ASME B31.1-2016

(Revision of ASME B31.1-2014)

Power Piping

ASME Code for Pressure Piping, B31

AN INTERNATIONAL PIPING CODE®

The American Society of
Mechanical Engineers

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Two Park Avenue • New York, NY • 10016 USA

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The next edition of this Code is scheduled for publication in 2018. This Code will become effective 6 months after the Date of Issuance.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Code. Interpretations are published under http://go.asme.org/Interpretations. Periodically certain actions of the ASME B31 Committees may be published as Cases. Cases are published on the ASME Web site under the Committee Pages at http://go.asme.org/B31committee as they are issued.

Errata to codes and standards may be posted on the ASME Web site under the Committee Pages to provide corrections to incorrectly published items, or to correct typographical or grammatical errors in codes and standards. Such errata shall be used on the date posted.

The B31 Committee Pages can be found at http://go.asme.org/B31committee. The associated B31 Committee Pages for each code and standard can be accessed from this main page. There is an option available to automatically receive an e-mail notification when errata are posted to a particular code or standard. This option can be found on the appropriate Committee Page after selecting "Errata" in the "Publication Information" section.

The American Society of Mechanical Engineers
Two Park Avenue, New York, NY 10016-5990

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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 nondestructive 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; but 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. A designer is free to specify more rigid requirements as he feels they may be justified. Conversely, a designer who is capable of a more rigorous analysis than is specified in the Code may justify a less conservative design, and still satisfy the basic intent of the Code.

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.

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Code for Pressure Piping

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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, in 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; chemical, pharmaceutical, textile, paper, semiconductor, and cryogenic plants; 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, 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 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 chemical, 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 sets forth engineering requirements deemed necessary for safe design and construction of pressure piping. While safety is the basic consideration, this factor alone will not necessarily govern the final specifications for any piping system. The designer is cautioned that the Code is not a design handbook; it does not eliminate the need for the designer or for competent engineering judgment.

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 specific design requirements of the Code usually revolve around a simplified engineering approach to a subject. It is intended that a designer capable of applying more complete and rigorous analysis to special or unusual problems shall have latitude in the development of such designs and the evaluation of complex or combined stresses. In such cases the designer is responsible for demonstrating the validity of his approach.

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

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 issue, or the regulatory body having jurisdiction imposes the use of another issue, 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 which 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, he/she 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 as part of an Interpretation Supplement issued to the applicable Code Section.

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 as part of a Case Supplement issued to the applicable Code Section.

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 guidelines for addition of new materials in the 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 B31.1-2016
SUMMARY OF CHANGES

Following approval by the B31 Committee and ASME, and after public review, ASME B31.1-2016 was approved by the American National Standards Institute on May 31, 2016.

Changes given below are identified on the pages by a margin note, **(16),** placed next to the affected area.

Page	*Location*	*Change*
xii	Introduction	(1) Second paragraph revised (2) Footnote deleted
1–12	100.1.2	In subpara. (A), third and last paragraphs revised
	Fig. 100.1.2(B.1)	Fig. 100.1.2(B) redesignated as Fig. 100.1.2(B.1)
	Fig. 100.1.2(B.2)	Added
	Fig. 100.1.2(B.3)	Added
	100.1.4	Revised
	100.2	(1) Definitions of *alteration, cold spring, failure, failure analysis,* and *repair* added (2) Definitions of *component* and *covered piping systems (CPS)* revised (3) For *stresses,* subdefinitions rearranged
15	101.7.2	Revised
19	102.4.6	In subpara. (A), first paragraph revised
21, 24	104.1.2	Subparagraphs (C.3.1) and (C.3.2) revised
	Table 104.1.2(A)	Row for UNS No. N06690 added
25, 31	104.3.1	(1) DN values added in 13 places (2) In subpara. (C.2), cross-references revised
32, 33	104.5.1	In subpara. (A), first two paragraphs revised
34, 35	104.8	Revised
	104.8.1	Nomenclature for S_h revised
	104.8.3	Revised
38	107.4	Revised
41, 43	Table 112	General Note (c) revised
48	119.7.3	Second paragraph revised
	119.10.1	Nomenclature for S_h revised
50	121.4	First paragraph revised
	Table 121.5	Column for Diameter Nominal added

Page	*Location*	*Change*
51	121.7.2	In subpara. (A), first paragraph revised
53	122.1.1	In subparas. (E), (F), and (H), DN values added
55–58	122.1.7	Subparagraphs (B.5), (C.5), and (C.12) revised
59	122.3.2	Subparagraph (A.1) revised
60	122.3.6	Subparagraph (A.5) revised
74–80	Table 126.1	(1) API 570 added (2) For MSS SP-45, SP-51, SP-61, SP-75, SP-83, and SP-95, titles revised (3) ASME B31J added (4) For AWS QC1, title revised
84–91	127.4.8	Subparagraph (F) revised
	Fig. 127.4.8(E)	Note (4) revised
	Fig. 127.4.8(F)	Title revised
	Fig. 127.4.8(G)	Title revised
	127.4.10	Revised
94	129.3.3	First paragraph revised
	129.3.3.1	Revised in its entirety
95	Table 129.3.3.1	Added
	129.3.4.5	Revised
96	Table 129.3.4.1	(1) Row for Grade 690 added (2) In last row, Grade deleted (3) Note (2) revised
97, 98	132.1.1	Revised
100, 103	132.4.2	In subparagraph (E), equation revised
104	132.6	Subparagraph (B) revised
106	136.1.4	Revised in its entirety
107–109	136.3.2	Last paragraph revised
	136.4.2	First paragraph revised
	136.4.3	First paragraph revised
	Table 136.4	(1) Seven DN values added (2) General Note (b) revised (3) Note (5) redesignated as (6), and new Note (5) added
	136.4.4	First paragraph revised
110	136.4.5	First paragraph revised
	136.4.6	First paragraph revised
114	138	Last paragraph revised
	139	Subparagraph (E) revised
	140	Third paragraph added

Page	*Location*	*Change*
115, 116	141	Revised in its entirety
140, 141	Table A-3	Under Seamless Pipe and Tube, Austenitic, A312 N08904 added
142, 143	Table A-3	A312 TP317LMN added
144, 145	Table A-3	(1) Under Ferritic/Austenitic, A789 and A790 S32101 added (2) For A789 2205, Type or Grade revised (3) For A790 2205, Type or Grade, Specified Minimum Tensile, and stress values revised
148, 149	Table A-3	Under Welded Pipe and Tube — Without Filler Metal, Austenitic, A312 N08904 and TP317LMN added
150, 151	Table A-3	(1) Under Ferritic/Austenitic, A789 and A790 S32101 added (2) For A789 2205, Type or Grade revised (3) For A790 2205, Type or Grade, Specified Minimum Tensile, and stress values revised
156, 157	Table A-3	(1) Under Welded Pipe — Filler Metal Added, Ferritic/Austenitic, A928 2205 added (2) Under Plate, Sheet, and Strip, Austenitic, A240 N08904 added
158, 159	Table A-3	(1) A240 317LMN added (2) Under Ferritic/Austenitic, A240 S32101 added (3) For A240 2205, Type or Grade, Specified Minimum Tensile, and stress values revised (4) Under Forgings, Austenitic, A182 F904L added
162, 163	Table A-3	Under Fittings (Seamless and Welded), Austenitic, for A403 WP304 and WP304H, Notes revised
164, 165	Table A-3	(1) A403 WPS31726 added (2) Under Ferritic/Austenitic, A815 S32101 added
166, 167	Table A-3	Under Bar, Austenitic, A479 N08904 and 317LMN added
168, 169	Table A-3	(1) Under Ferritic/Austenitic, A479 S32101 and 2205 added (2) Note (23) revised
170, 171	Table A-4	(1) Under Seamless Pipe and Tube, B167 N06690 added (2) For B444 N06625, Notes revised, and stress values for 1,150°F and 1,200°F deleted

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174, 175	Table A-4	(1) Under Welded Pipe and Tube, for B704 and B705 N06625, Notes revised, and stress values for 1,150°F and 1,200°F deleted (2) Under Plate, Sheet, and Strip, B168 N06690 added (3) For B443 N06625, Notes revised, and stress values for 1,150°F and 1,200°F deleted
176, 177	Table A-4	(1) Under Bars, Rods, Shapes, and Forgings, B166 N06690 added (2) For B446 and B564 N06625, Notes revised, and stress values for 1,150°F and 1,200°F deleted
178, 179	Table A-4	Under Welded Fittings, for B366 N06625, Notes revised, and stress values for 1,150°F and 1,200°F deleted
181	Table A-4	Note (23) added
182, 183	Table A-5	(1) Column for −20°F to 650°F deleted (2) Under Gray Cast Iron, for A126 Classes A, B, and C, Notes revised (3) For A278 Classes 40 through 60, stress values added (4) Under Ductile Cast Iron, for A395 60-40-18, A536 60-42-10, and A536 70-50-05, stress values added
188, 189	Table A-7	(1) Under Drawn Seamless Tube, for B210 A96061 T4, stress value for 250°F revised (2) For B210 A96061 T6, stress values for 250°F and 300°F revised (3) For B210 A96061 T4, T6 welded, Specified Minimum Yield deleted and first four stress values revised (4) Under Seamless Pipe and Seamless Extruded Tube, for B241 A95083 H112, Notes revised (5) For B241 A96061 T4, stress value for 250°F revised (6) For first B241 A96061 T6, Size or Thickness and stress value for 250°F revised (7) For second B241 A96061 T6, Size or Thickness, Notes, and stress values for 250°F and 300°F revised (8) For B241 A96061 T4, T6 welded, Specified Minimum Yield deleted and first four stress values revised (9) Under Drawn Seamless Condenser and Heat Exchanger Tube, for B234 A96061 T4, stress value for 250°F revised

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		(10) For B234 A96061 T6, stress values for 250°F and 300°F revised (11) For B234 A96061 T4, T6 welded, Specified Minimum Yield deleted and first four stress values revised
190, 191	Table A-7	(1) Under Arc-Welded Round Tube, eight B547 A96061 lines referencing Note (25) added (2) Under Sheet and Plate, for B209 A96061 T4, Size or Thickness and stress value for 250°F revised (3) For B209 A96061 T451, stress value for 250°F revised (4) For B209 A96061 T4 welded, Size or Thickness revised, Specified Minimum Yield deleted, and first four stress values revised (5) For B209 A96061 T451 welded, Specified Minimum Yield deleted and first four stress values revised (6) For B209 A96061 T6 and T651, stress value for 250°F revised (7) For B209 A96061 T6 welded and T651 welded, Specified Minimum Yield deleted and first four stress values revised
192, 193	Table A-7	(1) Under Die and Hand Forgings, for B247 A96061 T6, stress value for 250°F revised (2) For B247 A96061 T6 welded, Specified Minimum Yield deleted and first four stress values revised (3) Under Rods, Bars, and Shapes, for B221 A96061 T4 and T6, stress value for 250°F revised (4) For A96061 T4 welded and T6 welded, Specified Minimum Yield deleted and first four stress values revised
195	Table A-7	(1) Note (17) revised (2) Notes (24) and (25) added
208, 209	Table A-10	Under Stainless Steels, Austenitic, for A453 660, stress values for 200°F through 1,000°F added
233–235	Mandatory Appendix F	(1) For ASCE/SEI 7, newer edition added (2) Editions updated for ASTM A240/A240M, A312/A312M, A403/A403M, A479/A479M, A789/A789M, A790/A790M, A928/A928M, B166, B167, and B168 (3) Editions updated for 16 MSS standard practices (4) API 570 and ASME B31J added (5) List of organizations updated

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237–243	Mandatory Appendix G	(1) D_n, q, and ΔT deleted (2) References updated for D_o, d_n, f, N, N_E, N_i, P, S_c, S_h, S_{lp}, S_A, and SE (3) q_i added
298	IV-5.2	Second paragraph revised
	Table IV-5.2	SI units added
	IV-5.3	Revised
301	V-3.1	Revised
	V-4	First paragraph revised
302, 303	V-6	Revised in its entirety
309	V-10	Revised in its entirety
312	V-14	Added

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POWER PIPING

Chapter I
Scope and Definitions

100 GENERAL

This Power Piping Code is one of several Sections of the American Society of Mechanical Engineers 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. 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 an Addenda and will be revised yearly.

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, in 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, test, inspection, operation, and maintenance of piping systems.

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 or specially designed. It also includes hangers and supports and other equipment items necessary to prevent overstressing the pressure-containing components.

Rules governing piping for miscellaneous appurtenances, such as water columns, remote water level indicators, pressure gages, gage glasses, etc., are included within the scope of this Code, but the requirements for boiler appurtenances shall be in accordance with Section I of the ASME Boiler and Pressure Vessel Code, 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 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. (16)

(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 Figs. 100.1.2(A.1), 100.1.2(A.2), 100.1.2(B.1), 100.1.2(B.2), 100.1.2(B.3), and 100.1.2(C).

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 Section I of the ASME Boiler and Pressure Vessel Code. 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 Figs. PG-105.1 through PG-109 of Section I of the ASME Boiler and Pressure Vessel Code. 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 Section I of the