

ASME B31.3-2008
(Revision of ASME B31.3-2006)

Process Piping

ASME Code for Pressure Piping, B31

AN AMERICAN NATIONAL STANDARD



**The American Society of
Mechanical Engineers**



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CONTENTS

Foreword	xi
Committee Personnel	xiii
Introduction	xvii
Summary of Changes	xix
Chapter I Scope and Definitions	1
300 General Statements	1
Chapter II Design	10
Part 1 Conditions and Criteria	10
301 Design Conditions	10
302 Design Criteria	12
Part 2 Pressure Design of Piping Components	18
303 General	18
304 Pressure Design of Components	20
Part 3 Fluid Service Requirements for Piping Components	30
305 Pipe	30
306 Fittings, Bends, Miters, Laps, and Branch Connections	30
307 Valves and Specialty Components	32
308 Flanges, Blanks, Flange Facings, and Gaskets	32
309 Bolting	33
Part 4 Fluid Service Requirements for Piping Joints	33
310 General	33
311 Welded Joints	33
312 Flanged Joints	34
313 Expanded Joints	34
314 Threaded Joints	34
315 Tubing Joints	35
316 Caulked Joints	35
317 Soldered and Brazed Joints	35
318 Special Joints	35
Part 5 Flexibility and Support	36
319 Piping Flexibility	36
321 Piping Support	41
Part 6 Systems	43
322 Specific Piping Systems	43
Chapter III Materials	45
323 General Requirements	45
325 Materials — Miscellaneous	54
Chapter IV Standards for Piping Components	55
326 Dimensions and Ratings of Components	55
Chapter V Fabrication, Assembly, and Erection	58
327 General	58
328 Welding	58
330 Preheating	64
331 Heat Treatment	65
332 Bending and Forming	69
333 Brazing and Soldering	70
335 Assembly and Erection	70



Chapter VI	Inspection, Examination, and Testing	72
340	Inspection	72
341	Examination	72
342	Examination Personnel	79
343	Examination Procedures	79
344	Types of Examination	79
345	Testing	80
346	Records	83
Chapter VII	Nonmetallic Piping and Piping Lined With Nonmetals	84
A300	General Statements	84
Part 1	Conditions and Criteria	84
A301	Design Conditions	84
A302	Design Criteria	84
Part 2	Pressure Design of Piping Components	86
A303	General	86
A304	Pressure Design of Piping Components	86
Part 3	Fluid Service Requirements for Piping Components	87
A305	Pipe	87
A306	Fittings, Bends, Miters, Laps, and Branch Connections	87
A307	Valves and Specialty Components	88
A308	Flanges, Blanks, Flange Facings, and Gaskets	88
A309	Bolting	88
Part 4	Fluid Service Requirements for Piping Joints	88
A310	General	88
A311	Bonded Joints in Plastics	88
A312	Flanged Joints	89
A313	Expanded Joints	89
A314	Threaded Joints	89
A315	Tubing Joints	89
A316	Caulked Joints	89
A318	Special Joints	89
Part 5	Flexibility and Support	90
A319	Flexibility of Nonmetallic Piping	90
A321	Piping Support	91
Part 6	Systems	91
A322	Specific Piping Systems	91
Part 7	Materials	92
A323	General Requirements	92
A325	Materials — Miscellaneous	93
Part 8	Standards for Piping Components	93
A326	Dimensions and Ratings of Components	93
Part 9	Fabrication, Assembly, and Erection	94
A327	General	94
A328	Bonding of Plastics	94
A329	Fabrication of Piping Lined With Nonmetals	100
A332	Bending and Forming	100
A334	Joining Nonplastic Piping	100
A335	Assembly and Erection	100
Part 10	Inspection, Examination, and Testing	101
A340	Inspection	101
A341	Examination	101
A342	Examination Personnel	102
A343	Examination Procedures	102



A344	Types of Examination	102
A345	Testing	103
A346	Records	103
Chapter VIII	Piping for Category M Fluid Service	104
M300	General Statements	104
Part 1	Conditions and Criteria	104
M301	Design Conditions	104
M302	Design Criteria	104
Part 2	Pressure Design of Metallic Piping Components	105
M303	General	105
M304	Pressure Design of Metallic Components	105
Part 3	Fluid Service Requirements for Metallic Piping Components	105
M305	Pipe	105
M306	Metallic Fittings, Bends, Miters, Laps, and Branch Connections	105
M307	Metallic Valves and Specialty Components	105
M308	Flanges, Blanks, Flange Facings, and Gaskets	106
M309	Bolting	106
Part 4	Fluid Service Requirements for Metallic Piping Joints	106
M310	Metallic Piping, General	106
M311	Welded Joints in Metallic Piping	106
M312	Flanged Joints in Metallic Piping	106
M313	Expanded Joints in Metallic Piping	106
M314	Threaded Joints in Metallic Piping	106
M315	Tubing Joints in Metallic Piping	106
M316	Caulked Joints	106
M317	Soldered and Brazed Joints	106
M318	Special Joints in Metallic Piping	106
Part 5	Flexibility and Support of Metallic Piping	107
M319	Flexibility of Metallic Piping	107
M321	Piping Support	107
Part 6	Systems	107
M322	Specific Piping Systems	107
Part 7	Metallic Materials	107
M323	General Requirements	107
M325	Material – Miscellaneous	107
Part 8	Standards for Piping Components	107
M326	Dimensions and Ratings of Components	107
Part 9	Fabrication, Assembly, and Erection of Metallic Piping	108
M327	General	108
M328	Welding of Metals	108
M330	Preheating of Metals	108
M331	Heat Treatment of Metals	108
M332	Bending and Forming of Metals	108
M335	Assembly and Erection of Metallic Piping	108
Part 10	Inspection, Examination, Testing, and Records of Metallic Piping	108
M340	Inspection	108
M341	Examination	108
M342	Examination Personnel	109
M343	Examination Procedures	109
M344	Types of Examination	109
M345	Testing	109
M346	Records	109



Parts 11 Through 20, Corresponding to Chapter VII	109
MA300 General Statements	109
Part 11 Conditions and Criteria	109
MA301 Design Conditions	109
MA302 Design Criteria	109
Part 12 Pressure Design of Nonmetallic Piping Components	109
MA303 General	109
MA304 Pressure Design of Nonmetallic Components	109
Part 13 Fluid Service Requirements for Nonmetallic Piping Components	109
MA305 Pipe	109
MA306 Nonmetallic Fittings, Bends, Miters, Laps, and Branch Connections	109
MA307 Valves and Specialty Components	109
MA308 Flanges, Blanks, Flange Facings, and Gaskets	110
MA309 Bolting	110
Part 14 Fluid Service Requirements for Nonmetallic Piping Joints	110
MA310 General	110
MA311 Bonded Joints	110
MA312 Flanged Joints	110
MA313 Expanded Joints	110
MA314 Threaded Joints	110
MA315 Tubing Joints in Nonmetallic Piping	110
MA316 Caulked Joints	110
MA318 Special Joints	110
Part 15 Flexibility and Support of Nonmetallic Piping	110
MA319 Piping Flexibility	110
MA321 Piping Support	110
Part 16 Nonmetallic and Nonmetallic Lined Systems	110
MA322 Specific Piping Systems	110
Part 17 Nonmetallic Materials	110
MA323 General Requirements	110
Part 18 Standards for Nonmetallic and Nonmetallic Lined Piping Components	110
MA326 Dimensions and Ratings of Components	110
Part 19 Fabrication, Assembly, and Erection of Nonmetallic and Nonmetallic Lined Piping	110
MA327 General	110
MA328 Bonding of Plastics	111
MA329 Fabrication of Piping Lined With Nonmetals	111
MA332 Bending and Forming	111
MA334 Joining of Nonplastic Piping	111
MA335 Assembly and Erection	111
Part 20 Inspection, Examination, Testing, and Records of Nonmetallic and Nonmetallic Lined Piping	111
MA340 Inspection	111
MA341 Examination	111
MA342 Examination Personnel	111
MA343 Examination Procedures	111
MA344 Types of Examination	111
MA345 Testing	111
MA346 Records	111
Chapter IX High Pressure Piping	112
K300 General Statements	112
Part 1 Conditions and Criteria	112
K301 Design Conditions	112
K302 Design Criteria	113



Part 2	Pressure Design of Piping Components	115
K303	General	115
K304	Pressure Design of High Pressure Components	115
Part 3	Fluid Service Requirements for Piping Components	119
K305	Pipe	119
K306	Fittings, Bends, and Branch Connections	119
K307	Valves and Specialty Components	119
K308	Flanges, Blanks, Flange Facings, and Gaskets	119
K309	Bolting	120
Part 4	Fluid Service Requirements for Piping Joints	120
K310	General	120
K311	Welded Joints	120
K312	Flanged Joints	120
K313	Expanded Joints	120
K314	Threaded Joints	120
K315	Tubing Joints	121
K316	Caulked Joints	121
K317	Soldered and Brazed Joints	121
K318	Special Joints	121
Part 5	Flexibility and Support	121
K319	Flexibility	121
K321	Piping Support	121
Part 6	Systems	121
K322	Specific Piping Systems	121
Part 7	Materials	122
K323	General Requirements	122
K325	Miscellaneous Materials	126
Part 8	Standards for Piping Components	126
K326	Dimensions and Ratings of Components	126
Part 9	Fabrication, Assembly, and Erection	127
K327	General	127
K328	Welding	127
K330	Preheating	129
K331	Heat Treatment	130
K332	Bending and Forming	130
K333	Brazing and Soldering	131
K335	Assembly and Erection	131
Part 10	Inspection, Examination, and Testing	131
K340	Inspection	131
K341	Examination	131
K342	Examination Personnel	133
K343	Examination Procedures	133
K344	Types of Examination	133
K345	Leak Testing	134
K346	Records	135
Appendices		
300.1.1	Diagram Illustrating Application of B31.3 Piping at Equipment	3
302.3.5	Stress Range Factor, f	17
304.2.1	Nomenclature for Pipe Bends	21
304.2.3	Nomenclature for Miter Bends	21
304.3.3	Branch Connection Nomenclature	23
304.3.4	Extruded Outlet Header Nomenclature	25
304.5.3	Blanks	29
319.4.4A	Moments in Bends	39
319.4.4B	Moments in Branch Connections	39



323.2.2A	Minimum Temperatures Without Impact Testing for Carbon Steel Materials	48
323.2.2B	Reduction in Minimum Design Metal Temperature Without Impact Testing	50
328.3.2	Typical Backing Rings and Consumable Inserts	60
328.4.2	Typical Butt Weld End Preparation	60
328.4.3	Trimming and Permitted Misalignment	60
328.4.4	Preparation for Branch Connections	61
328.5.2A	Fillet Weld Size	62
328.5.2B	Typical Details for Double-Welded Slip-On and Socket Welding Flange Attachment Welds	62
328.5.2C	Minimum Welding Dimensions for Socket Welding Components Other Than Flanges	63
328.5.4A	Typical Welded Branch Connections	63
328.5.4B	Typical Welded Branch Connections	63
328.5.4C	Typical Welded Branch Connections	63
328.5.4D	Acceptable Details for Branch Attachment Welds	63
328.5.4E	Acceptable Details for Branch Attachment Suitable for 100% Radiography	64
328.5.5	Typical Fabricated Laps	64
335.3.3	Typical Threaded Joints Using Straight Threads	71
341.3.2	Typical Weld Imperfections	76
A328.5	Typical Plastic Piping Joints	99
K323.3.3	Example of an Acceptable Impact Test Specimen	125
K328.4.3	Pipe Bored for Alignment: Trimming and Permitted Misalignment	128
K328.5.4	Some Acceptable Welded Branch Connection Suitable for 100% Radiography	129
Tables		
300.4	Status of Appendices in B31.3	9
302.3.3C	Increased Casting Quality Factors, E_c	15
302.3.3D	Acceptance Levels for Castings	15
302.3.4	Longitudinal Weld Joint Quality Factor, E_j	16
302.3.5	Weld Joint Strength Reduction Factor, W	19
304.1.1	Values of Coefficient Y for $t \leq D/6$	20
304.4.1	BPV Code References for Closures	27
308.2.1	Permissible Size/ Rating Classes for Slip-On Flanges Used as Lapped Flanges	32
314.2.1	Minimum Thickness of Male Threaded Components	35
323.2.2	Requirements for Low Temperature Toughness Tests for Metals	46
323.2.2A	Tabular Values for Minimum Temperatures Without Impact Testing for Carbon Steel Materials	49
323.3.1	Impact Testing Requirements for Metals	51
323.3.4	Charpy Impact Test Temperature Reduction	52
323.3.5	Minimum Required Charpy V-Notch Impact Values	53
326.1	Component Standards	56
330.1	Preheat Temperatures	66
331.1	Requirements for Heat Treatment	67
341.3.2	Acceptance Criteria for Welds and Examination Methods for Evaluating Weld Imperfections	73
A323.2.2	Requirements for Low Temperature Toughness Tests for Nonmetals	93
A323.4.2C	Recommended Temperature Limits for Reinforced Thermosetting Resin Pipe	93
A323.4.3	Recommended Temperature Limits for Thermoplastics Used as Linings	94
A326.1	Component Standards	95
A341.3.2	Acceptance Criteria for Bonds	102



K302.3.3D	Acceptable Severity Levels for Steel Castings	115
K305.1.2	Required Ultrasonic or Eddy Current Examination of Pipe and Tubing for Longitudinal Defects	119
K323.3.1	Impact Testing Requirements	124
K323.3.5	Minimum Required Charpy V-Notch Impact Values	126
K326.1	Component Standards	127
K341.3.2	Acceptance Criteria for Welds	132

Appendices

A	Allowable Stresses and Quality Factors for Metallic Piping and Bolting	
	Materials	137
	Specification Index for Appendix A	137
	Notes for Appendix A Tables	141
	Table A-1 Basic Allowable Stresses in Tension for Metals	145
	Iron	
	Castings	145
	Carbon Steel	
	Pipes and Tubes	146
	Pipes (Structural Grade)	150
	Plates, Bars, Shapes, and Sheets	150
	Plates, Bars, Shapes, and Sheets (Structural)	152
	Forgings and Fittings	152
	Castings	152
	Low and Intermediate Alloy Steel	
	Pipes	154
	Plates	156
	Forgings and Fittings	158
	Castings	160
	Stainless Steel	
	Pipes and Tubes	162
	Plates and Sheets	166
	Forgings and Fittings	168
	Bar	172
	Castings	172
	Copper and Copper Alloy	
	Pipes and Tubes	174
	Plates and Sheets	174
	Forgings	176
	Castings	176
	Nickel and Nickel Alloy	
	Pipes and Tubes	178
	Plates and Sheets	180
	Forgings and Fittings	182
	Rod and Bar	184
	Castings	184
	Titanium and Titanium Alloy	
	Pipes and Tubes	186
	Plates and Sheets	186
	Forgings	186
	Zirconium and Zirconium Alloy	
	Pipes and Tubes	186
	Plates and Sheets	186
	Forgings and Bar	186
	Aluminum Alloy	
	Seamless Pipes and Tubes	188
	Welded Pipes and Tubes	189
	Structural Tubes	189



	Plates and Sheets	190
	Forgings and Fittings	192
	Castings	193
	Table A-1A Basic Casting Quality Factors, E_c	194
	Table A-1B Basic Quality Factors for Longitudinal Weld Joints in Pipes, Tubes, and Fittings, E_j	195
	Carbon Steel	195
	Low and Intermediate Alloy Steel	195
	Stainless Steel	196
	Copper and Copper Alloy	196
	Nickel and Nickel Alloy	197
	Titanium and Titanium Alloy	197
	Zirconium and Zirconium Alloy	197
	Aluminum Alloy	197
	Table A-2 Design Stress Values for Bolting Materials	198
	Carbon Steel	198
	Alloy Steel	198
	Stainless Steel	198
	Copper and Copper Alloy	204
	Nickel and Nickel Alloy	204
	Aluminum Alloy	206
B	Stress Tables and Allowable Pressure Tables for Nonmetals	208
C	Physical Properties of Piping Materials	213
D	Flexibility and Stress Intensification Factors	228
E	Reference Standards	232
F	Precautionary Considerations	238
G	Safeguarding	242
H	Sample Calculations for Branch Reinforcement	243
J	Nomenclature	247
K	Allowable Stresses for High Pressure Piping	260
L	Aluminum Alloy Pipe Flanges	274
M	Guide to Classifying Fluid Services	277
P	Alternative Rules for Evaluating Stress Range	279
Q	Quality System Program	281
S	Piping System Stress Analysis Examples	282
V	Allowable Variations in Elevated Temperature Service	295
X	Metallic Bellows Expansion Joints	298
Z	Preparation of Technical Inquiries	303
Index	304



FOREWORD

(08)

Responding to evident need and at the request of The American Society of Mechanical Engineers, 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.

Initial publication in 1935 was as the American Tentative Standard Code for Pressure Piping. Revisions from 1942 through 1955 were published as American Standard Code for Pressure Piping, ASA B31.1. It was then decided to publish as separate documents the various industry Sections, beginning with ASA B31.8-1955, Gas Transmission and Distribution Piping Systems. The first Petroleum Refinery Piping Code Section was designated ASA B31.3-1959. ASA B31.3 revisions were published in 1962 and 1966.

In 1967–1969, 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.

A draft Code Section for Chemical Plant Piping, prepared by Section Committee B31.6, was ready for approval in 1974. It was decided, rather than have two closely related Code Sections, to merge the Section Committees and develop a joint Code Section, titled Chemical Plant and Petroleum Refinery Piping. The first edition was published as ANSI B31.3-1976.

In this Code, responsibility for piping design was conceptually integrated with that for the overall processing facility, with safeguarding recognized as an effective safety measure. Three categories of Fluid Service were identified, with a separate Chapter for Category M Fluid Service. Coverage for nonmetallic piping was introduced. New concepts were better defined in five Addenda, the last of which added Appendix M, a graphic aid to selection of the proper Fluid Service category.

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. Section committee structure remains essentially unchanged.

The second edition of Chemical Plant and Petroleum Refinery Piping was compiled from the 1976 Edition and its five Addenda, with nonmetal requirements editorially relocated to a separate Chapter. Its new designation was ANSI/ASME B31.3-1980.

Section Committee B31.10 had a draft Code for Cryogenic Piping ready for approval in 1981. Again, it was decided to merge the two Section Committees and develop a more inclusive Code with the same title. The work of consolidation was partially completed in the ANSI/ASME B31.3-1984 Edition.

Significant changes were made in Addenda to the 1984 Edition: integration of cryogenic requirements was completed; a new stand-alone Chapter on high-pressure piping was added; and coverage of fabrication, inspection, testing, and allowable stresses was reorganized. The new Edition was redesignated as ASME/ANSI B31.3-1987 Edition.

Addenda to subsequent Editions, published at three-year intervals, have been primarily to keep the Code up-to-date. New Appendices have been added, however, on requirements for bellows expansion joints, estimating service life, submittal of Inquiries, aluminum flanges, and quality control in the 1990, 1993, 1999, and 2002 Editions, all designated as ASME B31.3.

In a program to clarify the application of all Sections of the Code for Pressure Piping, changes are being made in the Introduction and Scope statements of B31.3, and its title is changed to Process Piping.

Under direction of ASME Codes and Standards management, metric units of measurement are being emphasized. With certain exceptions, SI metric units were listed first in the 1996 Edition and were designated as the standard. Instructions for conversion are given where metric data



are not available. U.S. customary units also are given. By agreement, either system may be used.

In this Edition of the Code, SI metric units are given first, with U.S. customary units in parentheses. Appendices H and X, the tables in Appendices A and K, and Tables C-1, C-3, and C-6 in Appendix C are exceptions. Values in metric units are to be regarded as the standard, unless otherwise agreed between the contracting parties. Instructions are given, in those tables that have not been converted for converting tabular data in U.S. units to appropriate SI units.

Interpretations, Code Cases, and errata to the B31.3 Code on Process Piping are published on the following ASME web page: <http://cstools.asme.org/csconnect/CommitteePages.cfm?Committee=N10020400>.



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INTRODUCTION

(08)

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, chemical, pharmaceutical, textile, paper, semiconductor, and cryogenic plants, and related processing plants and terminals

B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids: piping transporting products which 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 Transportation and Distribution Piping Systems: piping transporting products which are predominately gas between sources and terminals, including compressor, regulating, and metering stations; 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

B31.11 Slurry Transportation Piping Systems: piping transporting aqueous slurries between plants and terminals and within terminals, pumping, and regulating stations

This is the B31.3 Process Piping Code Section. Hereafter, in this Introduction and in the text of this Code Section B31.3, 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 which 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 Code 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 the following:

ANSI Z223.1 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 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 installation. The designer is cautioned that the Code is not a design handbook; it does not do away with 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 assure 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 piping 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 two years.

Code users will note that clauses in the Code are not necessarily numbered consecutively. Such discontinuities result from following a common outline, insofar as practical, 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.

It is intended that this edition of Code Section B31.3 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 installation 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 Code revisions without assurance that they are acceptable to the proper authorities in the jurisdiction where the piping is to be installed.

The B31 Committee has established an orderly procedure to consider requests for interpretation and revision of Code requirements. To receive consideration, such request must be in writing and must give full particulars in accordance with Appendix Z.

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.

A Case is the prescribed form of reply 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.

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.

A request for revision of the Code will be placed on the Committee's agenda. Further information or active participation on the part of the proponent may be requested during consideration of a proposed revision.

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 addition of new materials in the ASME Boiler and Pressure Vessel Code, Section II and Section VIII, Division 1, Appendix B. (To develop usage and gain experience, unlisted materials may be used in accordance with para. 323.1.2.) Metric versions of Tables A-1 and A-2 are in the course of preparation. Please refer to the B31.3 Process Piping Web pages at <http://cstools.asme.org/csconnect/CommitteePages.cfm>.



ASME B31.3-2008 SUMMARY OF CHANGES

Following approval by the B31 Committee and ASME, and after public review, ASME B31.3-2008 was approved by the American National Standards Institute on September 19, 2008.

Changes given below are identified on the pages by a margin note, **(08)**, placed next to the affected area.

<i>Page</i>	<i>Location</i>	<i>Change</i>
xi, xii	Foreword	Last paragraph revised
xvii, xviii	Introduction	Third to last paragraph revised
2, 4	300.2	<i>elevated temperature fluid service</i> added
10	301.1	Revised in its entirety
	301.2.2(a)	Revised
11	301.5.3	Revised
13	302.3.2	Footnote (2) revised
15, 18	302.3.5	(1) Subparagraphs (c) and (e) revised (2) Subparagraph (f) added
	302.3.6(a)	In second paragraph, cross-reference to Table Y-3 deleted
19	Table 302.3.5	Added
28	304.5.1(a)	Revised
29	304.7.2	Subparagraphs (b) and (d) revised
30	305.2.4	Added
32	308.2.3	First cross-reference revised
33, 34	311.2	(1) Subparagraphs 311.2.3 through 311.2.6 redesignated as 311.2.4 through 311.2.7, respectively (2) New subpara. 311.2.3 added
38	319.4.1(c)	Footnote 9 revised
42, 43	321.3.2	Revised
	322.6.3(a)	Revised
56, 57	Table 326.1	(1) ASME B16.28 deleted (2) For AWWA C115, title revised (3) For MSS SP-43, Note reference added (4) Note (3) revised
65	331.1.1(e)	Added
71	335.10	Added
77	341.3.4(f)	Added
	341.4.1	Title revised



<i>Page</i>	<i>Location</i>	<i>Change</i>
78	341.4.4	Added
81	345.2.3	Subparagraphs (a) and (b) revised
82	345.3.3	Subparagraphs (a), (b), and (c) revised
	345.4.2	Subparagraphs (a) and (b) revised
87	A304.5.1(a)	Revised
	A304.7.2	Title revised
88	A307	Title revised
93, 94	A326.4	Revised
95, 96	Table A326.1	(1) First body heading and various titles revised (2) Under Nonmetallic Fittings, Valves, and Flanges, ASTM D 2846M, D 5685, F 423, F 491, F 492, F 546, F 599, F 781, and MSS SP-122 added (3) Under Nonmetallic Pipes and Tubes, ASTM D 2846M, F 423, F 441M, F 442M, F 491, F 492, F 546, F 599, and F 781 added (4) Under Miscellaneous, ASTM D 2672 deleted
109	MA307	Revised
113, 114	K302.3.1(d)	Revised
	K302.3.2(b)(1)	(1) Revised (2) Footnote 1 added
	K302.3.2(b)(2)	In second paragraph, Table Y-3 cross-reference deleted
	K302.3.2(c)(2)	Table Y-3 cross-reference deleted
	K302.3.2(d)	Revised
	K302.3.3(a)	Revised
115	K302.3.6(a)	Revised
117	K304.4(b)	Revised
	K304.5.1(b)	Revised
	K304.5.2(b)	Revised
	K304.5.3	Revised
	K304.7.2	(1) First paragraph revised (2) Subparagraph (c) revised
118	K304.8.2(a)	Revised
	K304.8.3(a)	Footnote 10 (formerly footnote 9) revised
	K304.8.5	First paragraph revised
120	K309	Revised
127	Table K326.1	Under Metallic Fittings, Valves, and Flanges, ASME B16.48 added



<i>Page</i>	<i>Location</i>	<i>Change</i>
132	Table K341.3.2	(1) Acceptable Value Limits revised (2) Note (3) revised
134, 135	K345	Revised in its entirety
138–140	Specification Index for Appendix A	Revised
141, 144	Notes for Appendix A Tables	Note (78) added
150, 151	Table A-1	Under Carbon Steel, third body subheading revised
152, 153	Table A-1	Under Carbon Steel, first body subheading revised
178	Table A-1	Under Nickel and Nickel Alloy, Pipes and Tubes, for Ni–Mo–Cr B 619 N06455, P-No. revised
180, 181	Table A-1	(1) For Ni–Mo–Cr B 622 N06455, B 619 N10276, B 622 N10276, B 619 N06022, and B 622 N06022, P-No revised (2) For Low C–Ni–Cr–Mo B 619 N06059 and B 622 N06059, P-No. revised (3) Ni–Mo B 619, B 622, and B 626 N10675 added
182, 183	Table A-1	(1) Under Plates and Sheets, for Low C–Ni–Fe–Cr–Mo–Cu B 625 N08031, P-No. added (2) For Low C–Ni–Mo–Cr B 575 N06455 and N10276, P-No. revised (3) For Ni–Cr–Mo–Cb B 575 N06022, P-No. revised (4) For Low C–Ni–Cr–Mo B 575 N06059, P-No. added (5) Ni–Mo B 333 N10675 added (6) Under Forgings and Fittings, for Ni B 366 N02200, Ni–Fe–Cr B 564 N08811, and Ni–Cr–Fe B 366 N06600, S-No. replaced by P-No.
184, 185	Table A-1	(1) For Ni–Cr–Mo–Fe B 366 N06002, and Low C–Ni–Fe–Cr–Mo–Cu B 366 and B 564 N08031, S-No. replaced by P-No. (2) For Ni–Mo–Cr B 366 and B 564 N10276, P-No. revised (3) For Ni–Mo–Cr B 366 and Ni–Cr–Mo B 564 N06022, P-No. revised (4) For Low C–Ni–Cr–Mo B 366 and B 564 N06059, S-No. replaced by P-No. (5) Ni–Mo B 366, B 462, and B 564 N10675 added (6) Under Rod and Bar, for Low C–Ni–Fe–Cr–Mo–Cu B 649 N08031, S-No. replaced by P-No.



<i>Page</i>	<i>Location</i>	<i>Change</i>
		(7) For Ni–Mo–Cr B 574 N06455, P-No. revised
		(8) For Low C–Ni–Cr–Mo B 574 N06059, S-No. replaced by P-No.
		(9) Ni–Mo B 335 N10675 added
		(10) Under Castings, for Ni–Cr–Mo A 494 CX-2MW, S-No. replaced by P-No.
191	Table A-1	Under Aluminum Alloy, Plates and Sheets, for second B 209 Grade 5083, Temper revised
193	Table A-1	Under Castings, for B 26 Temper F, Specified Min. Yield Strength and stress values revised
195	Table A-1B	Under Low and Intermediate Alloy Steel, for A 333 and A 671, Note (78) added to second line
196	Table A-1B	For A 672 and A 691, Note (78) added to second line
197	Table A-1B	Under Nickel and Nickel Alloy, B 626 added
209	Specification Index for Appendix B	(1) Titles for ASTM D 2997, ASTM F 441, AWWA C302, and AWWA C950 revised (2) Note (1) revised
210	Notes for Appendix B Tables	(1) Note (4) deleted (2) Note (5) redesignated as (4)
211	Table B-1	Revised in its entirety
226	Table C-6	General Note added
231	Table D300	Note (7) revised
232–236	Appendix E	(1) ASTM A 36, A 508, B 333, B 335, B 338, B 363, B 462, B 564, B 619, B 622, and B 861 revised (2) ASTM B 336, B 626, and D 5685 added (3) ASME A13.1 added (4) ASME B16.28 deleted (5) ICC Uniform Building Code added (6) MSS SP-122 added (7) NACE MR0103 added (8) Address for ICC added
240	F323.4(b)(6)	Text and footnote 1 revised
241	F335.10	Added
247–258	Appendix J	Revised
275	L303.3	ASME B16.5 cross-references corrected by errata in five places to read Annex C, Table C1, Group Ia, Group I, or Group Ib



<i>Page</i>	<i>Location</i>	<i>Change</i>
279	P302.3.5	First paragraph revised
	P319.4.4(a)	Nomenclature for i_a revised
286	S302.1	First paragraph revised
287, 288	S302.6.1	First paragraph revised
	S302.6.2	Revised
	S302.7	Revised
289	S302.8	First paragraph revised
292, 294	S303.8	Last paragraph revised
295–297	V303.1	Revised in its entirety
	V304	Revised in its entirety
299	X302.1.2(c)	Revised
300	Fig. X302.1.3	General Note (b) revised
302	X302.2.3(a)	Revised
304–316	Index	Revised

NOTES:

- (1) The interpretations to ASME B31.3 issued between November 1, 2005 and October 31, 2007 follow the last page of this edition as a separate supplement, Interpretations Volume 21.
- (2) After the interpretations, a separate supplement containing Cases 178, 180, and 181 follows.



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Chapter I

Scope and Definitions

300 GENERAL STATEMENTS

(a) *Identification.* This Process Piping Code is a Section of the American Society of Mechanical Engineers Code for Pressure Piping, ASME B31, an American National Standard. It is published as a separate document for convenience of Code users.

(b) *Responsibilities*

(1) *Owner.* The owner of a piping installation shall have overall responsibility for compliance with this Code, and for establishing the requirements for design, construction, examination, inspection, and testing which will govern the entire fluid handling or process installation of which the piping is a part. The owner is also responsible for designating piping in certain fluid services and for determining if a specific Quality System is to be employed. [See paras. 300(d)(4), (d)(5), (e), and Appendix Q.]

(2) *Designer.* The designer is responsible to the owner for assurance that the engineering design of piping complies with the requirements of this Code and with any additional requirements established by the owner.

(3) *Manufacturer, Fabricator, and Erector.* The manufacturer, fabricator, and erector of piping are responsible for providing materials, components, and workmanship in compliance with the requirements of this Code and of the engineering design.

(4) *Owner's Inspector.* The owner's Inspector (see para. 340) is responsible to the owner for ensuring that the requirements of this Code for inspection, examination, and testing are met. If a Quality System is specified by the owner to be employed, the owner's Inspector is responsible for verifying that it is implemented.

(c) *Intent of the Code*

(1) It is the intent of this Code to set forth engineering requirements deemed necessary for safe design and construction of piping installations.

(2) This Code is not intended to apply to the operation, examination, inspection, testing, maintenance, or repair of piping that has been placed in service. The provisions of this Code may optionally be applied for those purposes, although other considerations may also be necessary.

(3) Engineering requirements of this Code, while considered necessary and adequate for safe design, generally employ a simplified approach to the subject. A designer capable of applying a more rigorous analysis

shall have the latitude to do so; however, the approach must be documented in the engineering design and its validity accepted by the owner. The approach used shall provide details of design, construction, examination, inspection, and testing for the design conditions of para. 301, with calculations consistent with the design criteria of this Code.

(4) Piping elements should, insofar as practicable, conform to the specifications and standards listed in this Code. Piping elements neither specifically approved nor specifically prohibited by this Code may be used provided they are qualified for use as set forth in applicable Chapters of this Code.

(5) The engineering design shall specify any unusual requirements for a particular service. Where service requirements necessitate measures beyond those required by this Code, such measures shall be specified by the engineering design. Where so specified, the Code requires that they be accomplished.

(6) Compatibility of materials with the service and hazards from instability of contained fluids are not within the scope of this Code. See para. F323.

(d) *Determining Code Requirements*

(1) Code requirements for design and construction include fluid service requirements, which affect selection and application of materials, components, and joints. Fluid service requirements include prohibitions, limitations, and conditions, such as temperature limits or a requirement for safeguarding (see para. 300.2 and Appendix G). Code requirements for a piping system are the most restrictive of those which apply to any of its elements.

(2) For metallic piping not in Category M or high pressure fluid service, Code requirements are found in Chapters I through VI (the base Code), and fluid service requirements are found in

- (a) Chapter III for materials
- (b) Chapter II, Part 3, for components
- (c) Chapter II, Part 4, for joints

(3) For nonmetallic piping and piping lined with nonmetals, all requirements are found in Chapter VII. (Paragraph designations begin with "A.")

(4) For piping in a fluid service designated by the owner as Category M (see para. 300.2 and Appendix M), all requirements are found in Chapter VIII. (Paragraph designations begin with "M.")

(5) For piping in a fluid service designated by the owner as Category D (see para. 300.2 and Appendix M),



piping elements restricted to Category D Fluid Service in Chapters I through VII, as well as elements suitable for other fluid services, may be used.

(6) Metallic piping elements suitable for Normal Fluid Service in Chapters I through VI may also be used under severe cyclic conditions unless a specific requirement for severe cyclic conditions is stated.

(e) *High Pressure Piping.* Chapter IX provides alternative rules for design and construction of piping designated by the owner as being in High Pressure Fluid Service.

(1) These rules apply only when specified by the owner, and only as a whole, not in part.

(2) Chapter IX rules do not provide for Category M Fluid Service. See para. K300.1.4.

(3) Paragraph designations begin with “K.”

(f) *Appendices.* Appendices of this Code contain Code requirements, supplementary guidance, or other information. See para. 300.4 for a description of the status of each Appendix.

300.1 Scope

Rules for the Process Piping Code Section B31.3¹ have been developed considering piping typically found in petroleum refineries; chemical, pharmaceutical, textile, paper, semiconductor, and cryogenic plants; and related processing plants and terminals.

300.1.1 Content and Coverage

(a) This Code prescribes requirements for materials and components, design, fabrication, assembly, erection, examination, inspection, and testing of piping.

(b) This Code applies to piping for all fluids, including

- (1) raw, intermediate, and finished chemicals
- (2) petroleum products
- (3) gas, steam, air, and water
- (4) fluidized solids
- (5) refrigerants
- (6) cryogenic fluids

(c) See Fig. 300.1.1 for a diagram illustrating the application of B31.3 piping at equipment. The joint connecting piping to equipment is within the scope of B31.3.

300.1.2 Packaged Equipment Piping. Also included within the scope of this Code is piping which interconnects pieces or stages within a packaged equipment assembly.

300.1.3 Exclusions. This Code excludes the following:

(a) piping systems designed for internal gage pressures at or above zero but less than 105 kPa (15 psi), provided the fluid handled is nonflammable, nontoxic, and not damaging to human tissues as defined in 300.2,

¹B31 references here and elsewhere in this Code are to the ASME B31 Code for Pressure Piping and its various Sections, which are identified and briefly described in the Introduction.

and its design temperature is from -29°C (-20°F) through 186°C (366°F)

(b) power boilers in accordance with BPV Code² Section I and boiler external piping which is required to conform to B31.1

(c) tubes, tube headers, crossovers, and manifolds of fired heaters, which are internal to the heater enclosure

(d) pressure vessels, heat exchangers, pumps, compressors, and other fluid handling or processing equipment, including internal piping and connections for external piping

300.2 Definitions

(08)

Some of the terms relating to piping are defined below. For welding, brazing, and soldering terms not shown here, definitions in accordance with AWS Standard A3.0³ apply.

air-hardened steel: a steel that hardens during cooling in air from a temperature above its transformation range.

anneal heat treatment: see *heat treatment*.

arc cutting: a group of cutting processes wherein the severing or removing of metals is effected by melting with the heat of an arc between an electrode and the base metal. (Includes carbon-arc cutting, metal-arc cutting, gas metal-arc cutting, gas tungsten-arc cutting, plasma-arc cutting, and air carbon-arc cutting.) See also *oxygen-arc cutting*.

arc welding (AW): a group of welding processes which produces coalescence of metals by heating them with an arc or arcs, with or without the application of pressure and with or without the use of filler metal.

assembly: the joining together of two or more piping components by bolting, welding, bonding, screwing, brazing, soldering, cementing, or use of packing devices as specified by the engineering design.

automatic welding: welding with equipment which performs the welding operation without adjustment of the controls by an operator. The equipment may or may not perform the loading and unloading of the work.

backing filler metal: see *consumable insert*.

backing ring: material in the form of a ring used to support molten weld metal.

balanced piping system: see para. 319.2.2(a).

²BPV Code references here and elsewhere in this Code are to the ASME Boiler and Pressure Vessel Code and its various Sections as follows:

- Section I, Power Boilers
- Section II, Materials, Part D
- Section V, Nondestructive Examination
- Section VIII, Pressure Vessels, Divisions 1 and 2
- Section IX, Welding and Brazing Qualifications

³AWS A3.0, Standard Welding Terms and Definitions, Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Coupling and Thermal Spraying

