ASME B31.12-2023
(Revision of ASME B31.12-2019)

Hydrogen Piping and Pipelines

ASME Code for Pressure Piping, B31

AN AMERICAN NATIONAL STANDARD

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Two Park Avenue • New York, NY • 10016 USA

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This code or standard was developed under procedures accredited as meeting the criteria for American National Standards. The standards committee that approved the code or standard was balanced to ensure that individuals from competent and concerned interests had an opportunity to participate. The proposed code or standard was made available for public review and comment, which provided an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

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The endnotes and preamble in this document (if any) are part of this American National Standard.

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FOREWORD

Responding to an evident need and at the request of The American Society of Mechanical Engineers (ASME), the American Standards Association initiated Project B31 in March 1926, with ASME as sole administrative sponsor. The breadth of the field involved required that membership of the Sectional Committee be drawn from some 40 engineering societies, industries, government bureaus, institutes, and trade associations.

The initial publication in 1935 was the American Tentative Standard Code for Pressure Piping. Revisions from 1942 through 1955 were published as the American Standard Code for Pressure Piping, ASA B31.1. Then it was decided that the various industry sections, beginning with ASA B31.8-1955, Gas Transmission and Distribution Piping Systems, be published as separate documents. The first Petroleum Refinery Piping Code Section was designated ASA B31.3-1959. ASA B31.3 revisions were published in 1962 and 1966. Between 1967 and 1969, the American Standards Association became first the United States of America Standards Institute, then the American National Standards Institute. The Sectional Committee became American National Standards Committee B31, and the Code was renamed the American National Standard Code for Pressure Piping. The next B31.3 revision was designated ANSI B31.3-1973. Addenda were published through 1975. The Standards Committee was reorganized in 1978 as a Committee operating under ASME procedures with ANSI accreditation. It is now the ASME Code for Pressure Piping, B31 Committee. The Section committee structure remains essentially unchanged.

As a result of preliminary studies, it was concluded that gaps exist between existing piping and pipeline codes and standards, and hydrogen infrastructure applications. A Project Team was formed under the ASME B31 Standards Committee to develop a new B31.12 Code for hydrogen piping and pipelines. The Project Team was subsequently restructured under the B31 Standards Committee as a Section Committee.

Since the first edition, the B31.12 Code has applied to design, construction, operation, and maintenance requirements for piping, pipelines, and distribution systems in hydrogen service. Typical applications are power generation, process plants, refining, transportation, distribution, and automotive filling stations. This Code is composed of Part GR, General Requirements, including common requirements referenced by all other parts; Part IP, Industrial Piping; and Part PL, Pipelines, including distribution systems. These Parts incorporate information specific to hydrogen service and either reference or incorporate applicable parts of ASME B31.3, Process Piping; ASME B31.1, Power Piping; ASME B31.8, Gas Transmission and Distribution Piping Systems; ASME B31.8S, Managing System Integrity of Gas Pipelines; and Section VIII, Division 3 of the ASME Boiler and Pressure Vessel Code, where appropriate.

Material performance factors have been included to account for the adverse effects of hydrogen gas on the mechanical properties of carbon and low alloy steels operating within the hydrogen embrittlement range. Many materials included in ASME B31.3 have been omitted from ASME B31.12 tables due to their unsuitability for hydrogen service. Rules have been added for conversion or retrofit of existing pipeline and distribution systems from natural gas or petroleum to hydrogen service. Parts covering commercial, residential, and nonmetallic systems will be added in future editions. Material performance factors will be reevaluated as materials research data are developed and understanding of hydrogen embrittlement of carbon and low alloy steels increases.

ASME B31.12-2008 was approved by the American National Standards Institute on December 3, 2008.
ASME B31.12-2011 was approved by the American National Standards Institute on June 7, 2011.
ASME B31.12-2014 was approved by the American National Standards Institute on October 24, 2014.
ASME B31.12-2019 was approved by the American National Standards Institute on March 19, 2019.
ASME B31.12-2023 was approved by the American National Standards Institute on August 24, 2023.

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Code for Pressure Piping

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

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Revisions and Errata. The committee processes revisions to this Code on a continuous basis to incorporate changes that appear necessary or desirable as demonstrated by the experience gained from the application of the Code. Approved revisions will be published in the next edition of the Code.

In addition, the committee may post errata on the committee web page. Errata become effective on the date posted. Users can register on the committee web page to receive e-mail notifications of posted errata.

This Code is always open for comment, and the committee welcomes proposals for revisions. Such proposals should be as specific as possible, citing the paragraph number, the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent background information and supporting documentation.

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(a) The most common applications for cases are

(1) to permit early implementation of a revision based on an urgent need

(2) to provide alternative requirements

(3) to allow users to gain experience with alternative or potential additional requirements prior to incorporation directly into the Code

(4) to permit the use of a new material or process

(b) Users are cautioned that not all jurisdictions or owners automatically accept cases. Cases are not to be considered as approving, recommending, certifying, or endorsing any proprietary or specific design, or as limiting in any way the freedom of manufacturers, constructors, or owners to choose any method of design or any form of construction that conforms to the Code.

(c) A proposed case shall be written as a question and reply in the same format as existing cases. The proposal shall also include the following information:

(1) a statement of need and background information

(2) the urgency of the case (e.g., the case concerns a project that is underway or imminent)

(3) the Code and the paragraph, figure, or table number

(4) the editions of the Code to which the proposed case applies

(d) A case is effective for use when the public review process has been completed and it is approved by the cognizant supervisory board. Approved cases are posted on the committee web page.

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Interpretations are published in the ASME Interpretations Database at https://go.asme.org/Interpretations as they are issued.

Committee Meetings. The B31 Standards Committee regularly holds meetings that are open to the public. Persons wishing to attend any meeting should contact the secretary of the committee. Information on future committee meetings can be found on the committee web page at https://go.asme.org/B31committee.

INTRODUCTION

(23)

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 reflect the kinds of piping installations considered during its development, as follows:

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; 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, pumping, regulating, and metering stations

B31.5 Refrigeration Piping: 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 handling gaseous hydrogen and gaseous hydrogen mixtures

This is Code Section B31.12, Hydrogen Piping and Pipelines. Hereafter, in this Introduction and in the text of this Code Section B31.12, 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

– 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 99 Health Care Facilities: medical and laboratory gas systems

– 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.

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

ASME Committee B31 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 3 yr.

It is intended that this edition of Code Section B31.12 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.

Materials ordinarily are listed in the stress tables only when sufficient usage in piping within the scope of the Code has been shown. 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 the 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. GR-2.1.1(b).]

ASME B31.12-2023
SUMMARY OF CHANGES

Following approval by the ASME B31 Committee and ASME, and after public review, ASME B31.12-2023 was approved by the American National Standards Institute on August 24, 2023.

Mandatory Appendices V and VIII, noted as "in preparation" in previous editions, have been deleted. In addition, ASME B31.12-2023 includes the following changes identified by a margin note, **(23)**.

Page	*Location*	*Change*
xv	Introduction	Updated
1	GR-1.1	First sentence revised
16	GR-2.1.2	(1) In subpara. (b), first sentence added (2) Subparagraph (b)(6) editorially revised
14	Table GR-2.1.1-1	General Note (a) and Notes (2), (4), and (5) revised
16	Table GR-2.1.1-2	Revised in its entirety
18	Figure GR-2.1.2-1	Notes redesignated
19	Table GR-2.1.2-2	Notes revised
27	GR-3.1	Editorially revised
27	GR-3.2	Editorially revised
27	GR-3.2.3	In first paragraph, cross-reference to ASME BPVC updated
27	GR-3.2.5	Subparagraph (a)(1) editorially revised
35	GR-3.4.4	In subpara. (e), SI unit added
44	Table GR-3.5-1	Minimum preheat temperature required for carbon steel revised
48	GR-3.8.5	Subparagraph (d)(1) editorially revised
50	GR-3.9.2	Reinstated by errata
70	Chapter GR-6	Revised in its entirety
71	IP-1.1.2	Subparagraphs (b) and (c) revised
76	IP-2.2.10	Subparagraphs (c) and (d) revised
93	IP-5.3.5	Subparagraph (c) editorially revised
96	Chapter IP-6	Revised in its entirety
97	IP-7.2.3	Footnotes renumbered
105	IP-10.4.2	Revised
105	IP-10.4.2.1	Added
105	IP-10.4.2.2	Added
106	Table IP-10.4.2.2-1	Former Table IP-10.4.2-1 revised
106	IP-10.4.5.2	Revised in its entirety
109	IP-10.4.5.7	Subparagraphs (b)(1) through (b)(3) editorially revised
111	IP-10.7.2	Revised
113	PL-1.3	Subparagraph (e) revised
119	Table PL-2.5.2-1	Revised in its entirety
119	PL-2.5.3	In subpara. (h), cross-reference updated
120	Table PL-2.5.5-1	Revised in its entirety

Page	*Location*	*Change*
120	PL-2.6.2	(1) In subparas. (a) through (e), units deleted (2) Equation in subpara. (e) revised
121	PL-2.6.5	In subpara. (a), unit deleted
121	PL-2.6.6	In subpara. (a)(3), nomenclature revised
124	PL-3.2.1	SI units added
125	PL-3.2.2	SI units added
128	PL-3.7.1	Revised
129	Table PL-3.7.1-3	Celsius temperatures added
133	PL-3.7.3	In subparas. (a), (a)(1), (a)(2), and (b), SI units revised
134	PL-3.7.5	In subpara. (b), SI unit revised
135	PL-3.8	In subpara. (a), SI unit revised
136	PL-3.10.7	In subpara. (c), SI unit revised
137	PL-3.12.3	Revised
139	PL-3.13.5	Subparagraphs (a), (a)(1), (b), (c), (c)(1), and (c)(3) revised
143	PL-3.18.1	In subparas. (a), (b)(4), (b)(6), (c)(3), and (e)(2), SI units revised
144	PL-3.18.2	In subpara. (a)(2), SI units revised
144	PL-3.19	(1) Deleted and former para. PL-3.19.1 redesignated (2) Title and subparas. (a) and (b)(6) revised
144	PL-3.19.1	Former para. PL-3.19.2 redesignated and title revised
145	PL-3.19.2	(1) Former para. PL-3.19.3 redesignated (2) Title and first paragraph revised (3) Subparagraphs (g) through (h)(11) deleted and subsequent subparagraphs redesignated
145	PL-3.19.3	Former para. PL-3.19.4 redesignated
145	PL-3.19.4	Former para. PL-3.19.5 redesignated
145	PL-3.19.5	Former para. PL-3.19.6 redesignated
145	PL-3.19.6	Former para. PL-3.19.7 redesignated
146	PL-3.19.7	(1) Former para. PL-3.19.8 redesignated (2) In subpara. (b)(2)(-c), SI unit added
146	PL-3.21	In subpara. (i), SI unit revised
148	I-1.3.2.1	In subpara. (a), SI unit revised
153	Mandatory Appendix II	Revised
164	VII-3.3.2	SI units revised
164	VII-3.5.3	Former para. VII-3.5.2(d) redesignated
168	IX-1	Subparagraph (e) revised
170	Table IX-1A	(1) Note (55) redesignated as Note (4) (2) Notes (42) and (56) deleted
201	Table IX-1B	SMYS for API 5L, Grade X52, corrected by errata from 317 MPa to 359 MPa
208	Table IX-4	(1) Minimum temperature, °F, for stainless steel 14Cr-24Ni revised (2) Note (14) redesignated as Note (3)
218	A-2	Revised
218	A-2.2	First paragraph revised
219	Table A-2-1	Revised in its entirety

Page	*Location*	*Change*
219	A-2.4	(1) Second and third paragraphs revised (2) Last paragraph deleted
219	A-2.5	Revised in its entirety
219	A-2.6	First paragraph revised
220	A-2.10	Revised in its entirety
220	A-2.10.1	Added
221	A-2.13	Added
221	A-3.1.1	SI unit added
222	A-3.5	In subpara. (d), SI unit added
223	Figure A-3.5-1	In illustration (f), SI unit added
226	A-9.1.5	SI units added
230	C-1	SI unit added
234	E-1	Last sentence added
239	F-1	First sentence added
239	F-2.1	Editorially revised

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PART GR
GENERAL REQUIREMENTS

Chapter GR-1
Scope and Definitions

(23) GR-1.1 SCOPE

This Code is applicable to piping and pipelines handling gaseous hydrogen and gaseous hydrogen mixtures and to piping in liquid hydrogen service. This Code is applicable up to and including the joint connecting the piping to associated pressure vessels and equipment but not to the vessels and equipment themselves. It is applicable to the location and type of support elements but not to the structure to which the support elements are attached. The design for pressure and temperature shall be in accordance with the requirements of Part IP for industrial piping and Part PL for pipelines. This Code is presented in the following parts and appendices:

(a) Part GR — General Requirements. Part GR contains requirements applicable to and referenced by other parts. It contains definitions and requirements for materials, welding, brazing, heat treating, forming, testing, inspection, examination, operation, and maintenance. It also contains quality system topics common to the other parts.

(b) Part IP — Industrial Piping. Part IP includes requirements for components, design, fabrication, assembly, erection, inspection, examination, and testing of piping.

(c) Part PL — Pipelines. Part PL sets forth requirements for components, design, installation, and testing of hydrogen pipelines.

(d) Mandatory Appendices I through IX

(e) Nonmandatory Appendices A through F

Each part defines requirements for piping or pipelines, as applicable, within its scope. The requirements are different for different aspects of components, design, fabrication, installation, assembly, erection, inspection, examination, and testing. It is required that each part be used in conjunction with the General Requirements section but independent of the other parts. The joint connecting piping governed by two different parts shall be subject exclusively to the requirements of one of the two parts. It is not intended that this edition of this Code be applied retroactively to existing hydrogen systems.

GR-1.2 RESPONSIBILITIES

GR-1.2.1 Owner

The owner shall have overall responsibility for compliance with this Code and for establishing the requirements for design, construction, examination, inspection, testing, operation, and maintenance of the hydrogen piping or pipeline system.

GR-1.2.2 Designer

The designer is responsible to the owner for assurance that the engineering design of piping or the pipeline system complies with the requirements of this Code and with any additional requirements established by the owner.

GR-1.2.3 Construction Organization

The construction organization of piping and pipeline systems is responsible for providing materials, components, and workmanship in compliance with the requirements of this Code and the engineering design.

GR-1.2.4 Owner's Inspector

The owner's Inspector is responsible to the owner to verify that all required examinations, inspections, and testing are complete. The owner's Inspector verifies that all required certifications and records have been completed. Also, the owner's Inspector is responsible for verification of the construction organization's quality systems program implementation.

GR-1.3 INTENT OF THE CODE

(a) It is the intent of this Code to set forth engineering requirements deemed necessary for safe design, construction, and installation of piping and pipeline systems in hydrogen service.

(b) This Code generally specifies a simplified approach for many of its requirements. A designer may choose to use a more rigorous analysis to develop design and construction requirements. When the designer decides to take this