ASME B31.3-2006

(Revision of ASME B31.3-2004)

Process Piping

ASME Code for Pressure Piping, B31

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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Three Park Avenue • New York, NY 10016

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The next edition of this Code is scheduled for publication in 2008. This Code will become effective 6 months after the Date of Issuance. There will be no addenda issued to this edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. The interpretations will be included with this edition.

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

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FOREWORD

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 and Code Cases are published on the ASME website. Go to *http://cstools. asme.org*, click on Committee Central, click on Board on Pressure Technology Codes and Standards, click on B31 Code for Pressure Piping Standards Committee, and then click on B31.3 Process Piping Section Committee.

ASME CODE FOR PRESSURE PIPING, B31

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INTRODUCTION

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

Rules for each Section 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.

A Case is normally issued for a limited period. If at the end of that period it has been incorporated in the Code, or if no further use of its provisions is anticipated, it will be allowed to expire. Otherwise, it will be renewed for a limited period.

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.*

SUMMARY OF CHANGES

Following approval by the B31 Committee and ASME, and after public review, ASME B31.3-2006 was approved by the American National Standards Institute on November 14, 2006.

Changes given below are identified on the pages by a margin note, **(06),** placed next to the affected area.

Page	*Location*	*Change*
14	302.3.5(c)	Second sentence corrected by errata
16	Fig. 302.3.5	Title corrected by errata
17	302.3.5(e)	Revised
18	304.1.2(a)	In eq. (3a), *W* added by errata
20, 22	304.3.3(a)	In nomenclature for *t*, two parentheses in penultimate sentence deleted by errata
26, 27	304.5.1	Revised in its entirety
	304.5.2	Nomenclature for S_f corrected by errata
	304.5.3	(1) Subparagraph (a) added and existing text designated as (b) (2) In eq. (15), *W* added by errata
	304.7.2	Title and first paragraph revised
30	307.2	Subparagraph 307.2.2 added and existing text designated as para. 307.2.1
	Table 308.2.1	Column for PN deleted
31	309.2.1	Revised
	309.2.2	Revised
35, 36	319.3.6	Revised
52	326.1.2	Revised
54	Table 326.1	Under Miscellaneous, title of MSS SP-73 revised
55	328.2.2(e)	Revised
64	Table 331.1.1	In fourth column, first, second, third, fourth, third-to-last, and second-to-last entries revised
70	Table 341.3.2	Under Examination Methods, Visual, sixth entry corrected by errata
76	344.6.1	Cross-references in first paragraph and subparagraph (a) revised
78	345.4.2(c)	Revised
81	A302.3	Title revised
	A302.3.2	In footnote 1, titles of ASTM D 2321 and D 2837 revised

Page	*Location*	*Change*
82	A304.1.2	Title revised
83	A304.5	Title revised
	A304.5.1	Revised in its entirety
	A305	Revised
	A306	Title revised
84	A308.2.1	Revised
	A309.3	Revised
88	A323.2	Title revised
91, 92	Table A326.1	(1) Under Nonmetallic Fittings, titles revised for ASTM D 2467, D 3309, D 4024, and F 439 (2) Under Nonmetallic Fittings, ASTM F 423, F 491, F 492, F 546, F 599, and F 781 deleted (3) Under Nonmetallic Pipes and Tubes, titles revised for ASTM D 2672, D 3035, D 3309, F 441, and F 1673 (4) Under Nonmetallic Pipes and Tubes, ASTM F 423, F 491, F 492, F 546, F 599, and F 781 deleted (5) Under Miscellaneous, titles revised for ASTM D 2564 and D 2672
93	A328.2.5(b)	Footnote 5 revised
94	A328.5.5	Reference to footnote 5 added
97	A335.4.1	Revised
101	M306.4.2(b)	Revised
106	MA323.4.2	Revised
108	K300(a)	Revised
111, 112	K304.1.2	Revised in its entirety
118	K323.1.1	Revised in its entirety
119	K323.3.4(a)	Revised
122	K328.2.5	Deleted
123	Table K326.1	ASME B1.20.1 added
124	K328.4.3(a)(1)	In fourth line, measurement corrected by errata to read 1.5 mm
127	K341.4.1(b)(1)	Revised
135, 137	Notes for Appendix A Tables	In Note (75), metric tabular values added by errata
144	Table A-1	Under Carbon Steel, Pipes and Tubes, for API 5L Grades X65, X70, and X80, Note (77) added by errata

Page	*Location*	*Change*
152, 153	Table A-1	Under Low and Intermediate Alloy Steel, Forgings and Fittings, for 1¼Cr–½Mo A 234, Grade corrected by errata to read WP11
166	Table A-1	Under Stainless Steel, Castings, for A 351 Grade CD3M-W-Cu-N, S-No. corrected by errata to read S-10H
176, 177	Table A-1	Under Nickel and Nickel Alloy, Plates and Sheets, third B 688 N08367 deleted by errata
182	Table A-1	Under Aluminum Alloy, Seamless Pipes and Tubes, B 241 Grade 5652 deleted
193	Table A-2	Under Carbon Steel, for A 194, Grade 2 transferred from first line to second line by errata
203	Specification Index for Appendix B	Titles revised for ASTM D 2672, D 3035, and D 3309
205	Table B-1	For PEEK material, maximum recommended Celsius temperature corrected by errata to read 230
228–233	Appendix E	(1) First paragraph revised (2) ASTM A 508/A 508M, A 723/A 723M, B 338, B 363, D 1527, D 1600, D 1785 through D 2282, D 2321 through D 2467, D 2513 through D 2657, D 2672 through D 2855, D 3035 through D 3839, D 4024, E213, F 336, F 438, F 439, F 441/F 441M, F 493, and F 1055 through F 1673 updated (3) ASTM B 861, D 6041, F 714, and F 1970 added (4) ASTM F 423, F 491, F 492, F 546, F 599, and F 781 deleted (5) AISC M016 added (6) For ASME publications, years deleted (7) MSS SP-53 and SP-73 updated (8) PFI ES-7 updated (9) Addresses for AISC, CGA, PPI, and ANSI updated
243–253	Appendix J	(1) For c, D, E, I_i, P, S, S_A, S_E, S_h, S_L, $\overline{T}$, t, t_m, and Y, para. S300 added by errata (2) For E_a, para. P319.4.4 added by errata (3) Entries for F_a, f, and f_m corrected by errata (4) For second N_E and N_i entries, reference transferred into Paragraph column by errata

Page	*Location*	*Change*
		(5) Entries for P_i, S_c, and T_j corrected by errata (6) Definition for S_{om} corrected by errata (7) Revised
254	Appendix K	(1) ASTM B 337 deleted (2) ASTM B 861 added
266, 267	Table K-1	Under Titanium and Titanium Alloy, all lines revised
268	L300	Revised
269	Table L301.2M	Column heads revised
	L303.2.3	Revised
	L303.3.2	Revised
272	Fig. M300	In Col. 3, fourth box, cross-reference corrected by errata to read para. 300(d)(4)
273	P302.3.5	(1) First paragraph corrected by errata (2) Nomenclatures for eqs. (P1a) and (P1d) deleted by errata
276	S300.1	Revised
280–288	S302	Added
	S303	Added
292	X302.1.2(c)	Corrected by errata
293	Fig. X302.1.3	General Note (a) revised
295	X302.2.2(b)	In third line, measurement corrected by errata to read 2.4 mm
	X302.2.3	Revised in its entirety

NOTES:
(1) The interpretations to ASME B31.3 issued between November 1, 2003 and October 31, 2005 follow the last page of this edition as a separate supplement, Interpretations Volume 20.
(2) After the interpretations, a separate supplement containing Case 178 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 B31.3[1] 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, and its design temperature is from −29°C (−20°F) through 186°C (366°F)

(b) power boilers in accordance with BPV Code[2] 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

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 A3.0[3] 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).

[1] B31 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.

[2] BPV 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

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