron Pipe
Direct Tapping Comparison Study

Ductile Iron Pipe Energy Savings
Ductile Iron Pipe
Flanged Ductile Iron Pipe
Gasket Materials Used for Ductile Iron Pipe in Water and Sewage Service
Linings Available for Ductile Iron Pipe & Fittings
Thrust Restraint Design for Ductile Iron Pipe
Truck Loads on Pipe Buried at Shallow Depths
Bridge Crossings with Ductile Iron Pipe
Ductile Iron Pipe Subaqueous Crossings
Hydraulic Analysis of Ductile Iron Pipe
Stray Current Effects on Ductile Iron Pipe
Polyethylene Encasement: Effective, Economical Protection for Ductile Iron Pipe in Corrosive Environments
Direct Tapping of Ductile Iron Pipe Encased in Polyethylene
Tapping Tests on Ductile Iron Pipe
A Comparison of Engineering Considerations for Pressure Pipe
Ductile Iron Pipe versus pvc
Ductile Iron pipe vs. Steel Pipe
Polyethylene Encasement Installation Guide
Field Welding and Cutting Ductile Iron Pipe

It may also be prudent to list our web site address (http://www.dipra.org) here so that people that require information about ductile iron pipe can easily contact us.

Ductile Iron Pipe in Deep Trench Installations
Ductile Iron Pipe Installation Guide
Ductile Iron Pipe Subaqueous Crossings
Concentrated Consulting Engineering Programs
Polyethylene Encasements
Corrosion Control Seminars
Ductile Iron Pipe Thrust Restraint Design, 1986 Edition
Inside Diameter/Velocity and Headloss/Pumping Costs

EXPANSION JOINT MANUFACTURERS ASSOCIATION

The Expansion Joint Manufacturers Association (EJMA) publishes a handbook called the *Standards of the Expansion Joint Manufacturers Association.* The book contains manufacturing standard practices as well as comprehensive and detailed engineering data concerning pipe expansion joint types, installation layouts and locations, movements, forces, moments, cycle-life expectancy, and effects of corrosion, erosion, and testing.

FLUID CONTROLS INSTITUTE

The Fluid Controls Institute (FCI) publishes voluntary standards that have been developed by consensus of the member companies. The following is a list of the FCI publications:

FCI 68-1 78	Solenoid Valves for Gas Service
FCI 68-2 78	A Procedure in Rating Flow and Pressure Characteristics of Solenoid Valves for Liquid Service
FCI 69-1 89	Pressure Rating Standard for Steam Traps (R 1994)
FCI 70-2 91	Quality Control Standard for Control Valve Seat Leakage
FCI 73-1 95	Pressure Rating Standard for ''Y'' Type Strainers
FCI 74-1 90	Spring-Loaded Lift Disc Check Valve
FCI 75-1 79	Characteristics of Solenoid Valves (R 1991)
FCI 78-1 78	Pressure Rating Standard for Pipeline Strainer Other Than ''Y'' Type
FCI 79-1 86	Proof of Pressure Ratings for Pressure Reducing Regulators (R 1993)
FCI 81-1 85	Proof of Pressure Ratings for Temperature Regulators (R 1993)
FCI 82-1 85	Recommended Methods for Testing and Classifying the Water Hammer Characteristics of Electrically Operated Valves (R 1991)
FCI 84-1	Metric Definition of the Valve Flow Coefficient Cv
FCI 85-1 89	Production Testing for Steam Traps (R 1994)
FCI 86-1 93	Standard Solenoid Valve Terminology and Nomenclature
FCI 87-1 93	Classification and Operating Principles of Steam Traps
FCI 87-2 90	Power Signal Standard for Spring-Diaphragm Actuated Control Valves
FCI 87-2	Control Valves (R 1994)
FCI 89-1 92	Guide for Selection, Installation and Maintenance of Pipeline Strainers
FCI 91-1 94	Standard for Qualification of Control Valve Stern Seals to Most EPA Emission Guidelines for Volatile Organic Compounds

FACTORY MUTUAL ENGINEERING & RESEARCH CORPORATION

The Factory Mutual Engineering & Research Corporation is usually referred to as Factory Mutual (FM). FM performs examinations of equipment, materials, and services before listing them as ''approved'' in the guide *Approval Guide to Equipment, Materials and Services*. The following publications of FM may be of interest to people involved with fire protection systems piping:

Approval Guide to Equipment, Materials and Services
Automatic Sprinkler Systems
Fixed Extinguishing Systems
Oil Safety Shutoff Valves
Gas Safety Shutoff Valves
Supplemental Data
Property Loss Control Catalog

FLUID SEALING ASSOCIATION

The Fluid Sealing Association publishes various documents related to gaskets and seals used in mechanical joints to maintain leak-tightness of the fluid piping and ducting systems. These documents include the following:

Ducting Systems Technical Handbook
Nonmetallic Gasket Handbook
Compression Packings Handbook
Molded Packings Handbook
Rubber Expansion Joints/Flexible Pipe Connectors
Mechanical Seal Handbook
Glossary of Terms

HEAT EXCHANGE INSTITUTE

The Heat Exchange Institute (HEI) publishes voluntary standards developed to express the consensus of member companies concerned with the fabrication of heat exchangers and similar equipment. The following are typical of the standards published by this institute:

HE14	Method and Procedure for the Determination of Dissolved Oxygen
HE15	Standards for Closed Feedwater Heaters
HE17	Standards for Direct Contact Barometric and Low Level Condensers

HE18	Standard for Power Plant Heat Exchangers
HE18A	Standards for Steam Jet Vacuum Systems
HEI10	Standards for Steam Surface Condensers, 8th Edition

HYDRAULIC INSTITUTE

The following is the list of the Hydraulic Institute (HI) publications:

Hydraulic Institute Standards, 1994 Edition

ANSI/HI 1.1-1.5	Centrifugal Pumps
ANSI/HI 1.6	Centrifugal Pump Test
ANSI/HI 5.1-5.6	Sealless Centrifugal Pumps
ANSI/HI 2.1-2.5	Vertical Pumps
ANSI/HI 2.6	Vertical Pump Test
ANSI/HI 3.1-3.5	Rotary Pumps
ANSI/HI 3.6	Rotary Pump Test
ANSI/HI 4.1-4.6	Sealless Rotary Pumps
ANSI/HI 6.1-6.5	Reciprocating Power Pumps
ANSI/HI 6.6	Reciprocating Pump Test
ANSI/HI 7.1-7.5	Controlled Volume Pumps
ANSI/HI 8.1-8.5	Direct Acting (Steam) Pumps
ANSI/HI 9.1-9.5	Pumps General Guidelines

Engineering Data Book, 2nd Edition (1990)

The information previously contained in the *Pipe Friction Manual* has been incorporated into the *Engineering Data Book;* the *Pipe Friction Manual* is no longer available.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

The following standards published by the Institute of Electrical and Electronics Engineers (IEEE) are of interest to those involved in the design and construction of nuclear power plant piping systems:

IEEE 323-83	Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations

IEEE 336-85	Standard Installation, Inspection, and Testing Requirements for Power, Instrumentation, and Control Equipment at Nuclear Facilities
IEEE 344-87	Recommended Practice for Seismic Qualification of Class IE Equipment for Nuclear Power Generating Stations
IEEE 352-87	Guide for General Principles of Reliability Analysis of Nuclear Power Generating Station Safety Systems
IEEE 379-94	Standard Application of the Single Failure Criterion to Nuclear Power Generating Station Safety Systems
IEEE 382-96	Standard for Qualification of Actuators for Power Operated Valve Assemblies with Safety-Related Functions for Nuclear Power Plants

INSTRUMENT SOCIETY OF AMERICA

The Instrument Society of America (ISA) develops and publishes periodicals, books, standards, recommended practices, monographs, references, and training aids pertaining to instruments and automated controls. The following publications of the ISA contain information related to piping:

Recommended Practices (RP)

RP 16.5-61	Recommended Practice for Installation, Operation, Maintenance Instructions for Glass Tube Variable Area Meters (Rotometers)
RP 31.1-77	Recommended Practice for Specification, Installation, and Calibration of Turbine Flowmeters
RP 42.1-92	Recommended Practice for Nomenclature for Instrument Tube Fittings
RP 60.9-81	Recommended Practice for Piping Guide for Control Centers
RP 75.18-89	Recommended Practice for Control Valve Position Stability
RP 75.21-89	Recommended Practice for Process Data Presentation for Control Valves
RP 75.23-95	Considerations for Evaluating Control Valve Cavitation

Standards

S 5.1-84	Instrumentation Symbols and Identification

S 5.2-76	Binary Logic Diagrams for Process Operations
S 5.3-83	Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer
S 5.4-91	Standard Instrument Loop Diagrams
S 5.5-85	Graphic Symbols for Process Displays
S 7.0.01	Quality Standard for Instrument Air
S 12.4-70	Instrument Purging for Reduction of Hazardous Area Classification
S 18.1-79	Annunciator Sequences and Specifications (R 1985)
S 20-81	Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves
S 26-68	Dynamic Response Testing of Process Control Instrumentation
S 37.3-75	Strain Gauge Pressure Transducers, Specifications, and Tests (R 1982)
S 37.5-75	Strain Gauge Linear Acceleration Transducers, Specifications, and Tests (R 1982)
S 37.6-76	Specifications and Tests of Potentiometric Pressure Transducers (R 1982)
S 37.8-77	Specifications and Tests for Strain Gauge Force Transducers (R 1982)
S 51.1-79	Process Instrumentation Terminology
S 67.01-94	Transducer and Transmitter Installation for Nuclear Safety Applications
S 67.02.01-96	Nuclear - Safety - Related Instrument Sensing Line Piping and Tubing Standards for Use in Nuclear Power Plants
S 67.03-82	Light Water Reactor Coolant Pressure Boundary Leak Detection
S 67.04-94	Setpoints for Nuclear Safety-Related Instrumentation
S 67.10-94	Sample-Line Piping and Tubing Standard for Use in Nuclear Power Plants
S 75.01-85	Flow Equations for Sizing Control Valves
S 75.02-96	Control Valve Capacity Test Procedure
S 75.03-92	Face-to-Face Dimensions for Integral Flanged Globe-Style Control Valve Bodies (ANSI Classes 125, 150, 250, 300, and 600)

S 75.04-95	Face-to-Face Dimensions for Flangeless Control Valves (ANSI Classes 150, 300, and 600)
S 75.05-83	Control Valve Terminology
S 75.07-87	Laboratory Measurement of Aerodynamic Noise Generated by Control Valves
S 75.08-85	Installed Face-to-Face Dimensions for Flanged Clamp or Pinch Valves
S 75.11-85	Inherent Flow Characteristic and Rangeability of Control Valves
S 75.12-93	Face-to-Face Dimensions for Socket Weld-End and Screwed-End Globe-Style Control Valves (ANSI Classes 150, 300, 600, 900, 1500, and 2500)
S 75.14-93	Face-to-Face Dimensions for Butt-Weld-End Globe Style Control Valves (ANSI Classes 4500)
S 75.15-94	Face-to-Face Dimensions for Butt-Weld-End Globe-Style Control Valves (ANSI Classes 150, 300, 600, 900, 1500, and 2500)
S 75.17-89	Control Valve Aerodynamic Noise Prediction Standard
S 75.19-95	Hydrostatic Testing of Control Valves (Formerly ASME/ANSI B16.37-80)
ISA MC96.1	Temperature Measurement Thermocouples (1982)
ISA RP2.1	Manometer Tables (1985)
ISA RP12.4	Pressurized Enclosures (1996)
ISA RP75.23	Considerations for Evaluating Control Valve Cavitation
ISA S75.16	Face-to-Face Dimensions for Flanged Globe-Style Control Valve Bodies (ANSI Classes 900, 1500, and 2500) (1994)
ISA S75.20	Face-to-Face Dimensions for Separable Flanged Globe-Style Control Valves (ANSI Classes 150, 300, and 600) (1991)
ISA S75.22	Face-to-Centerline Dimensions for Flanged Globe-Style Angle Control Valve Bodies (ANSI Classes 150, 300, and 600) (1992)
ISA S77.70	Fossil Fuel Power Plant Instrument Piping Installation (1995)

ISA S84.01	Application of Safety Instrumented Systems for the Process Industries (1996)
ISA DIRECT	Directory of Instrumentation, 1992

Handbook

ISA Handbook of Control Valves

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY

The Manufacturers Standardization Society (MSS) publishes Standard Practices (SP) which provide a basis for common practice by the manufacturers, the user, and the general public. Compliance to the Standard Practices of MSS is required by reference in a code, specification, sales contract, law, or regulation. The MSS is also represented on the committees of other standardization groups, such as ANSI and ASME. Many of the ASME B16 series standards were originally developed as MSS Standard Practices. Once a Standard Practice is adopted as ANSI standard, it is discontinued as an MSS Standard Practice.

The following is a complete list of MSS Standard Practices published and in current use:

Standard Practices (SP)

SP-6-96	Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings
SP-9-97	Spot Facing for Bronze, Iron, and Steel Flanges
SP-25-93	Standard Marking System for Valves, Fittings, Flanges, and Unions
SP-42-90	Class 150 Corrosion Resistant Gate, Globe, Angle, and Check Valves with Flanged and Butt-Weld Ends
SP-43-91	Wrought Stainless Steel Butt-Welding Fittings, Including Reference to Other Corrosion Resistant Materials
SP-44-96	Steel Pipe Line Flanges (superseded by ASME B16.47)
SP-45-92	Bypass and Drain Connection Standard
SP-51-91	Class 15OLW Corrosion Resistant Cast Flanges and Flanged Fittings
SP-53-95	Quality Standard for Steel Castings and Forgings for Valves, Flanges, and Fittings and Other Piping Components

	Magnetic Particle Examination Method
SP-54-95	Quality Standard for Steel Casting for Valves, Flanges, and Fittings and Other Piping Components, Radiographic Examination Method (R 1990)
SP-55-96	Quality Standard for Steel Castings for Valves, Flanges, and Fittings and Other Piping Components, Visual Method for Evaluation of Irregularities
SP-58-93	Pipe Hangers and Supports—Materials, Design, and Manufacture
SP-60-91	Connecting Flange Joint Between Tapping Sleeves and Tapping Valves (R 1986)
SP-61-92	Pressure Testing of Steel Valves
SP-65-94	High Pressure Chemical Industry Flanges and Threaded Stubs for Use with Lens Gaskets
SP-67-95	Butterfly Valves
SP-68-97	High Pressure-Offset Seat Butterfly Valves with Offset Design
SP-69-96	Pipe Hangers and Supports—Selection and Application
SP-70-90	Cast Iron Gate Valves, Flanged, and Threaded Ends
SP-71-97	Cast Iron Swing Check Valves, Flanged and Threaded Ends
SP-72-92	Ball Valves with Flanged or Butt-Welding Ends for General Service
SP-73-91	Brazing Joints for Wrought and Cast Copper Alloy Solder Joint Pressure Fittings
SP-75-93	Specification for High Test Wrought Butt-Welding Fittings
SP-77-95	Guidelines for Pipe Support Contractual Relationships and Responsibilities of the Pipe Hanger Contractor with the Purchaser's Engineer or the Pipe Fabricator and/or Erector
SP-78-87	Cast Iron Plug Valves, Flanged and Threaded Ends
SP-79-92	Socket-Welding Reducer Inserts
SP-80-97	Bronze Gate, Globe, Angle, and Check Valves

SP-81-95	Stainless Steel, Bonnetless Flanged Knife Gate Valves
SP-82-92	Valve Pressure Testing Methods
SP-83-95	Class 3000 Steel Pipe Unions Socket-Welding and Threaded
SP-85-94	Cast Iron Globe and Angle Valves Flanged and Threaded Ends
SP-86-97	Guidelines for Metric Data in Standards for Valves, Flanges, Fittings, and Actuators
SP-87-91	Factory-Made Butt-Welding Fittings for Class 1 Nuclear Piping Applications (R 1986)
SP-88-93	Diaphragm Type Valves (R 1988)
SP-89-98	Pipe Hangers and Supports—Fabrication and Installation Practices
SP-90-86	Guidelines on Terminology for Pipe Hangers and Supports
SP-91-92	Guidelines for Manual Operation of Valves
SP-92-87	Valve User Guide
SP-93-87	Quality Standard for Steel Castings and Forgings for Valves, Flanges, and Fittings and Other Piping Components Liquid Penetrant Examination Method
SP-94-92	Quality Standard for Ferritic and Martensitic Steel Castings for Valves, Flanges, and Fittings, and Other Piping Components Ultrasonic Examination Method (R 1987)
SP-95-86	Swage(d) Nipples and Bull Plugs
SP-96-96	Guidelines on Terminology for Valves and Fittings
SP-97-95	Forged Carbon Steel Branch Outlet Fittings—Socket Welding, Threaded, and Butt-Welding Ends
SP-98-96	Protective Epoxy Coatings for the Interior of Valves and Hydrants
SP-99-94	Instrument Valves
SP-100-97	Qualification Requirements for Elastomer Diaphragms for Nuclear Service Diaphragm Type Valves
SP-101-89	Part-Turn Valve Actuator Attachment Flange and Driving Component Dimensions and Performance Characteristics

SP-102-89	Multi-Turn Valve Actuator Attachment Flange and Driving Component Dimensions and Performance Characteristics
SP-103-95	Wrought Copper and Copper Alloy Insert Fittings for Polybutylene Systems
SP-104-95	Wrought Copper Solder Joint Pressure Fittings
MS SP-105	Instrument Valves for Code Applications (Jan. 1, 1996)
MSS SP-106	Cast Copper Alloy Flanges and Flanged Fittings Class 125, 150 and 300 (Jan. 1, 1990)
MSS SP-107	Transition Union Fittings for Joining Metal and Plastic Products (Jan. 1, 1991)
MSS SP-108	Resilient-Seated Cast Iron-Eccentric Plug Valves (Jan. 1, 1996)
MSS SP-109	Welded Fabricated Copper Solder Joint Pressure Fittings (Jan. 1, 1997)
MSS SP-110	Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends (Jan. 1, 1996)
MSS SP-111	Gray-Iron and Ductile-Iron Tapping Sleeves (Jan. 1, 1996)
MSS SP-112	Quality Standard for Evaluation of Cast Surface Finishes Visual and Tactile Method (Jan. 1, 1993)
MSS SP-113	Standard Practice for Connecting Joint Between Tapping Machines and Tapping Valves (Jan. 1, 1994)
MSS SP-114	Corrosion Resistant Pipe Fittings Threaded and Socket Welding Class 150 and 1000 (Jan. 1, 1995)
MSS SP-115	Excess Flow Valves for Natural Gas Service (Jan. 1, 1995)
MSS SP-116	Service Line Valves and Fittings for Drinking Water Systems (Jan. 1, 1996)
MSS SP-117	Bellows Seals for Globe and Gate Valves (Jan. 1, 1996)
MSS SP-118	Compact Steel Globe and Check Valves Flanges, Flangeless, Threaded and Welding Ends (Chemical and Petroleum Refinery Service) (Jan. 1, 1996)
MSS SP-119	Belled End Socket Welding Fittings, Stainless Steel and Copper Nickel (Nov. 1, 1996)

MSS SP-120	Flexible Graphite Packing System or Rising Stern Steel Valves (Design Requirements) (March 1, 1997)
MSS SP-121	Qualification Testing Methods for Stem Packing for Rising Stem Steel Valves (March 1, 1997)
MSS SP-122	Plastic Industrial Ball Valves (Jan. 1, 1997)

NATIONAL FIRE PROTECTION ASSOCIATION

The National Fire Protection Association (NFPA) is a voluntary association of members representing all aspects of fire protection, such as professional societies, educational institutions, public officials, insurance companies, equipment manufacturers, builders and contractors, and transportation groups. The NFPA publishes codes, standards, guides, and recommended practices in a 12-volume set of books called the *National Fire Codes*. Conformance to the *National Fire Codes* may be required by federal, state, and local laws and regulations. Sometimes insurance companies may leave no choice for the owner/user of the facility but to comply with the fire protection and prevention requirements of the applicable National Fire Codes.

Volumes 1 through 8 contain actual text of the National Fire Codes and Standards. The requirements contained in these volumes have been judged suitable for legal adoption and enforcement. Volumes 9 through 11 contain recommended practices and guides considered to be good engineering practices. Volume 12 contains formal interpretations, tentative interim amendments, and errata that relate to the documents in Volumes 1 through 11.

Here is a list of NFPA publications. For specific NFPA Codes and Standards related to fire protection systems piping, refer to Chapter C2, Part C of this handbook.

National Fire Protection Association Publications

Technical Committee Documentation and Reports
Automatic Sprinkler Systems Handbook, Sixth Edition
Automatic Sprinkler and Standpipe Systems, Second Edition
Flammable and Combustible Liquids Code Handbook, Fifth Edition
Fire Litigation Handbook
SFPE Handbook of Fire Protection Engineering, First Edition
Fire Protection Guide to Hazardous Materials, Eleventh Edition
Fire Protection Handbook, Seventeenth Edition
Liquefied Petroleum Gases Handbook, Third Edition
Life Safety Code Handbook, Sixth Edition
National Electrical Code Handbook, Seventh Edition
National Fuel Gas Code Handbook, Second Edition

National Fire Codes and Standards, Volumes 1 through 12
Formal Interpretations, Volume 13

PIPE FABRICATION INSTITUTE

The Pipe Fabrication Institute (PFI) publishes advisory Engineering Standards (ES) and Technical Bulletins (TB) intended to serve the needs of the pipe-fabricating industry at the design level and in actual shop operations. The PFI standards contain minimum requirements; however, the designer or fabricator may consider specifying additional requirements beyond the scope of PFI publications. The use of PFI standards or bulletins is voluntary. A complete listing of PFI publications follows:

Engineering Standards (ES)

ES-1-92	Internal Machining and Solid Machined Backing Rings for Circumferential Butt Welds
ES-2-92	Method of Dimensioning Piping Assemblies
ES-3-81	Fabricating Tolerances (R 1990)
ES-4-85	Hydrostatic Testing of Fabricated Piping (R 1988)
ES-5-93	Cleaning of Fabricated Piping
ES-7-94	Minimum Length and Spacing for Welded Nozzles
ES-11-75	Permanent Marking on Piping Materials (R 1990)
ES-16-85	Access Holes, Bosses, and Plugs for Radiographic Inspection of Pipe Welds (R 1988)
ES-20-97	Wall Thickness Measurement by Ultrasonic Examination
ES-21-92	Internal Machining and Fit-Up of GTAW Root Pass Circumferential Butt Welds (R 1989)
ES-22-95	Recommended Practice for Color Coding of Piping Materials
ES-24-92	Pipe Bending Methods, Tolerances, Process, and Material Requirements
ES-25-93	Random Radiography of Pressure Retaining Girth Butt Welds
ES-26-93	Welded Load Bearing Attachments to Pressure Retaining Piping Materials
ES-27-94	''Visual Examination''—The Purpose, Meaning, and Limitation of the Term
ES-29-93	Abrasive Blast Cleaning of Ferritic Piping Materials

ES-30-86	Random Ultrasonic Examination of Butt Welds (R 1989)
ES-31-92	Standard for Protection of Ends of Fabricated Piping Assemblies
ES-32-93	Tool Calibration
ES-34-92	Painting of Fabricated Piping (R 1989)
ES-35-93	Nonsymmetrical Bevels and Joint Configurations for Butt Welds
ES-36-95	Branch Reinforcement Work Sheets
PFI ES-37	Loading and Shipping of Piping Assemblies (March 1, 1997)
PFI ES-39	Fabricated Tolerances for Grooved Piping Systems (Feb. 1, 1994)
PFI ES-40	Method of Dimensioning Grooved Piping Assemblies (Feb. 1, 1994)
PFI ES-41	Material Control and Traceability of Piping Components (Jan. 1, 1995)
PFI ES-42	Positive Material Identification of Piping Components Using Portable X-Ray Emission Type Test Equipment (Jan. 1, 1996)
PFI ES-44	Drafting Practices Standard (March 1, 1997)

Technical Bulletins (TB)

TB1-94	Pressure-Temperature Ratings of Seamless Pipe Used in Power Plant Piping Systems
TB3-93	Guidelines Clarifying Relationships and Design Engineering Responsibilities Between Purchasers' Engineers and Pipe Fabricator or Pipe Fabricator Erector (R 1988)
TB7-97	Guideline for Fabrication and Installation of Stainless Steel High Priority Distribution Systems

PLASTICS PIPE INSTITUTE

Those interested in the application of plastics piping systems may find the following Plastics Pipe Institute (PPI) publications of help:

PPI Handbook of Polyethylene Piping
Engineering Basics of Plastics Piping
Plastic Piping Manual

In addition, the PPI publishes technical reports (TR), technical notes (TN), recommendations (REC), statements (STA), and model specifications (MS) dealing with plastics piping.

Technical Reports (TR)

PPI TR2/6	Policies and Procedures for the Listing of Thermoplastic Pipe, Fittings and Fixture Materials when Evaluated under Constant Internal Pressure with Flow (ASTM F 948) (1987)
PPI TR-3	Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials; Addendum—1992 (1992)
PPI TR-4	Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings Compounds; Correction Notice (1994)
PPI TR-5	Standards for Plastics Piping (1990)
PPI TR-7	Recommended Method for Calculation of Nominal Weight of Plastic Pipe (1988)
PPI TR-9	Recommended Design Factors for Pressure Applications of Thermoplastic Pipe Materials (1992)
PPI TR-11	Resistance of Thermoplastic Piping Materials to Micro- and Macro-Biological Attack (1989)
PPI TR13	Poly (Vinyl Chloride) (PVC) Plastic Piping Design and Installation (1973)
PPI TR14	Water Flow Characteristics of Thermoplastic Pipe (1992)
PPI TR18	Weatherability of Thermoplastic Piping (1973)
PPI TR19	Thermoplastics Piping for the Transport of Chemicals; Errata (1991)
PPI TR20	Joining Polyolefin Pipe (1973)
PPI TR21	Thermal Expansion and Contraction of Plastic Pipe; Errata (1974)
PPI TR-22	Polyethylene Plastic Piping Distribution Systems for Components of Liquid Petroleum Gases; Revision—1991 (1988)
PPI TR-30	Thermoplastic Fuel Gas Piping Investigation of Maximum Temperatures At-

	tained by Plastics Pipe Inside Service Risers (1988)
PPI TR-31	Underground Installation of Polyolefin Piping (1988)
PPI TR-32	Recommended Minimum In-Plant Quality Control Program for Production of Polyethylene Gas Distribution Piping Systems (1989)
PPI TR8	Installation Procedures for Polyethylene (PE) Plastic Pipe (1984)

Technical Notices (TN)

PPI TN-15	Resistance of Polyethylene Pipe to a Sanitary Sewage Environment (1992)
PPI TN-16	Rate Process Method for Evaluating Performance of Polyethylene Pipe (1992)
PPI TN2	Sealants for Polyvinyl Chloride (PVC) Plastic Piping (1970)
PPI TN8/8	Making Threaded Joints with Thermoplastic Pipe and Fittings (1973)
PPI TN12/3	Coefficients of Thermal Expansion Thermoplastic Piping Materials (1977)
PPI REC.A	Limiting Water Velocities in Thermoplastic Piping Systems (1971)
PPI REC.B	Thermoplastic Piping for the Transport of Compressed Air or Other Compressed Gases (1989)
PPI REC.C	Pressure Rating of PVC Plastic Piping for Water at Elevated Temperatures (1973)
PPI STA.L	Thermoplastic Piping in Fire Sprinkler Systems
PPI STA.H	Noise in Piping Systems (1988)
PPI.STA.N	Pipe Permeation (R 1990) (1984)
PPI STA.R	Technical Considerations When Using Polyethylene (PE) (1992)
PPI STA.S	Caution Statement on Heat Fusion Methods of Polyethylene Pipe and/or Fittings of Similar Colors (1991)
PPI MS-2	Model Specification for Polyethylene Plastic Pipe Tubing and Fittings for Natural Gas Distribution (1990)

STEEL STRUCTURES PAINTING COUNCIL

The Steel Structures Painting Council (SSPC) publishes specifications, which include surface preparation (SP), pretreatment (PT), paint application (PA), and paint and paint systems (PS). These specifications identify practical and economical methods of surface preparation and painting steel structures. They are used to clean and paint piping and other steel equipment. With the exception of paint and paint system specifications, the following are the commonly used SSPC specifications:

Surface Preparation (SP) Specifications

SSPC-Vis I-89	Pictorial Surface Preparation Standard for Painting Steel Surfaces
SSPC-Vis 2-82	Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces
SSPC-SP 1-82	Solvent Cleaning
SSPC-SP 2-95	Hand Tool Cleaning
SSPC-SP 3-95	Power Tool Cleaning
SSPC-SP 5-94	White Metal Blast Cleaning
SSPC-SP 6-94	Commercial Blast Cleaning
SSPC-SP 7-94	Brush-Off Blast Cleaning
SSPC-SP 8-91	Pickling
SSPC-SP 10-94	Near-White Blast Cleaning
SSPC-SP 11-95	Power Tool Cleaning and Base Metal

Pretreatment Specifications (PT)

SSPC-PT 1	Wetting Oil Treatment
SSPC-PT 2	Cold Phosphate Surface Treatment
SSPC-PT 3	Basic Zinc Chromate-Vinyl Butyral Washcoat
SSPC-PT 4	Hot Phosphate Surface Treatment

Paint Application (PA) Guides

SSPC-PA I-91	Shop, Field, and Maintenance Painting
SSPC-PA 2-91	Measurement of Dry Paint Thickness with Magnetic Gauges

TUBULAR EXCHANGER MANUFACTURERS ASSOCIATION

The Tabular Exchanger Manufacturers Association (TEMA) publishes standards for use by manufacturers and users. The following is a list of some Heat Exchange Institute (HEI) publications that may be of interest:

HEI 8	Standards for Power Plant Heat Exchangers, Second Edition
HEI 8A	Standards for Steam Jet Vacuum Systems, Fourth Edition
HEI 10	Standards for Steam Surface Condensers, Eighth Edition
HEI 10A	Standards for Steam Surface Condensers Addendum, Eighth Edition
HEI TSD	Standards and Typical Specifications for Deaerators, Fifth Edition

UNDERWRITERS LABORATORIES

The UL is a nonprofit organization that develops specifications and standards directed toward assuring the safety of materials, products, and equipment when used in accordance with the conditions for which they were designed. It also tests items for conformance to these and other nationally recognized standards and publishes lists of items approved as a result of the tests. The NFPA codes require that items to be used in fire protection and prevention systems be approved and listed. The UL-published *UL Fire Protection Equipment List* (such as a listing of fire-loop piping material and equipment manufacturers) is one of the publications normally used by those involved in piping associated with fire protection systems.

FOREIGN CODES AND STANDARDS

The basic principles of piping design and construction may not differ much from one country to another, but the requirements of country-specific codes and standards may vary substantially. Therefore, the personnel involved in the engineering design, construction, operation, and maintenance of piping systems must ensure that the requirements of applicable codes and standards are complied with to ensure the safety of the general public and workers associated with the facility.

The user is advised to verify the latest applicable version/edition of the code and/or standard before invoking their requirements for any application.

Appendix E10 provides a listing of British, DIN, Japanese, and ISO codes, standards, and specifications related to piping.

BRITISH STANDARDS AND SPECIFICATIONS

Pipe, Tube, and Fittings

Appendix E10, Table E10.B1 lists British standards and specifications for pipe, tube, and fittings.

Flanges, Bolts, Nuts, and Gaskets

Appendix E10, Table E10.B2 lists British standards and specifications for flanges, bolts, nuts, and gaskets.

Valves

Appendix E10, Table E10.B3 lists British standards and specifications for valves.

DIN STANDARDS AND SPECIFICATIONS

Pipe, Tube, and Fittings

Appendix E10, Table E10.D1 lists DIN standards and specifications for pipe, tube, and fittings.

Flanges, Bolts, Nuts, and Gaskets

Appendix E10, Table E10.D2 lists DIN standards and specifications for flanges, bolts, nuts, and gaskets.

Valves

Appendix E10, Table E10.D3 lists DIN standards and specifications for valves.

JAPANESE STANDARDS AND SPECIFICATIONS

Pipe, Tube, and Fittings

Appendix E10, Table E10.J1 lists Japanese standards and specifications for pipe, tube, and fittings.

Flanges, Bolts, Nuts, and Gaskets

Appendix E10, Table E10.J2 lists Japanese standards and specifications for flanges, bolts, nuts, and gaskets.

Valves

Appendix E10, Table E10.J3 lists Japanese standards and specifications for valves.

ISO STANDARDS AND SPECIFICATIONS

Pipe, Tube, and Fittings

Appendix E10, Table E10.I1 lists ISO standards and specifications for pipe, tube and fittings.

Flanges, Bolts, Nuts, and Gaskets

Appendix E10, Table E10.I2 lists ISO standards and specifications for flanges, bolts, nuts, and gaskets.

Valves

Appendix E10, Table E10.I3 lists ISO standards and specifications for valves.

Other chapters include reference to other international or foreign standards and specifications relevant to the piping and related components.

REFERENCES

1. *ASME Boiler and Pressure Vessel Code,* Section 1, Power Boilers, 1998 Edition, American Society of Mechanical Engineers, New York.
2. *ASME Boiler and Pressure Vessel Code,* Section II, Material Specifications, 1998 Edition, American Society of Mechanical Engineers, New York.
3. *ASME Boiler and Pressure Vessel Code,* Section III, Division 1, Nuclear Power Plant Components, 1998 Edition, American Society of Mechanical Engineers, New York.
4. Code of Federal Regulations, Title 10, Part 50, Section 50.55a, Codes and Standards, January 1, 1998, Office of the Federal Register, National Archives and Records Administration, Washington, D.C.
5. *ASME Boiler and Pressure Vessel Code,* Section V, Nondestructive Examination, 1998 Edition, American Society of Mechanical Engineers, New York.
6. *ASME Boiler and Pressure Vessel Code,* Section VIII, Pressure Vessels, 1998 Edition, American Society of Mechanical Engineers, New York.
7. *ASME B31, Code for Pressure Piping,* Section B31.1, Power Piping, 1998 Edition, American Society of Mechanical Engineers, New York.
8. *ASME Boiler and Pressure Vessel Code,* Section IX, Welding and Brazing Qualifications, 1998 Addendum, American Society of Mechanical Engineers, New York.
9. *ASME Boiler and Pressure Vessel Code,* Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1998 Edition, American Society of Mechanical Engineers, New York.
10. *ASME B31, Code for Pressure Piping,* Section B31.9, Building Services Piping, 1996 Edition, American Society of Mechanical Engineers, New York.
11. *ASME B31, Code for Pressure Piping,* Section B31.3, Process Piping, 1996 Edition, American Society of Mechanical Engineers, New York.
12. *ASME B31, Code for Pressure Piping,* Section B31.4, Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohol, 1992 Edition with Addenda B31.1A-1994, American Society of Mechanical Engineers, New York.

13. *ASME B31, Code for Pressure Piping,* Section B31.5, Refrigeration Piping, 1992 Edition with Addenda B31.5A-1994, American Society of Mechanical Engineers, New York.
14. *ASME B31, Code for Pressure Piping,* Section B31.8, Gas Transmission and Distribution Piping Systems, 1995 Edition, American Society of Mechanical Engineers, New York.
15. *ASME B31, Code for Pressure Piping,* Section B31.11, Slurry Transportation Piping Systems, 1989 Edition, American Society of Mechanical Engineers, New York.
16. USAS B31.2, *Fuel Gas Piping,* 1968 Edition, American Society of Mechanical Engineers, New York.