ASME B31.1-2007

(Revision of ASME B31.1-2004)

Power 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 2007 edition of this Code is being issued with an automatic update service that includes addenda, interpretations, and cases. The use of addenda allows revisions made in response to public review comments or committee actions to be published on a regular basis; revisions published in addenda will become effective 6 months after the Date of Issuance of the addenda. The next edition of this Code is scheduled for publication in 2010.

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

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FOREWORD

The general *philosophy* underlying this Power Piping Code is to parallel those provisions of Section I, Power Boilers, of the ASME Boiler and Pressure Vessel Code, as they can be applied to power piping systems. The Allowable Stress Values for power piping are generally consistent with those assigned for power boilers. This Code is more conservative than some other piping codes, reflecting the need for long service life and maximum reliability in power plant installations.

The Power Piping Code as currently written does not differentiate between the design, fabrication, and erection requirements for *critical and noncritical piping systems,* except for certain stress calculations and mandatory nondestructive tests of welds for heavy wall, high temperature applications. The *problem involved* is to try to reach agreement on how to evaluate criticality, and to avoid the inference that noncritical systems do not require competence in design, fabrication, and erection. Some day such levels of quality may be definable, so that the need for the many different piping codes will be overcome.

There are many instances where the Code serves to *warn a designer,* fabricator, or erector against possible pitfalls; but the Code is *not a handbook,* and cannot substitute for education, experience, and sound engineering judgment.

Nonmandatory Appendices are included in the Code. Each contains information on a specific subject, and is maintained current with the Code. Although written in mandatory language, these Appendices are offered for application at the user's discretion.

The Code *never intentionally puts a ceiling limit on conservatism.* A designer is free to specify more rigid requirements as he feels they may be justified. *Conversely, a designer who is capable* of a more rigorous analysis than is specified in the Code may justify a less conservative design, and still satisfy the basic intent of the Code.

The Power Piping Committee strives to keep abreast of the current technological improvements in new materials, fabrication practices, and testing techniques; and endeavors to keep the Code updated to permit the use of acceptable new developments.

ASME CODE FOR PRESSURE PIPING, B31

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C. J. Harvey, Alabama Public Service Commission
D. T. Jagger, Ohio Department of Commerce
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P. Sher, State of Connecticut
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D. A. Starr, Nebraska Department of Labor
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INTRODUCTION

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

Rules for each Section have been developed considering the need for application of specific requirements for various types of pressure piping. Applications considered for each Code Section include:

B31.1 Power Piping: piping typically found in electric power generating stations, in industrial and institutional plants, geothermal heating systems, and central and district heating and cooling systems;

B31.3 Process Piping: piping typically found in petroleum refineries, chemical, pharmaceutical, textile, paper, semiconductor, and cryogenic plants, and related processing plants and terminals;

B31.4 Pipeline Transportation Systems for 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; 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;

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

This is the B31.1 Power Piping Code Section. Hereafter, in this Introduction and in the text of this Code Section B31.1, where the word *Code* is used without specific identification, it means this Code Section.

It is the owner's responsibility to select the Code Section 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 selected Code Section, if necessary, to assure safe piping for the proposed installation.

Certain piping within a facility may be subject to other codes and standards, including but not limited to:

ASME Boiler and Pressure Vessel Code, Section III: nuclear power piping;

ANSI Z223.1 National Fuel Gas Code: piping for fuel gas from the point of delivery to the connection of each fuel utilization device;

NFPA Fire Protection Standards: fire protection systems using water, carbon dioxide, halon, foam, dry chemical, and wet chemicals;

NFPA 99 Health Care Facilities: medical and laboratory gas systems;

NFPA 8503 Standard for Pulverized Fuel Systems: piping for pulverized coal from the coal mills to the burners;

Building and plumbing codes, as applicable, for potable hot and cold water, and for sewer and drain systems.

The Code sets forth engineering requirements deemed necessary for safe design and construction of pressure piping. While safety is the basic consideration, this factor alone will not necessarily govern the final specifications for any piping system. The designer is cautioned that the Code is not a design handbook; it does not 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.

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

This Code Section includes the following:

(a) references to acceptable material specifications and component standards, including dimensional requirements and pressure-temperature ratings

(b) requirements for design of components and assemblies, including pipe supports

(c) requirements and data for evaluation and limitation of stresses, reactions, and movements associated with pressure, temperature changes, and other forces

(d) guidance and limitations on the selection and application of materials, components, and joining methods

(e) requirements for the fabrication, assembly, and erection of piping

(f) requirements for examination, inspection, and testing of piping

(g) requirements for operation and maintenance of piping systems

It is intended that this Edition of Code Section B31.1 and any subsequent Addenda 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 and Addenda issued at least 6 months prior to the original contract date for the first phase of activity covering a piping system or systems shall be the governing document for all design, materials, fabrication, erection, examination, and testing for the piping until the completion of the work and initial operation.

Users of this Code are cautioned against making use of revisions without assurance that they are acceptable to the proper authorities in the jurisdiction where the piping is to be installed.

Code users will note that clauses in the Code are not necessarily numbered consecutively. Such discontinuities result from following a common outline, insofar as practicable, for all Code Sections. In this way, corresponding material is correspondingly numbered in most Code Sections, thus facilitating reference by those who have occasion to use more than one Section.

The Code is under the direction of ASME Committee B31, Code for Pressure Piping, which is organized and operates under procedures of The American Society of Mechanical Engineers which have been accredited by the American National Standards Institute. The Committee is a continuing one, and keeps all Code Sections current with new developments in materials, construction, and industrial practice. Addenda are issued periodically. New editions are published at intervals of three to five years.

When no Section of the ASME Code for Pressure Piping, specifically covers a piping system, at his discretion the user may select any Section determined to be generally applicable. However, it is cautioned that supplementary requirements to the Section chosen may be necessary to provide for a safe piping system for the intended application. Technical limitations of the various Sections, legal requirements, and possible applicability of other codes or standards are some of the factors to be considered by the user in determining the applicability of any Section of this Code.

The Committee has established an orderly procedure to consider requests for interpretation and revision of Code requirements. To receive consideration, inquiries must be in writing and must give full particulars (see Mandatory Appendix H covering preparation of technical inquiries). The Committee will not respond to inquiries requesting assignment of a Code Section to a piping installation.

The approved reply to an inquiry will be sent directly to the inquirer. In addition, the question and reply will be published as part of an Interpretation Supplement issued to the applicable Code Section.

A Case is the prescribed form of reply to an inquiry when study indicates that the Code wording needs clarification or when the reply modifies existing requirements of the Code or grants permission to use new materials or alternative constructions. The Case will be published as part of a Case Supplement issued to the applicable Code Section.

A case is normally issued for a limited period after which it may be renewed, incorporated in the Code, or allowed to expire if there is no indication of further need for the requirements covered by the Case. However, the provisions of a Case may be used after its expiration or withdrawal, provided the Case was effective on the original contract date or was adopted before completion of the work; and the contracting parties agree to its use.

Materials are listed in the Stress Tables only when sufficient usage in piping within the scope of the Code has been shown. Materials may be covered by a Case. Requests for listing shall include evidence of satisfactory usage and specific data to permit establishment of allowable stresses, maximum and minimum temperature limits, and other restrictions. Additional criteria can be found in the guidelines for addition of new materials in the ASME Boiler and Pressure Vessel Code, Section II and Section VIII, Division 1, Appendix B. (To develop usage and gain experience, unlisted materials may be used in accordance with para. 123.1.)

Requests for interpretation and suggestions for revision should be addressed to the Secretary, ASME B31 Committee, Three Park Avenue, New York, NY 10016-5990.

ASME B31.1-2007
SUMMARY OF CHANGES

Following approval by the B31 Committee and ASME, and after public review, ASME B31.1-2007 was approved by the American National Standards Institute on May 30, 2007.

Changes given below are identified on the pages by a margin note, **(07),** placed next to the affected area.

Page	*Location*	*Change*
1	100.1.1	First paragraph revised
5–9	100.2	*Covered piping systems, Operating Company,* and *stresses* added
12–14	102.3.2	Revised in its entirety
	102.4.5(B)	Last paragraph revised
15	Fig. 102.4.5	Fig. 104.2.1 redesignated as Fig. 102.4.5
19	104.3.1(D.2)	(1) First paragraph revised (2) Nomenclature for t_r revised
20, 21	Fig. 104.3.1(D)	Revised in its entirety
22	104.3.1(D.2.2)	Equations revised
	104.3.1(D.2.3)	Nomenclature for A_6 added
28	104.8.2	Nomenclature for M_B revised
	104.8.3	Revised
32	107.8.3	Revised
34–37	Table 112	For items (d), (h), and (i), and for Notes (9) and (11), cross-references to ASME B16.5 revised
38	114.2.1	Revised
	114.2.3	Revised
39–42	119	Revised in its entirety
44	121.7.2(A)	First paragraph revised
45	Table 121.7.2(A)	Revised in its entirety
46	122.1.1	First paragraph revised
54	122.4	(1) Title revised (2) Subparagraphs (A.4) and (A.10) revised
55	Fig. 122.4	Bottom callout revised
57	122.8	Revised
	122.8.1(B.1.2)	Revised
58	122.8.2(C.2)	Revised

Page	*Location*	*Change*
59	122.8.3(B)	Revised
67	Table 126.1	Under Seamless Pipe and Tube, ASTM B 622 added
68	Table 126.1	(1) Under Welded Pipe and Tube, ASTM B 619 and B 626 added (2) Under Pipe, Sheet, and Strip, ASTM B 435 added (3) Under Rods, Bars, and Shapes, ASTM B 572 added
69	Table 126.1	(1) MSS SP-106 added (2) ASME B16.50 added
86	Table 132	(1) For P-No. 4, in General Note (c), cross-reference to (a)(3) deleted by errata (2) For P-No. 5A, General Notes (b) and (c) redesignated as (c) and (d), respectively, and new General Note (b) added (3) For P-No. 5A, in General Note (c), cross-reference to (a)(3) deleted by errata
92	136.4.1	Revised
95	136.4.6	(1) In first paragraph, cross-reference revised (2) Subparagraph (A) revised
98, 99	Chapter VII	Added
154–157	Table A-3	For A 479 materials, Type revised
160, 161	Table A-4	(1) Under Seamless Pipe and Tube, two B 622 R30556 lines added (2) Second B 677 N08925 line added
162, 163	Table A-4	(1) Under Welded Pipe and Tube, two B 619 R30556 and two B 626 R30556 added (2) Second B 673 N08925 and B 674 N08925 lines added
164, 165	Table A-4	(1) Under Plate, Sheet, and Strip, two B 435 R30556 lines added (2) Second B 625 N08925 line added
166, 167	Table A-4	(1) Under Bars, Rods, Shapes, and Forgings, two B 572 R30556 lines added (2) Second B 649 N08925 line added
168, 169	Table A-4	(1) Under Seamless Fittings, two B 366 R30556 lines added (2) Under Welded Fittings, second B 366 N08925 line added (3) Two B 366 R30556 lines added
176, 177	Table A-6	(1) Under Bolts, Nuts, and Studs, third B 150 C61400 added

Page	*Location*	*Change*
		(2) Note (2) revised
210–213	Table D-1	(1) Notes renumbered in order referenced (2) Fillet welds entry revised (3) Note (12) [formerly Note (11)] revised
218	Mandatory Appendix F	(1) ASTM B 366 revised (2) ASTM B 435, B 572, B 619, B 622, and B 626 added (3) MSS SP-106 added (4) ASME B16.50 added
220	Mandatory Appendix G	Nomenclature for A_6 added
260	III-3.4.2(B)	Cross-reference corrected by errata to read para. III-1.2.2
261	Table III-4.2.1	Revised in its entirety
273	Nonmandatory Appendix V Definitions	*Operating Company* transferred to para. 100.2
278	Fig. V-6.5	Note (2) revised

SPECIAL NOTE:

The Interpretations to ASME B31.1 issued between January 1, 2006 and December 31, 2006 follow the last page of this Edition as a separate supplement, Interpretations Volume 42. After the Interpretations, a separate supplement, Cases No. 32, follows.

POWER PIPING

Chapter I
Scope and Definitions

100 GENERAL

This Power Piping Code is one of several Sections of the American Society of Mechanical Engineers Code for Pressure Piping, B31. This Section is published as a separate document for convenience.

Standards and specifications specifically incorporated by reference into this Code are shown in Table 126.1. It is not considered practical to refer to a dated edition of each of the standards and specifications in this Code. Instead, the dated edition references are included in an Addenda and will be revised yearly.

100.1 Scope

Rules for this Code Section have been developed considering the needs for applications which include piping typically found in electric power generating stations, in industrial and institutional plants, geothermal heating systems, and central and district heating and cooling systems.

(07) **100.1.1** This Code prescribes requirements for the design, materials, fabrication, erection, test, inspection, operation, and maintenance of piping systems.

Piping as used in this Code includes pipe, flanges, bolting, gaskets, valves, relief devices, fittings, and the pressure containing portions of other piping components, whether manufactured in accordance with Standards listed in Table 126.1 or specially designed. It also includes hangers and supports and other equipment items necessary to prevent overstressing the pressure containing components.

Rules governing piping for miscellaneous appurtenances, such as water columns, remote water level indicators, pressure gages, gage glasses, etc., are included within the scope of this Code, but the requirements for boiler appurtenances shall be in accordance with Section I of the ASME Boiler and Pressure Vessel Code, PG-60.

The users of this Code are advised that in some areas legislation may establish governmental jurisdiction over the subject matter covered by this Code. However, any such legal requirement shall not relieve the owner of his inspection responsibilities specified in para. 136.1.

100.1.2 Power piping systems as covered by this Code apply to all piping and their component parts except as excluded in para. 100.1.3. They include but are not limited to steam, water, oil, gas, and air services.

(A) This Code covers boiler external piping as defined below for power boilers and high temperature, high pressure water boilers in which: steam or vapor is generated at a pressure of more than 15 psig [100 kPa (gage)]; and high temperature water is generated at pressures exceeding 160 psig [1 103 kPa (gage)] and/or temperatures exceeding 250°F (120°C).

Boiler external piping shall be considered as that piping which begins where the boiler proper terminates at

(1) the first circumferential joint for welding end connections; or

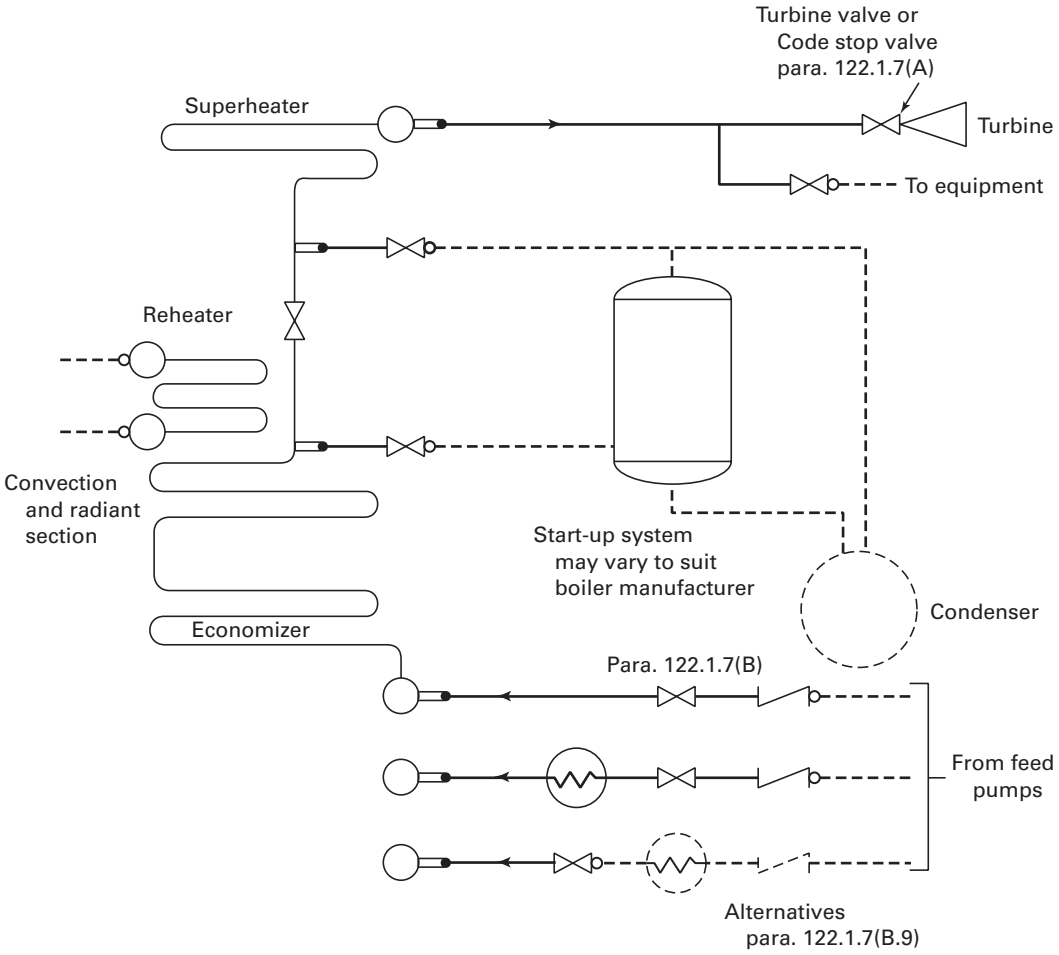
(2) the face of the first flange in bolted flanged connections; or

(3) the first threaded joint in that type of connection; and which extends up to and including the valve or valves required by para. 122.1.

The terminal points themselves are considered part of the boiler external piping. The terminal points and piping external to power boilers are illustrated by Figs. 100.1.2(A), 100.1.2(B), and 100.1.2(C).

Piping between the terminal points and the valve or valves required by para. 122.1 shall be provided with Data Reports, inspection, and stamping as required by Section I of the ASME Boiler and Pressure Vessel Code. All welding and brazing of this piping shall be performed by manufacturers or contractors authorized to use the appropriate symbol shown in Figs. PG-105.1 through PG-105.3 of Section I of the ASME Boiler and Pressure Vessel Code. The installation of boiler external piping by mechanical means may be performed by an organization not holding a Code symbol stamp. However, the holder of a valid S, A, or PP Certificate of Authorization shall be responsible for the documentation and hydrostatic test, regardless of the method of assembly. The quality control system requirements of Section I of the ASME Boiler and Pressure Vessel Code shall apply. These requirements are shown in Appendix J of this Code.

Fig. 100.1.2(A) Code Jurisdictional Limits for Piping — Forced Flow Steam Generator With No Fixed Steam and Water Line



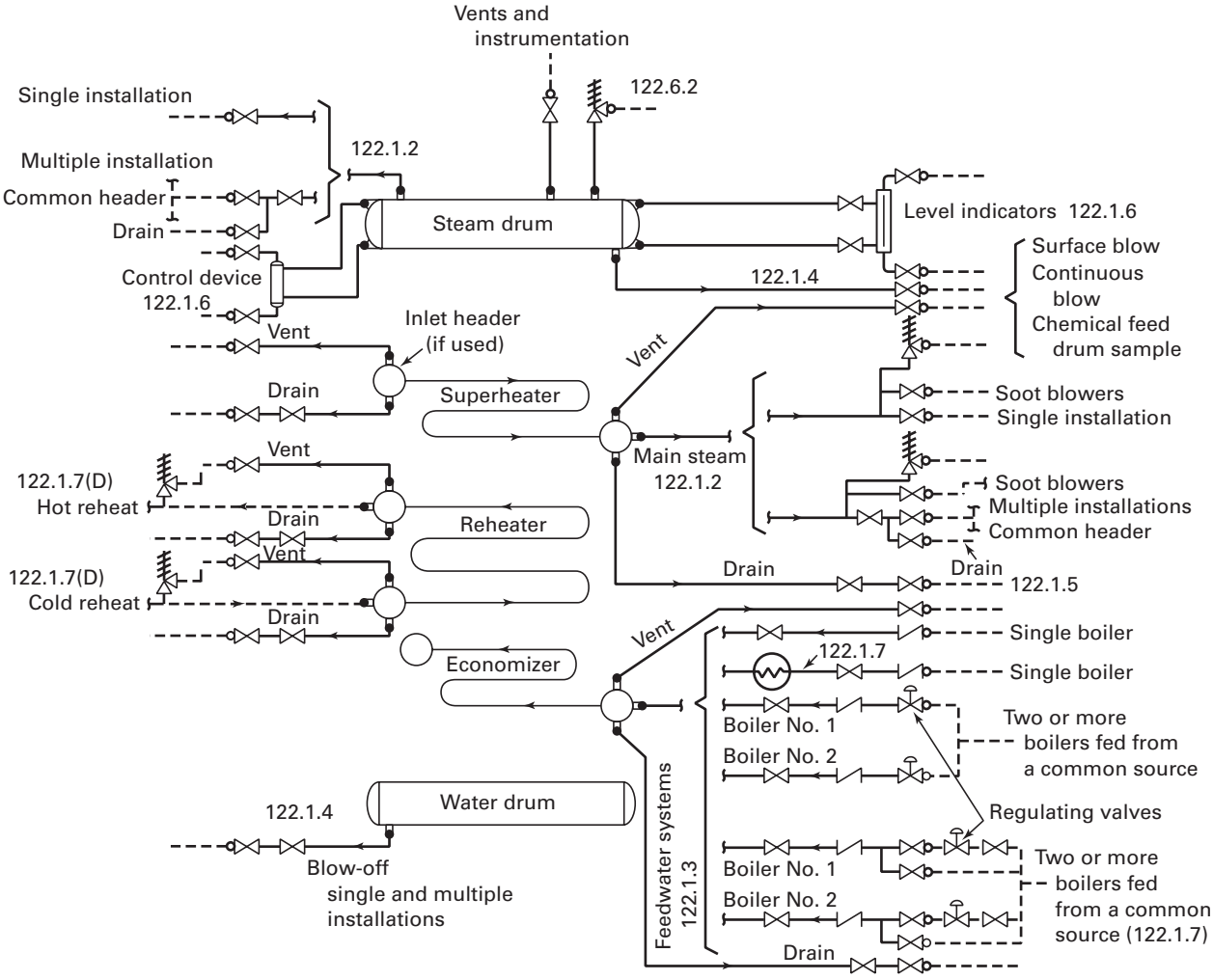
Administrative Jurisdiction and Technical Responsibility

——— Boiler Proper — The ASME Boiler and Pressure Vessel Code (ASME BPVC) has total administrative jurisdiction and technical responsibility. Refer to ASME BPVC Section I Preamble.

●——— Boiler External Piping and Joint (BEP) — The ASME BPVC has total administrative jurisdiction (mandatory certification by Code Symbol stamping, ASME Data Forms, and Authorized Inspection) of BEP. The ASME Section Committee B31.1 has been assigned technical responsibility. Refer to ASME BPVC Section I Preamble, fifth, sixth, and seventh paragraphs and ASME B31.1 Scope, para. 100.1.2(A). Applicable ASME B31.1 Editions and Addenda are referenced in ASME BPVC Section I, PG-58.3.

o- - - - - Nonboiler External Piping and Joint (NBEP) — The ASME Code Committee for Pressure Piping, B31, has total administrative and technical responsibility.

Fig. 100.1.2(B) Code Jurisdictional Limits for Piping — Drum-Type Boilers



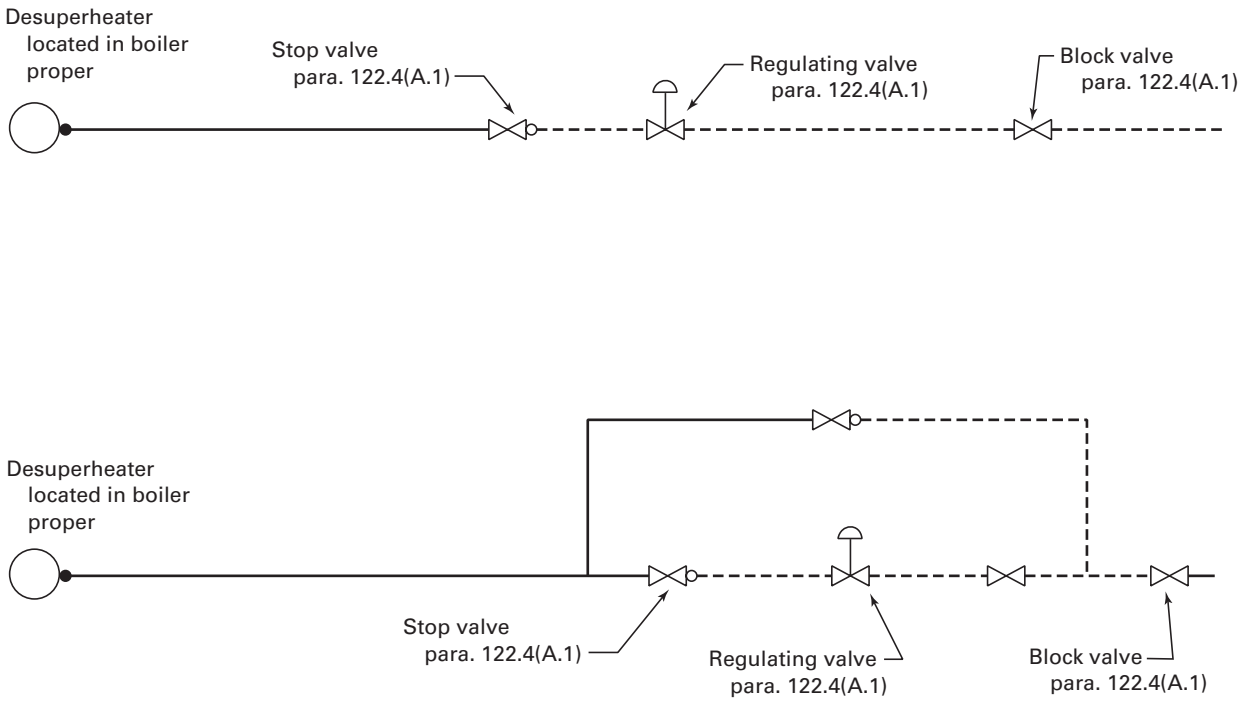
Administrative Jurisdiction and Technical Responsibility

——— Boiler Proper — The ASME Boiler and Pressure Vessel Code (ASME BPVC) has total administrative jurisdiction and technical responsibility. Refer to ASME BPVC Section I Preamble.

●——— Boiler External Piping and Joint (BEP) — The ASME BPVC has total administrative jurisdiction (mandatory certification by Code Symbol stamping, ASME Data Forms, and Authorized Inspection) of BEP. The ASME Section Committee B31.1 has been assigned technical responsibility. Refer to ASME BPVC Section I Preamble and ASME B31.1 Scope, para. 100.1.2(A). Applicable ASME B31.1 Editions and Addenda are referenced in ASME BPVC Section I, PG-58.3.

○- - - - Nonboiler External Piping and Joint (NBEP) — The ASME Code Committee for Pressure Piping, B31, has total administrative and technical responsibility.

Fig. 100.1.2(C) Code Jurisdictional Limits for Piping — Spray-Type Desuperheater



Administrative Jurisdiction and Technical Responsibility

——— Boiler Proper — The ASME Boiler and Pressure Vessel Code (ASME BPVC) has total administrative jurisdiction and technical responsibility. Refer to ASME BPVC Section 1 Preamble.

●——— Boiler External Piping and Joint (BEP) — The ASME BPVC has total administrative jurisdiction (mandatory certification by Code Symbol stamping, ASME Data Forms, and Authorized Inspection) of BEP. The ASME Section Committee B31.1 has been assigned technical responsibility. Refer to ASME BPVC Section I Preamble and ASME B31.1 Scope, para. 100.1.2(A). Applicable ASME B31.1 Editions and Addenda are referenced in ASME BPVC Section I, PG-58.3.

o– – – Nonboiler External Piping and Joint (NBEP) — The ASME Code Committee for Pressure Piping, B31, has total administrative and technical responsibility.

The valve or valves required by para. 122.1 are part of the boiler external piping, but do not require ASME Boiler and Pressure Vessel Code, Section I inspection and stamping except for safety, safety relief, and relief valves; see para. 107.8.2. Refer to PG-11.

Pipe connections meeting all other requirements of this Code but not exceeding NPS ½ may be welded to pipe or boiler headers without inspection and stamping required by Section I of the ASME Boiler and Pressure Vessel Code.

(B) Nonboiler external piping includes all the piping covered by this Code except for that portion defined above as boiler external piping.

100.1.3 This Code does not apply to the following:

(A) economizers, heaters, pressure vessels, and components covered by Sections of the ASME Boiler and Pressure Vessel Code

(B) building heating and distribution steam and condensate piping designed for 15 psig [100 kPa (gage)] or less, or hot water heating systems designed for 30 psig [200 kPa (gage)] or less

(C) piping for hydraulic or pneumatic tools and their components downstream of the first block or stop valve off the system distribution header

(D) piping for marine or other installations under Federal control

(E) towers, building frames, tanks, mechanical equipment, instruments, and foundations

(07) 100.2 Definitions

Some commonly used terms relating to piping are defined below. Terms related to welding generally agree with AWS A3.0. Some welding terms are defined with specified reference to piping. For welding terms used in this Code, but not shown here, definitions of AWS A3.0 apply.

anchor: a rigid restraint providing substantially full fixation, permitting neither translatory nor rotational displacement of the pipe.

annealing: see *heat treatments.*

arc welding: a group of welding processes wherein coalescence is produced by heating with an electric 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, caulking, brazing, soldering, cementing, or threading into their installed location as specified by the engineering design.

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

backing ring: backing in the form of a ring that can be used in the welding of piping.

ball joint: a component which permits universal rotational movement in a piping system.

base metal: the metal to be welded, brazed, soldered, or cut.

branch connection: the attachment of a branch pipe to the run of a main pipe with or without the use of fittings.

braze welding: a method of welding whereby a groove, fillet, plug, or slot weld is made using a nonferrous filler metal having a melting point below that of the base metals, but above 840°F (450°C). The filler metal is not distributed in the joint by capillary action. (Bronze welding, formerly used, is a misnomer for this term.)

brazing: a metal joining process wherein coalescence is produced by use of a nonferrous filler metal having a melting point above 840°F (450°C) but lower than that of the base metals joined. The filler metal is distributed between the closely fitted surfaces of the joint by capillary action.

butt joint: a joint between two members lying approximately in the same plane.

component: component as used in this Code is defined as consisting of but not limited to items such as pipe, piping subassemblies, parts, valves, strainers, relief devices, fittings, etc.

specially designed component: a component designed in accordance with para. 104.7.2.

standard component: a component manufactured in accordance with one or more of the standards listed in Table 126.1.

covered piping systems (CPS): piping systems on which condition assessments are to be conducted. As a minimum for electric power generating stations, the CPS systems are to include NPS 4 and larger of the main steam, hot reheat steam, cold reheat steam, and boiler feedwater piping systems. In addition to the above, CPS also includes NPS 4 and larger piping in other systems that operate above 750°F (400°C) or above 1,025 psi (7 100 kPa). The Operating Company may, in its judgment, include other piping systems determined to be hazardous by an engineering evaluation of probability and consequences of failure.

defect: a flaw (imperfection or unintentional discontinuity) of such size, shape, orientation, location, or properties as to be rejectable.

discontinuity: a lack of continuity or cohesion; an interruption in the normal physical structure of material or a product.

employer: the owner, manufacturer, fabricator, contractor, assembler, or installer responsible for the welding, brazing, and NDE performed by his organization including procedure and performance qualifications.