

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

# Hydrogen Piping and Pipelines

**ASME Code for Pressure Piping, B31**

**AN AMERICAN NATIONAL STANDARD**



**The American Society of  
Mechanical Engineers**

**ASME B31.12-2023**  
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**AN AMERICAN NATIONAL STANDARD**



**The American Society of  
Mechanical Engineers**

Two Park Avenue • New York, NY • 10016 USA

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# CONTENTS

Foreword .....		xi
Committee Roster .....		xi
Correspondence With the B31 Committee .....		xiii
Introduction .....		xv
Summary of Changes .....		xvii
<b>Part GR</b>	<b>General Requirements</b> .....	<b>1</b>
<b>Chapter GR-1</b>	<b>Scope and Definitions</b> .....	<b>1</b>
GR-1.1	Scope .....	1
GR-1.2	Responsibilities .....	1
GR-1.3	Intent of the Code .....	1
GR-1.4	Packaged Equipment Requirements .....	2
GR-1.5	Terms and Definitions .....	2
GR-1.6	ASME B31.12 Appendices .....	11
GR-1.7	Nomenclature .....	12
<b>Chapter GR-2</b>	<b>Materials</b> .....	<b>13</b>
GR-2.1	General Requirements .....	13
GR-2.2	Joining and Auxiliary Materials .....	26
<b>Chapter GR-3</b>	<b>Welding, Brazing, Heat Treating, Forming, and Testing</b> .....	<b>27</b>
GR-3.1	General .....	27
GR-3.2	Welding and Brazing .....	27
GR-3.3	Welding and Brazing Materials .....	30
GR-3.4	Construction of Weldments .....	30
GR-3.5	Preheating for Weldments .....	44
GR-3.6	Heat Treatment .....	45
GR-3.7	Specific and Alternative Heat Treat Requirements .....	47
GR-3.8	Construction of Brazements .....	47
GR-3.9	Forming of Pipe Components .....	49
GR-3.10	Hardness Testing .....	50
<b>Chapter GR-4</b>	<b>Inspection, Examination, and Testing</b> .....	<b>52</b>
GR-4.1	General .....	52
GR-4.2	Inspection .....	52
GR-4.3	Examination .....	52
GR-4.4	Personnel Qualification and Certification .....	53
GR-4.5	Extent of Required Examination and Testing .....	54
GR-4.6	Acceptance Criteria .....	54
GR-4.7	Supplementary Examination .....	54
GR-4.8	Examinations to Resolve Uncertainty .....	54
GR-4.9	Defective Components and Workmanship .....	54

GR-4.10	Progressive Sampling for Examination .....	54
GR-4.11	Testing .....	54
GR-4.12	Records .....	54
GR-4.13	NDE Definitions .....	54
<b>Chapter GR-5</b>	<b>Operation and Maintenance .....</b>	<b>56</b>
GR-5.1	General .....	56
GR-5.2	Operation and Maintenance Plan .....	56
GR-5.3	Maintenance Requirements .....	58
GR-5.4	Leakage Surveys .....	60
GR-5.5	Repair Procedures .....	60
GR-5.6	Injurious Dents and Mechanical Damage .....	61
GR-5.7	Permanent Repair of Welds With Defects .....	62
GR-5.8	Permanent Field Repair of Leaks and Nonleaking Corroded Areas .....	62
GR-5.9	Permanent Field Repair of Hydrogen Stress Cracking in Hard Spots and Stress Corrosion Cracking .....	62
GR-5.10	Testing and Examination of Repairs .....	62
GR-5.11	Valve Maintenance .....	63
GR-5.12	Transmission Pipeline Maintenance .....	63
GR-5.13	Abandoning of Transmission Facilities .....	64
GR-5.14	Decommissioning of Transmission Facilities .....	64
GR-5.15	Recommissioning of Transmission Facilities .....	64
GR-5.16	Repositioning a Pipeline in Service .....	64
GR-5.17	Testing for Integrity Assessment of In-Service Pipelines .....	65
GR-5.18	Distribution Pipeline Maintenance .....	66
GR-5.19	Leakage Surveys .....	66
GR-5.20	Leakage Investigation and Action .....	66
GR-5.21	Repair, Testing, and Examination of Pipelines Operating at Hoop Stress Levels at or Above 30% of the SMYS .....	67
GR-5.22	Requirements for Abandoning, Disconnecting, and Reinstating Distribution Facilities .....	67
GR-5.23	Maintenance of Specific Facilities .....	68
<b>Chapter GR-6</b>	<b>Quality System Program for Hydrogen Piping and Pipeline Systems .....</b>	<b>70</b>
GR-6.1	Quality System Program for Industrial Piping .....	70
GR-6.2	Quality System Program for Pipelines .....	70
<b>Part IP</b>	<b>Industrial Piping .....</b>	<b>71</b>
<b>Chapter IP-1</b>	<b>Scope and Responsibilities .....</b>	<b>71</b>
IP-1.1	Scope .....	71
IP-1.2	Responsibilities .....	71
IP-1.3	Intent .....	71
IP-1.4	Determining Code Requirements .....	71
<b>Chapter IP-2</b>	<b>Design Conditions and Criteria .....</b>	<b>72</b>
IP-2.1	Design Conditions .....	72
IP-2.2	Design Criteria .....	73
<b>Chapter IP-3</b>	<b>Pressure Design of Piping Components .....</b>	<b>79</b>
IP-3.1	General .....	79
IP-3.2	Straight Pipe .....	79
IP-3.3	Curved and Mitered Segments of Pipe .....	80

IP-3.4	Branch Connections	81
IP-3.5	Closures	87
IP-3.6	Pressure Design of Flanges and Blanks	88
IP-3.7	Reducers	88
IP-3.8	Pressure Design of Other Components	88
<b>Chapter IP-4</b>	<b>Service Requirements for Piping Components</b>	<b>91</b>
IP-4.1	Valves and Specialty Components	91
IP-4.2	Bolting and Tapped Holes for Components	91
<b>Chapter IP-5</b>	<b>Service Requirements for Piping Joints</b>	<b>92</b>
IP-5.1	Scope	92
IP-5.2	Welded Joints	92
IP-5.3	Flanged Joints	92
IP-5.4	Expanded Joints	93
IP-5.5	Threaded Joints	94
IP-5.6	Caulked Joints	94
IP-5.7	Brazed and Soldered Joints	95
IP-5.8	Special Joints	95
<b>Chapter IP-6</b>	<b>Flexibility and Support</b>	<b>96</b>
IP-6.1	Analysis of Displacement Loads	96
IP-6.2	Analysis of Sustained Loads	96
IP-6.3	Piping Support	96
<b>Chapter IP-7</b>	<b>Specific Piping Systems</b>	<b>97</b>
IP-7.1	Instrument Piping	97
IP-7.2	Pressure-Relieving Systems	97
<b>Chapter IP-8</b>	<b>Dimensions and Ratings of Components</b>	<b>98</b>
IP-8.1	Dimensional Requirements	98
IP-8.2	Ratings of Components	98
IP-8.3	Reference Documents	98
<b>Chapter IP-9</b>	<b>Fabrication, Erection, and Assembly</b>	<b>101</b>
IP-9.1	General	101
IP-9.2	Responsibility	101
IP-9.3	Content and Coverage	101
IP-9.4	Packaged Equipment Piping	101
IP-9.5	Exclusions	101
IP-9.6	Fabrication and Erection	101
IP-9.7	Construction of Weldments	101
IP-9.8	Preheating for Weldments	102
IP-9.9	Heat Treatment	102
IP-9.10	Specific and Alternative Heat Treatment Requirements	102
IP-9.11	Construction of Brazements	102
IP-9.12	Bending and Forming of Pipe and Tube	102
IP-9.13	Assembly and Erection	103
IP-9.14	Threaded Joints	103
IP-9.15	Tubing Joints	103
IP-9.16	Expanded Joints and Special Joints	103

IP-9.17	Pipe Attachments and Supports . . . . .	103
IP-9.18	Cleaning of Piping . . . . .	103
<b>Chapter IP-10</b>	<b>Inspection, Examination, and Testing . . . . .</b>	<b>105</b>
IP-10.1	Scope . . . . .	105
IP-10.2	Responsibility . . . . .	105
IP-10.3	Inspections by Owner's Inspector . . . . .	105
IP-10.4	Examination Requirements . . . . .	105
IP-10.5	Testing . . . . .	109
IP-10.6	Hydrostatic Leak Test . . . . .	111
IP-10.7	Pneumatic Leak Test . . . . .	111
IP-10.8	Hydrostatic-Pneumatic Leak Test . . . . .	112
IP-10.9	Sensitive Leak Test . . . . .	112
IP-10.10	Alternative Leak Test . . . . .	112
IP-10.11	Mechanical and Metallurgical Testing . . . . .	112
IP-10.12	Records of Testing . . . . .	112
<b>Part PL</b>	<b>Pipelines . . . . .</b>	<b>113</b>
<b>Chapter PL-1</b>	<b>Scope and Exclusions . . . . .</b>	<b>113</b>
PL-1.1	Scope . . . . .	113
PL-1.2	Content and Coverage . . . . .	113
PL-1.3	Exclusions . . . . .	113
<b>Chapter PL-2</b>	<b>Pipeline Systems Components and Fabrication Details . . . . .</b>	<b>114</b>
PL-2.1	Purpose . . . . .	114
PL-2.2	Piping System Components . . . . .	114
PL-2.3	Reinforcement of Fabricated Branch Connections . . . . .	116
PL-2.4	Multiple Openings and Extruded Outlets . . . . .	118
PL-2.5	Expansion and Flexibility . . . . .	119
PL-2.6	Design for Longitudinal Stress . . . . .	119
PL-2.7	Supports and Anchorage for Aboveground Piping . . . . .	122
PL-2.8	Anchorage for Buried Piping . . . . .	122
<b>Chapter PL-3</b>	<b>Design, Installation, and Testing . . . . .</b>	<b>124</b>
PL-3.1	Provisions for Design . . . . .	124
PL-3.2	Buildings Intended for Human Occupancy . . . . .	124
PL-3.3	Considerations Necessary for Concentrations of People in Location Class 1 or Class 2 . . . . .	125
PL-3.4	Intent . . . . .	125
PL-3.5	Risk Assessment . . . . .	126
PL-3.6	Location Class and Changes in Number of Buildings Intended for Human Occupancy . . . . .	126
PL-3.7	Steel Pipeline . . . . .	128
PL-3.8	Hot Taps . . . . .	135
PL-3.9	Precautions to Prevent Combustion of Hydrogen-Air Mixtures During Construction Operations . . . . .	135
PL-3.10	Testing After Construction . . . . .	136
PL-3.11	Commissioning of Facilities . . . . .	137
PL-3.12	Pipe-Type and Bottle-Type Holders . . . . .	137
PL-3.13	Control and Limiting of Hydrogen Gas Pressure . . . . .	138
PL-3.14	Upgrading . . . . .	140

PL-3.15	Valves . . . . .	141
PL-3.16	Vault Provisions for Design, Construction, and Installation of Pipeline Components . . . .	142
PL-3.17	Location for Customers' Meter and Regulator Installations . . . . .	143
PL-3.18	Hydrogen Gas Service Lines . . . . .	143
PL-3.19	Installation Inspection . . . . .	144
PL-3.20	Repair or Removal of Defective Welds in Piping Intended to Operate at Hoop Stress Levels of 20% or More of the SMYS . . . . .	144
PL-3.21	Steel Pipeline Service Conversions . . . . .	146

**Mandatory Appendices**

I	Design of Aboveground Hydrogen Gas Pipeline Facilities . . . . .	148
II	Reference Standards . . . . .	153
III	Safeguarding . . . . .	156
IV	Nomenclature . . . . .	158
VII	Gas Leakage and Control Criteria . . . . .	163
IX	Allowable Stresses and Quality Factors for Metallic Piping, Pipeline, and Bolting Materials	168

**Nonmandatory Appendices**

A	Precautionary Considerations . . . . .	218
B	Alternative Rules for Evaluating Stress Range . . . . .	228
C	Recommended Practices for Proof Testing of Pipelines in Place . . . . .	230
D	Estimating Strain in Dents . . . . .	233
E	Sample Calculations for Branch Reinforcement of Piping . . . . .	234
F	Welded Branch Connections and Extruded Headers in Pipeline Systems . . . . .	239
G	Guideline for Higher Fracture Toughness Steel in Gaseous Hydrogen Service for Pipelines and Piping Systems . . . . .	245

**Figures**

GR-2.1.2-1	Minimum Temperature Without Impact Testing for Carbon Steel Materials . . . . .	18
GR-2.1.2-2	Reduction in Minimum Design Metal Temperature Without Impact Testing . . . . .	21
GR-3.4.3-1	Geometry of Weld Joint Detail Single Vee Groove Butt With Extended Land . . . . .	32
GR-3.4.3-2	Geometry of Weld Joint Detail Square Butt Weld . . . . .	32
GR-3.4.3-3	Geometry of Weld Joint Detail Single Vee Groove Butt, Open Root . . . . .	32
GR-3.4.3-4	Unequal Pipe Component Thicknesses, Thicker Components Bored for Alignment . . . . .	33
GR-3.4.3-5	Unequal Pipe Component Thicknesses, Thicker Components Taper-Bored to Align . . . . .	33
GR-3.4.3-6	Geometry of Weld Joint Detail Single Vee Groove Butt, Continuous Flat Backing Ring . . . . .	33
GR-3.4.3-7	Geometry of Weld Joint Detail Single Vee Groove Butt, Continuous Tapered Backing Ring . . . . .	34
GR-3.4.3-8	Geometry of Weld Joint Detail Single Vee Groove Butt, Consumable Insert . . . . .	34
GR-3.4.3-9	Preparation and Alignment of Pipe Branch to Pipe Header Connection . . . . .	34
GR-3.4.4-1	Geometry of Weld Deposit Single Vee Groove Butt, Open Root . . . . .	36
GR-3.4.4-2	Geometry of Weld Deposit Root Single Vee Groove Butt With Extended Land (Without Filler Metal) . . . . .	36
GR-3.4.4-3	Geometry of Weld Deposit Square Butt End (Without Filler Metal) . . . . .	36
GR-3.4.5-1	Welding End Transition — Maximum Envelope . . . . .	37
GR-3.4.6-1	Geometry of Weld Deposit Single Vee Groove Butt, Open Root With Concavity . . . . .	38
GR-3.4.7-1	Fillet Weld Size . . . . .	40

GR-3.4.7-2	Typical Details for Double-Welded Slip-On Flanges . . . . .	40
GR-3.4.7-3	Minimum Welding Dimensions for Socket Welding Components to Pipe Including Fit-Up Detail . . . . .	41
GR-3.4.9-1	Typical Welded Branch Connections . . . . .	41
GR-3.4.9-2	Acceptable Details for Pipe Branch Attachment Welds . . . . .	42
GR-3.4.9-3	Acceptable Detail for Branch Connection of Pipe Fitting . . . . .	43
GR-3.4.9-4	Acceptable Details for Branch Attachment Suitable for 100% Radiography . . . . .	43
GR-3.8-1	Joints for Tubular Components . . . . .	48
GR-3.10-1	Location of Vickers Hardness Indentations . . . . .	51
IP-3.3.1-1	Nomenclature for Pipe Bends . . . . .	80
IP-3.3.3-1	Nomenclature for Miter Bends . . . . .	80
IP-3.4.2-1	Branch Connection Nomenclature . . . . .	83
IP-3.4.3-1	Extruded Outlet Header Nomenclature . . . . .	85
IP-3.6.3-1	Blanks . . . . .	89
IP-9.14-1	Typical Threaded Joints Using Straight Threads . . . . .	104
A-3.5-1	Weld Quality Illustrations for Autogenous Welded Pipe or Tube . . . . .	223
D-1-1	Method for Estimating Strain in Dents . . . . .	233
E-2-1	Illustrations for Examples in Nonmandatory Appendix E . . . . .	235
F-1-1	. . . . .	240
F-1-2	. . . . .	240
F-1-3	. . . . .	241
F-1-4	. . . . .	241
F-2.1-1	. . . . .	242
F-2.1.5-1	. . . . .	243
F-2.2-1	. . . . .	244
 <b>Tables</b>		
GR-2.1.1-1	Material Specification Index for Piping and Pipe Components . . . . .	14
GR-2.1.1-2	Material Specification Index for Pipelines . . . . .	16
GR-2.1.2-1	Requirements for Low Temperature Toughness Tests for Metals . . . . .	17
GR-2.1.2-2	Tabular Values for Maximum Temperatures Without Impact Testing for Carbon Steel Materials . . . . .	19
GR-2.1.3-1	Impact Testing Requirements for Metals . . . . .	22
GR-2.1.3-2	Charpy Impact Test Temperature Reduction . . . . .	23
GR-2.1.3-3	Minimum Required Charpy V-Notch Impact Values . . . . .	24
GR-3.4.6-1	Weld Reinforcement . . . . .	38
GR-3.5-1	Postheat Temperatures . . . . .	44
GR-3.6.1-1	Requirements for Postweld Heat Treatment of Weldments . . . . .	45
GR-3.10-1	Hardness Testing Acceptance Criteria . . . . .	50
IP-2.2.1-1	Increased Casting Quality Factors, $E_c$ . . . . .	76
IP-2.2.2-2	Acceptance Levels for Castings . . . . .	77
IP-2.2.9-1	Longitudinal Weld Joint Quality Factor, $E_j$ . . . . .	78
IP-3.2-1	Values of Coefficient $Y$ for $t < D/6$ . . . . .	79
IP-3.5-1	ASME BPVC, Section VIII, Division 1 References for Closures . . . . .	87
IP-8.1.1-1	Component Standards . . . . .	99
IP-10.4.2.2-1	Required Nondestructive Examinations Other Than VT . . . . .	106

IP-10.4.3-1	Acceptance Criteria for Weldments and Methods for Evaluating Weld Imperfections . . .	107
IP-10.4.3-2	Hardness Testing Acceptance Criteria for Weldments . . . . .	108
IP-10.4.3-3	Criterion Value Notes for Table IP-10.4.3-1 . . . . .	108
PL-2.3.2-1	Reinforcement of Fabricated Branch Connections, Special Requirements . . . . .	118
PL-2.5.2-1	Thermal Expansion of Carbon and Low Alloy Steel . . . . .	119
PL-2.5.5-1	Modulus of Elasticity for Carbon and Low Alloy Steel . . . . .	120
PL-3.6.1-1	Location Class . . . . .	121
PL-3.7.1-1	Basic Design Factor, $F$ (Used With Option A) . . . . .	128
PL-3.7.1-2	Basic Design Factor, $F$ (Used With Option B) . . . . .	129
PL-3.7.1-3	Temperature Derating Factor, $T$ , for Steel Pipe . . . . .	129
PL-3.7.1-4	Nominal Chemical Composition Within a Specification/Grade . . . . .	130
PL-3.7.1-5	Material Constants for Fatigue Crack Growth Rate, $da/dN$ . . . . .	131
PL-3.7.1-6	Design Factors for Steel Pipe Construction (Used With Option A) . . . . .	132
PL-3.7.1-7	Design Factors for Steel Pipe Construction (Used With Option B) . . . . .	132
PL-3.7.5-1	Maximum Degree of Bending . . . . .	134
VII-5.3-1	Leak Classification and Action Criteria: Grade 1 . . . . .	166
VII-5.3-2	Leak Classification and Action Criteria: Grade 2 . . . . .	166
VII-5.3-3	Leak Classification and Action Criteria: Grade 3 . . . . .	167
IX-1A	Basic Allowable Stresses in Tension for Metal Piping Materials . . . . .	170
IX-1B	SMYS for Steel Pipe Commonly Used in Pipeline Systems . . . . .	201
IX-2	Basic Casting Quality Factors, $E_c$ . . . . .	202
IX-3A	Basic Quality Factors for Longitudinal Weld Joints in Pipes, Tubes, and Fittings, $E_j$ . . . .	203
IX-3B	Longitudinal Joints Factors for Pipeline Materials . . . . .	206
IX-4	Design Stress Values for Bolting Materials . . . . .	208
IX-5A	Carbon Steel Pipeline Materials Performance Factor, $H_f$ . . . . .	217
IX-5B	Carbon Steel Piping Materials Performance Factor, $M_f$ . . . . .	217
IX-5C	Low and Intermediate Alloy Steel Performance Factor, $M_f$ . . . . .	217
A-2-1	Materials Compatible With Hydrogen Service . . . . .	219

# 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.

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# 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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**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.

### Cases

(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.

**Interpretations.** Upon request, the committee will issue an interpretation of any requirement of this Code. An interpretation can be issued only in response to a request submitted through the online Interpretation Submittal Form at <https://go.asme.org/InterpretationRequest>. Upon submitting the form, the inquirer will receive an automatic e-mail confirming receipt.

ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Code requirements. If, based on the information submitted, it is the opinion of the committee that the inquirer should seek assistance, the request will be returned with the recommendation that such assistance be obtained. Inquirers can track the status of their requests at <https://go.asme.org/Interpretations>.

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# 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)**.

<i>Page</i>	<i>Location</i>	<i>Change</i>
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

<i>Page</i>	<i>Location</i>	<i>Change</i>
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

<i>Page</i>	<i>Location</i>	<i>Change</i>
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

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### 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