

ASME B31.1-2022
(Revision of ASME B31.1-2020)

Power Piping

ASME Code for Pressure Piping, B31

AN INTERNATIONAL PIPING CODE®



**The American Society of
Mechanical Engineers**

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FOREWORD

The general philosophy underlying this Power Piping Code is to parallel those provisions of Section I, Power Boilers, of the ASME Boiler and Pressure Vessel Code, as they can be applied to power piping systems. The allowable stress values for power piping are generally consistent with those assigned for power boilers. This Code is more conservative than some other piping codes, reflecting the need for long service life and maximum reliability in power plant installations.

The Power Piping Code as currently written does not differentiate among the design, fabrication, and erection requirements for critical and noncritical piping systems, except for certain stress calculations and mandatory non-destructive tests of welds for heavy wall, high-temperature applications. The problem involved is to try to reach agreement on how to evaluate criticality, and to avoid the inference that noncritical systems do not require competence in design, fabrication, and erection. Someday such levels of quality may be definable, so that the need for the many different piping codes will be overcome.

There are many instances where the Code serves to warn a designer, fabricator, or erector against possible pitfalls; however, the Code is not a handbook and cannot substitute for education, experience, and sound engineering judgment.

Nonmandatory Appendices are included in the Code. Each contains information on a specific subject, and is maintained current with the Code. Although written in mandatory language, these Appendices are offered for application at the user's discretion.

The Code never intentionally puts a ceiling limit on conservatism. The designer is free to specify more-rigid requirements if the designer feels such requirements are justified. Conversely, a designer who is capable of applying a more complete and rigorous analysis consistent with the design criteria of the Code may justify a method different from that specified in the Code and still satisfy the Code requirements.

The Power Piping Committee strives to keep abreast of the current technological improvements in new materials, fabrication practices, and testing techniques; and endeavors to keep the Code updated to permit the use of acceptable new developments.

ASME B31.1-2022 was approved by the American National Standards Institute on August 8, 2022.

ASME B31 COMMITTEE

Code for Pressure Piping

(The following is the roster of the Committee at the time of approval of this Code.)

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INTRODUCTION

The ASME B31 Code for Pressure Piping consists of a number of individually published Sections, each an American National Standard, under the direction of ASME Committee B31, Code for Pressure Piping.

Rules for each Section have been developed considering the need for application of specific requirements for various types of pressure piping. Applications considered for each Code Section include

- B31.1 Power Piping: piping typically found in electric power generating stations, industrial and institutional plants, geothermal heating systems, and central and district heating and cooling systems
- B31.3 Process Piping: piping typically found in petroleum refineries; onshore and offshore petroleum and natural gas production facilities; chemical, pharmaceutical, textile, paper, ore-processing, semiconductor, and cryogenic plants; food- and beverage-processing facilities, and related processing plants and terminals
- B31.4 Pipeline Transportation Systems for Liquids and Slurries: piping transporting products that are predominately liquid between plants and terminals, and within terminals and pumping, regulating, and metering stations
- B31.5 Refrigeration Piping and Heat Transfer Components: piping for refrigerants and secondary coolants
- B31.8 Gas Transmission and Distribution Piping Systems: piping transporting products that are predominately gas between sources and terminals, including compressor, regulating, and metering stations; and gas gathering pipelines
- B31.9 Building Services Piping: piping typically found in industrial, institutional, commercial, and public buildings, and in multi-unit residences, which does not require the range of sizes, pressures, and temperatures covered in ASME B31.1
- B31.12 Hydrogen Piping and Pipelines: piping in gaseous and liquid hydrogen service, and pipelines in gaseous hydrogen service

This is the B31.1 Power Piping Code Section. Hereafter, in this Introduction and in the text of this Code Section B31.1, where the word *Code* is used without specific identification, it means this Code Section.

It is the owner's responsibility to select the Code Section that most nearly applies to a proposed piping installation. Factors to be considered by the owner include limitations of the Code Section, jurisdictional requirements, and the applicability of other codes and standards. All applicable requirements of the selected Code Section shall be met. For some installations, more than one Code Section may apply to different parts of the installation. The owner is also responsible for imposing requirements supplementary to those of the selected Code Section, if necessary, to assure safe piping for the proposed installation.

Certain piping within a facility may be subject to other codes and standards, including but not limited to

- ASME Boiler and Pressure Vessel Code, Section III: nuclear power piping
- ANSI Z223.1/NFPA 54 National Fuel Gas Code: piping for fuel gas from the point of delivery to the connection of each fuel utilization device
- NFPA Fire Protection Standards: fire protection systems using water, carbon dioxide, halon, foam, dry chemicals, and wet chemicals
- NFPA 85 Boiler and Combustion Systems Hazards Code
- building and plumbing codes, as applicable, for potable hot and cold water, and for sewer and drain systems

The Code specifies engineering requirements deemed necessary for safe design, construction, operation, and maintenance of pressure piping. While safety is the overriding consideration, this factor alone will not necessarily govern the final specifications for any piping installation or operation. The Code is not a design handbook. Many decisions that must be made to produce a safe piping installation and to maintain system integrity are not specified in detail within this Code. The Code does not serve as a substitute for sound engineering judgment by the owner and the designer.

To the greatest possible extent, Code requirements for design are stated in terms of basic design principles and formulas. These are supplemented as necessary with specific requirements to ensure uniform application of principles and to guide selection and application of piping elements. The Code prohibits designs and practices known to be unsafe and contains warnings where caution, but not prohibition, is warranted.

The Code generally specifies a simplified approach for many of its requirements.

For design and construction, a designer may choose to use a more rigorous analysis to develop design and construction requirements. When the designer decides to take this approach, the designer shall provide to the owner details and calculations demonstrating that design, construction, examination, and testing are consistent with the criteria of the Code. These details shall be adequate for the owner to verify the validity of the approach and shall be approved by the owner. The details shall be documented in the engineering design.

For operation and maintenance, an owner may choose to use a more rigorous approach to develop operation and maintenance requirements. When the owner decides to take this approach, the owner shall provide details and calculations demonstrating that such alternative practices are consistent with the general philosophy of the Code. The details shall be documented in the operating records and retained for the lifetime of the facility.

This Code Section includes the following:

(a) references to acceptable material specifications and component standards, including dimensional requirements and pressure-temperature ratings

(b) requirements for design of components and assemblies, including pipe supports

(c) requirements and data for evaluation and limitation of stresses, reactions, and movements associated with pressure, temperature changes, and other forces

(d) guidance and limitations on the selection and application of materials, components, and joining methods

(e) requirements for the fabrication, assembly, and erection of piping

(f) requirements for examination, inspection, and testing of piping

(g) requirements for operation and maintenance of piping systems

Either U.S. Customary (USC) or International System (SI, also known as metric) units may be used with this edition. Local customary units may also be used to demonstrate compliance with this Code. One system of units should be used consistently for requirements applying to a specific installation. It is the responsibility of the organization performing calculations to ensure that a consistent system of units is used.

It is intended that this edition of Code Section B31.1 not be retroactive. Unless agreement is specifically made between contracting parties to use another edition, or the regulatory body having jurisdiction imposes the use of another edition, the latest edition issued at least 6 months prior to the original contract date for the first phase of activity covering a piping system or systems shall be the governing document for all design, materials, fabrication, erection, examination, and testing for the piping until the completion of the work and initial operation.

Users of this Code are cautioned against making use of revisions without assurance that they are acceptable to the proper authorities in the jurisdiction where the piping is to be installed.

Code users will note that clauses in the Code are not necessarily numbered consecutively. Such discontinuities result from following a common outline, insofar as practicable, for all Code Sections. In this way, corresponding material is correspondingly numbered in most Code Sections, thus facilitating reference by those who have occasion to use more than one Section.

The Code is under the direction of ASME Committee B31, Code for Pressure Piping, which is organized and operates under procedures of The American Society of Mechanical Engineers that have been accredited by the American National Standards Institute. The Committee is a continuing one, and keeps all Code Sections current with new developments in materials, construction, and industrial practice. New editions are published at intervals of two to five years.

When no Section of the ASME Code for Pressure Piping specifically covers a piping system, at the user's discretion, the user may select any Section determined to be generally applicable. However, it is cautioned that supplementary requirements to the Section chosen may be necessary to provide for a safe piping system for the intended application. Technical limitations of the various Sections, legal requirements, and possible applicability of other codes or standards are some of the factors to be considered by the user in determining the applicability of any Section of this Code.

The Committee has established an orderly procedure to consider requests for interpretation and revision of Code requirements. To receive consideration, inquiries must be in writing and must give full particulars (see [Mandatory Appendix H](#) covering preparation of technical inquiries). The Committee will not respond to inquiries requesting assignment of a Code Section to a piping installation.

The approved reply to an inquiry will be sent directly to the inquirer. In addition, the question and reply will be published on the ASME Interpretation Database at <http://go.asme.org/InterpsDatabase>.

A Case is the prescribed form of reply to an inquiry when study indicates that the Code wording needs clarification or when the reply modifies existing requirements of the Code or grants permission to use new materials or alternative constructions. The Case will be published on the B31.1 web page at <http://go.asme.org/B31committee>.

The ASME B31 Standards Committee took action to eliminate Code Case expiration dates effective September 21, 2007. This means that all Code Cases in effect as of this date will remain available for use until annulled by the ASME B31 Standards Committee.

Materials are listed in the stress tables only when sufficient usage in piping within the scope of the Code has been shown. Materials may be covered by a Case. Requests for listing shall include evidence of satisfactory usage and specific data to permit establishment of allowable stresses, maximum and minimum temperature limits, and other restrictions. Additional criteria can be found in the guide-

lines for addition of new materials in ASME Boiler and Pressure Vessel Code, Section II. (To develop usage and gain experience, unlisted materials may be used in accordance with [para. 123.1](#).)

Requests for interpretation and suggestions for revision should be addressed to the Secretary, ASME B31 Committee, Two Park Avenue, New York, NY 10016-5990.

ASME B31.1-2022

SUMMARY OF CHANGES

Following approval by the ASME B31 Committee and ASME, and after public review, ASME B31.1-2022 was approved by the American National Standards Institute on August 8, 2022.

ASME B31.1-2022 includes the following changes identified by a margin note, **(22)**.

<i>Page</i>	<i>Location</i>	<i>Change</i>
1	100.1.2	First paragraph under subpara. (a)(3) revised
2	Figure 100.1.2-1	Bottom of illustration and second definition in legend revised
3	Figure 100.1.2-2	Bottom of illustration and second definition in legend revised
4	Figure 100.1.2-3	Middle of illustration and second definition in legend revised
5	Figure 100.1.2-4	Second definition in legend revised
6	Figure 100.1.2-5	Second definition in legend revised
7	Figure 100.1.2-6	Second definition in legend revised
7	100.2	(1) Definitions of <i>arc strike</i> and <i>throttle valve</i> added (2) Definitions of <i>covered piping systems (CPS)</i> and <i>pipe and tube</i> revised
8	Figure 100.1.2-7	Illustration (c) and second definition in legend revised
9	Figure 100.1.2-8	Top and middle of illustration and second definition in legend revised
10	Figure 100.1.2-9	Added
11	Figure 100.1.2-10	Added
21	102.3.1	Subparagraph (c) revised
21	102.3.2	Subparagraph (a)(3) revised
28	Table 104.1.2-1	General Note (b) revised
28	104.2	(1) Title revised (2) Former para. 104.3.3 redesignated as 104.2.3
29	104.3	(1) Title and paras. 104.3.1(b)(2) and 104.3.1(c)(2) revised (2) Paragraphs 104.3.1(c)(5) and 104.3.1(c)(6) added (3) Former paras. 104.3.3 and 104.3.4 redesignated as 104.2.3 and 104.3.2, respectively
35	Figure 104.3.1-2	Revised in its entirety
37	104.5.1	(1) Subparagraph (a) revised (2) Former subpara. (c) deleted and subsequent subparagraph redesignated
40	Figure 104.8-1	Equations (15) and (16) revised
44	110	Last sentence added
46	Table 112-1	Notes (3), (4), and (6) revised
49	Table 114.2.1-1	General Note revised
57	122.1.1	Subparagraph (b) revised
57	122.1.2	Subparagraph (d) revised

<i>Page</i>	<i>Location</i>	<i>Change</i>
59	122.1.7	Last sentence in subpara. (b)(5) added
72	123.1.1	(1) Subparagraph (c)(1) revised (2) Subparagraph (c)(3) added
78	Table 126.1-1	Updated
89	127.4.8	Subparagraph (f) revised
99	Figure 127.4.8-7	Revised in its entirety
101	129.3.5	Revised
101	129.3.6	Added and subsequent paragraph redesignated
103	131.1	Second paragraph revised
103	131.6.1	Subparagraph (c) revised
104	Table 131.4.1-1	(1) Third column head revised (2) Note (2) added and subsequent Notes redesignated
105	132.1.3	Revised
105	132.4	Title and paras. 132.4.2 and 132.4.3 revised
106	Table 132.1.1-1	Note (4) revised
107	Table 132.1.1-2	Note (1) revised
107	Table 132.1.3-1	Title revised
108	Table 132.2-1	(1) Last column entries in fifth row deleted (2) P-No. 7, Group 1 row added
113	136.3.2	Revised in its entirety
114	Table 136.4.1-1	Note (6) revised
117	137.3.2	Revised
118	137.4.6	(1) Subparagraph (c) revised (2) Subparagraph (d) added
121	140	Subparagraph (h) revised
122	141.1	Subparagraphs (c) and (d) revised
123	144	Second paragraph revised
123	145	First and last paragraphs revised
126	Table A-1	(1) Under Wrought Fittings (Seamless and Welded), A420 row added (2) Note (1) revised
140	Table A-2	(1) Under Seamless Pipe and Tube, for A213 T12, Specified Minimum Yield revised (2) Under Seamless Pipe and Tube, for A213 T91, Types added, Notes deleted, and stress values revised (3) Under Seamless Pipe and Tube, for A335 P91, Types added, Notes deleted, and stress values revised (4) Under Seamless Pipe and Tube, for A369 FP91, Type 1 added and stress values revised (5) Under Seamless Pipe and Tube, A369 FP91 Type 2 row added (6) Under Seamless Pipe and Tube, A714 row deleted (7) Under Electric Resistance Welded Pipe, A714 row deleted (8) Under Electric Fusion Welded Pipe — Filler Metal Added, for A691 91, Type 1 added and stress values revised (9) Under Electric Fusion Welded Pipe — Filler Metal Added, two A691 91 Type 2 rows added

<i>Page</i>	<i>Location</i>	<i>Change</i>
		(10) Under Plate, for A387 91, Types added, Notes deleted, and stress values revised
		(11) Under Plate, four SA/EN 10028-2 rows added
		(12) Under Forgings, for A182 F91, Type added, and Specified Minimum Tensile and stress values revised
		(13) Under Forgings, A182 F91 Type 2 row added
		(14) Under Forgings, for A336 F91, Types added, Notes deleted, and Specified Minimum Tensile and stress values revised
		(15) Under Wrought Fittings (Seamless and Welded), for A234 WP91, Types added, Notes deleted, and Specified Minimum Tensile and stress values revised
		(16) Note (1) revised
		(17) Notes (10) and (11) deleted
		(18) Notes (15) through (18) added
152	Table A-3	Note (1) revised
188	Table A-4	(1) Under Welded Pipe and Tube, for B464, Note (1) deleted
		(2) Under Seamless Fittings, for B366 N06625, last two stress values deleted
		(3) Note (1) revised
202	Table A-5	Note (1) revised
206	Table A-6	(1) Under Seamless Pipe and Tube, for B43 C23000, Specified Minimum Tensile revised
		(2) Under Seamless Pipe and Tube, for B88, C10200 deleted
		(3) Under Seamless Pipe and Tube, for B302, C12000 deleted
		(4) Note (1) revised
212	Table A-7	(1) Arc-Welded Round Tube section deleted
		(2) Note (1) revised
		(3) Notes (14) through (16) deleted
		(4) Notes (23), (24), and (25) renumbered as (8), (10), and (23), respectively
220	Table A-8	Note (1) revised
228	Table A-9	(1) Specified Minimum Yield and allowable stress values for Grades 1 and F1 revised
		(2) Former General Note (i) deleted and subsequent Note redesignated
		(3) Note (1) revised
232	Table A-10	(1) Under Low and Intermediate Alloy Steel, A194 Grade 4 row deleted; for A354 Grade BD, Note (11) and second row deleted
		(2) Under Stainless Steels: Austenitic, for A193 Grade B8M, Specified Minimum Yield and last maximum allowable stress at 600°F revised
		(3) General Notes revised in their entirety
		(4) Note (1)(d) deleted and subsequent Notes redesignated
		(5) Notes (2) and (7) through (9) revised
		(6) Note (14) deleted
265	Mandatory Appendix F	Updated
269	Mandatory Appendix G	Definition of S_i added

<i>Page</i>	<i>Location</i>	<i>Change</i>
277	N-100	First paragraph revised
281	Table N-102.2.1-1	ASTM F2389 deleted from “SI Units” and moved to “U.S. Customary Units”
288	Mandatory Appendix N, N-104.5	Definitions of S_a and S_b revised
298	Table N-126.1-1	Updated
305	Mandatory Appendix N, N-136.1	Revised
308	Figure O-8-1	Dimensions revised in all three illustrations
314	Nonmandatory Appendix II, II-1.2	Definition of <i>open discharge installation</i> revised
316	Figure II-1.2-2	Dimension l revised to L_o
317	Nonmandatory Appendix II, II-2.2.1	Equation in subpara. (a)(1) and nomenclature in subpara. (a)(2) revised
318	Figure II-2.2.1-1	Equation revised
320	Figure II-2.2.1-3	(1) Equations revised (2) Upper right-hand illustration deleted
321	Nonmandatory Appendix II, II-2.3.1.1	Equation and nomenclature revised
321	Nonmandatory Appendix II, II-2.3.1.2	Second paragraph, equation, and nomenclature revised
322	Nonmandatory Appendix II, II-3.5.1.1	First paragraph, equation, and nomenclature revised
323	Nonmandatory Appendix II, II-3.5.1.3	Subparagraph (a) revised
324	Nonmandatory Appendix II, II-4.1	Last paragraph revised
324	Figure II-3.5.1.3-1	Top callout and dimension h revised
329	Nonmandatory Appendix II, II-7.1.1	Equation and nomenclature revised
329	Nonmandatory Appendix II, II-7.1.2	Equations revised
329	Nonmandatory Appendix II, II-7.1.3	Revised in its entirety
329	Nonmandatory Appendix II, II-7.1.4	Revised in its entirety
330	Figure II-7-1	Revised in its entirety
331	Figure II-7-2	I.D. value revised
332	Nonmandatory Appendix II, II-7.1.6	Revised in its entirety
333	Nonmandatory Appendix II, II-7.1.7	Last two equations revised
333	Nonmandatory Appendix II, II-7.1.8	Equations revised
334	Nonmandatory Appendix II, II-7.1.9	Revised in its entirety
334	Nonmandatory Appendix II, II-7.1.10	Revised
334	Figure II-7.1.9-1	(1) Values revised (2) “Attachment to vent pipe” callout added
336	Nonmandatory Appendix IV, IV-3.3	Revised
343	Nonmandatory Appendix V, V-7.6	Subparagraph (r) added
349	Nonmandatory Appendix V, V-12	Subparagraph (b) revised
351	Nonmandatory Appendix V, V-13.1.3	Revised
367	Table VIII-2	(1) Under Spec. No. A193, sixth row revised and seventh row added (2) Under Spec. No. A320, first and second rows revised

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Chapter I

Scope and Definitions

100 GENERAL

This Power Piping Code is one of several Sections of The American Society of Mechanical Engineers (ASME) Code for Pressure Piping, B31. This Section is published as a separate document for convenience.

Standards and specifications specifically incorporated by reference into this Code are shown in [Table 126.1-1](#). It is not considered practical to refer to a dated edition of each of the standards and specifications in this Code. Instead, the dated edition references are included in [Mandatory Appendix F](#).

100.1 Scope

Rules for this Code Section have been developed considering the needs for applications that include piping typically found in electric power generating stations, industrial and institutional plants, geothermal heating systems, and central and district heating and cooling systems.

100.1.1 This Code prescribes requirements for the design, materials, fabrication, erection, examination, testing, inspection, operation, and maintenance of piping systems. Where service requirements necessitate measures beyond those required by this Code, such measures shall be specified by the engineering design.

Piping as used in this Code includes pipe, flanges, bolting, gaskets, valves, pressure-relieving valves/devices, fittings, and the pressure-containing portions of other piping components, whether manufactured in accordance with standards listed in [Table 126.1-1](#) or specially designed. It also includes hangers and supports and other equipment items necessary to prevent over-stressing the pressure-containing components.

Rules governing piping for miscellaneous appurtenances, such as water columns, remote water level indicators, pressure gages, and gage glasses, are included within the scope of this Code, but the requirements for boiler appurtenances shall be in accordance with ASME Boiler and Pressure Vessel Code (BPVC), Section I, PG-60.

The users of this Code are advised that in some areas legislation may establish governmental jurisdiction over the subject matter covered by this Code. However, any such legal requirement shall not relieve the owner of

his/her inspection responsibilities specified in [para. 136.1](#).

100.1.2 Power piping systems as covered by this Code apply to all piping and their component parts except as excluded in [para. 100.1.3](#). They include but are not limited to steam, water, oil, gas, and air services. (22)

(a) This Code covers boiler external piping as defined below for power boilers and high-temperature, high-pressure water boilers in which steam or vapor is generated at a pressure of more than 15 psig [100 kPa (gage)]; and high-temperature water is generated at pressures exceeding 160 psig [1 103 kPa (gage)] and/or temperatures exceeding 250°F (120°C).

Boiler external piping shall be considered as piping that begins where the boiler proper terminates at

- (1) the first circumferential joint for welding end connections; or
- (2) the face of the first flange in bolted flanged connections; or
- (3) the first threaded joint in that type of connection, and that extends up to and including the valve or valves required by [para. 122.1](#).

The terminal points themselves are considered part of the boiler external piping. The terminal points and piping external to power boilers are illustrated by [Figures 100.1.2-1](#) through [100.1.2-10](#).

Piping between the terminal points and the valve or valves required by [para. 122.1](#) shall be provided with Data Reports, inspection, and stamping as required by ASME BPVC, Section I. All welding and brazing of this piping shall be performed by manufacturers or contractors authorized to use the ASME Certification Mark and appropriate Designators shown in ASME CA-1, Conformity Assessment Requirements. The installation of boiler external piping by mechanical means may be performed by an organization not holding an ASME Certification Mark. However, the holder of a valid ASME Certification Mark, Certificate of Authorization, with an "S," "A," or "PP" Designator shall be responsible for the documentation and hydrostatic test, regardless of the method of assembly. The quality control system requirements of ASME BPVC, Section I; ASME CA-1; and ASME QAI-1, Qualifications for Authorized Inspectors, shall apply.

The valve or valves required by [para. 122.1](#) are part of the boiler external piping, but do not require ASME BPVC, Section I inspection and stamping except for safety, safety