ASME B31.1-2024
(Revision of ASME B31.1-2022)

Power Piping

ASME Code for Pressure Piping, B31

AN INTERNATIONAL PIPING CODE®

The American Society of
Mechanical Engineers

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The American Society of
Mechanical Engineers

150 Clove Road • Little Falls, NJ • 07424 USA

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The next edition of this International Code is scheduled for publication in 2026. This International Code will become effective 6 months after the Date of Issuance.

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

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

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FOREWORD

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 among 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. Someday 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; however, 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. The designer is free to specify more-rigid requirements if the designer feels such requirements are justified. Conversely, a designer who is capable of applying a more complete and rigorous analysis consistent with the design criteria of this Code may justify a method different from that specified in the Code and still satisfy the Code requirements.

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 B31.1-2024 was approved by the American National Standards Institute on August 21, 2024.

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Code for Pressure Piping

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

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

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

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

Cases

(a) The most common applications for cases are

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

(2) to provide alternative requirements

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

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

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

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

(1) a statement of need and background information

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

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

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

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

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

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

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME committee or subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

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

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

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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, industrial and institutional plants, geothermal heating systems, and central and district heating and cooling systems

B31.3 Process Piping: piping typically found in petroleum refineries; onshore and offshore petroleum and natural gas production facilities; chemical, pharmaceutical, textile, paper, ore-processing, semiconductor, and cryogenic plants; food- and beverage-processing facilities, and related processing plants and terminals

B31.4 Pipeline Transportation Systems for Liquids and Slurries: piping transporting products that are predominately liquid between plants and terminals, and within terminals and pumping, regulating, and metering stations

B31.5 Refrigeration Piping and Heat Transfer Components: piping for refrigerants and secondary coolants

B31.8 Gas Transmission and Distribution Piping Systems: piping transporting products that are predominately gas between sources and terminals, including compressor, regulating, and metering stations; and gas gathering pipelines

B31.9 Building Services Piping: piping typically found in industrial, institutional, commercial, and public buildings, and in multi-unit residences, which does not require the range of sizes, pressures, and temperatures covered in ASME B31.1

B31.12 Hydrogen Piping and Pipelines: piping in gaseous and liquid hydrogen service, and pipelines in gaseous hydrogen service

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 that most nearly applies to a proposed piping installation. Factors to be considered by the owner include limitations of the Code Section, jurisdictional requirements, and the applicability of other codes and standards. All applicable requirements of the selected Code Section shall be met. For some installations, more than one Code Section may apply to different parts of the installation. The owner is also responsible for imposing requirements supplementary to those of the selected Code Section, if necessary, to assure safe piping for the proposed installation.

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

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

– ANSI Z223.1/NFPA 54 National Fuel Gas Code: piping for fuel gas from the point of delivery to the connection of each fuel utilization device

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

– NFPA 85 Boiler and Combustion Systems Hazards Code

– building and plumbing codes, as applicable, for potable hot and cold water, and for sewer and drain systems

The Code specifies engineering requirements deemed necessary for safe design, construction, operation, and maintenance of pressure piping. While safety is the overriding consideration, this factor alone will not necessarily govern the final specifications for any piping installation or operation. The Code is not a design handbook. Many decisions that must be made to produce a safe piping installation and to maintain system integrity are not specified in detail within this Code. The Code does not serve as a substitute for sound engineering judgment by the owner and the designer.

To the greatest possible extent, Code requirements for design are stated in terms of basic design principles and formulas. These are supplemented as necessary with specific requirements to ensure uniform application of principles and to guide selection and application of piping elements. The Code prohibits designs and practices known to be unsafe and contains warnings where caution, but not prohibition, is warranted.

The Code generally specifies a simplified approach for many of its requirements.

For design and construction, a designer may choose to use a more rigorous analysis to develop design and construction requirements. When the designer decides to take this approach, the designer shall provide to the owner details and calculations demonstrating that design, construction, examination, and testing are consistent with the criteria of the Code. These details shall be adequate for the owner to verify the validity of the approach and shall be approved by the owner. The details shall be documented in the engineering design.

For operation and maintenance, an owner may choose to use a more rigorous approach to develop operation and maintenance requirements. When the owner decides to take this approach, the owner shall provide details and calculations demonstrating that such alternative practices are consistent with the general philosophy of the Code. The details shall be documented in the operating records and retained for the lifetime of the facility.

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

Either U.S. Customary (USC) or International System (SI, also known as metric) units may be used with this edition. Local customary units may also be used to demonstrate compliance with this Code. One system of units should be used consistently for requirements applying to a specific installation. It is the responsibility of the organization performing calculations to ensure that a consistent system of units is used.

It is intended that this edition of Code Section B31.1 not be retroactive. Unless agreement is specifically made between contracting parties to use another edition, or the regulatory body having jurisdiction imposes the use of another edition, the latest edition issued at least 6 months prior to the original contract date for the first phase of activity covering a piping system or systems shall be the governing document for all design, materials, fabrication, erection, examination, and testing for the piping until the completion of the work and initial operation.

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 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 to five years.

When no Section of the ASME Code for Pressure Piping specifically covers a piping system, at the user's 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.

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 but are not considered listed materials unless specifically identified as such in the Case (please see the Correspondence With the Committee page for further information on Cases). 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 ASME Boiler and Pressure Vessel Code, Section II. (To develop usage and gain experience, unlisted materials may be used in accordance with para. 123.1.)

ASME B31.1-2024
SUMMARY OF CHANGES

Following approval by the ASME B31 Standards Committee and ASME, and after public review, ASME B31.1-2024 was approved by the American National Standards Institute on August 21, 2024.

Throughout this Code, reference citations have been updated. ASME B31.1-2024 also includes the following changes identified by a margin note, **(24)**.

Page	*Location*	*Change*
xii	Correspondence With the B31 Committee	Added
xiv	Introduction	Revised
1	100.1.1	Last sentence revised
1	100.1.2	Subparagraph (c) added
5	Figure 100.1.2-4	Caption designators updated
7	100.2	(1) Definitions of *designer* and *pipe* added (2) Definitions of *employer; stresses: displacement stress*; and *tube* revised (3) Definition of *pipe and tube* deleted
19	101.5.2	Third sentence added
19	101.5.3	Third sentence added
20	102.2.2	First paragraph revised
21	102.3.2	Titles of subparas. (a) and (b) revised; subpara. (a)(3) revised
23	Table 102.4.3-1	Title revised
22	102.4.5	First sentence in subpara. (a)(1) and last sentence in subpara. (b) revised
26	104.1.2	In subpara. (a), footnote 3 and item (1) in definition of t_m revised
28	104.2.3	Subparagraph (c)(1) revised
29	104.3.1	Subparagraphs (a), (c), (c)(6), (d)(2)(-b), (g)(4), and (g)(5) revised
39	104.8	First paragraph revised
39	104.8.1	Definition of S_{lp} added
39	104.8.2	Definition of P_o deleted
40	Figure 104.8-1	Revised
53	120.2.4	Last sentence revised
59	122.1.7	Subparagraph (b)(5) revised
68	122.8.1	(1) Last sentence in subpara. (a) added (2) Last sentence in subpara. (d)(1) revised
72	123.1.2	First paragraph revised
74	124.4	Second sentence revised
75	124.7	Subparagraph (a) revised
75	124.9	Second sentence revised
76	125.2	Added

Page	*Location*	*Change*
78	Table 126.1-1	Updated
87	127.2.1	Subparagraph (g) added and former subpara. (g) redesignated
88	127.3	Subparagraph (f) added
99	Figure 127.4.8-7	Cross-reference in illustration (b) updated
100	127.5.2	Revised
100	127.5.3	Revised
101	127.6	Revised
101	128.5.2	Revised
101	128.5.3	Revised
102	128.6	Revised
103	Table 129.3.3.1-1	Note (3)(a) revised
106	131.6.2	Subparagraph (a)(1)(-c) revised
108	Table 132.1.1-1	(1) Holding Temperature Range for P-No. 15E, Group 1 updated (2) Note (7) revised and Note (8) added
107	132.2	Subparagraphs (a) and (c) revised
112	132.7	Penultimate sentence revised
113	135.3	Revised in its entirety
115	136.1.2	Subparagraph (c) added
115	136.2.1	First sentence revised
117	Table 136.4.1-1	General Note (f) revised
118	136.4.5	Second-to-last paragraph in subpara. (b) revised
119	136.4.7	First sentence revised
120	137.2.1	Revised in its entirety
120	137.2.4	Last sentence revised
122	137.8	Second sentence revised
124	138	First paragraph revised
127	149	Revised in its entirety
130	Table A-1	(1) Under Furnace Butt Welded Pipe, for API 5L, Type or Class deleted (2) Under Electric Resistance Welded Pipe and Tube, for API 5L, Type or Class deleted (3) General Note (a) revised
144	Table A-2	(1) Under Electric Fusion Welded Pipe — Filler Metal Added, for A691, Note (19) added (2) Under Wrought Fittings (Seamless and Welded), for A234, Note (19) added (3) Under Castings, stress values for A217 Grade C12A and A1091 Grade C91 revised (4) General Note (a) revised (5) Note (19) added
156	Table A-3	(1) Under Seamless Pipe and Tube: Austenitic, for A213, A312, and A376, Notes revised (2) Under Welded Pipe and Tube — Without Filler Metal: Austenitic, for A249 and A312, Notes revised (3) Under Welded Pipe — Filler Metal Added: Austenitic, for A358 and A409, Note (29) added (4) Under Plate, Sheet, and Strip: Austenitic, for A240, Notes revised

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		(5) Under Forgings: Austenitic, Spec No. A182 added and Notes revised (6) Under Forgings: Austenitic, for A965, Note (29) added (7) Under Fittings (Seamless and Welded): Austenitic, for A403, Note (29) added (8) Under Bar: Austenitic, for A479, Notes revised (9) General Note (a) revised (10) In Note (24), second sentence corrected to include ASTM A182
192	Table A-4	General Note (a) revised
206	Table A-5	General Note (a) revised
210	Table A-6	(1) Spec. No. B706 added (2) General Note (a) revised (3) Note (6) revised and Note (9) added
216	Table A-7	(1) Under Seamless Pipe and Seamless Extruded Tube, for B241, Notes revised (2) Under Sheet and Plate, for B209, Notes revised (3) Under Rods, Bars, and Shapes, for B221, Notes revised (4) General Note (a) revised (5) Former Notes (14) through (16) deleted and subsequent notes redesignated; former Note (23) deleted
224	Table A-8	General Note (a) revised
232	Table A-9	General Note (a) revised
236	Table A-10	(1) Under Carbon Steel, F3125 and SAE J429 added (2) Under Low and Intermediate Alloy Steel, F3125 and SAE J429 added (3) General Note (a) revised and General Note (i) added (4) Notes (32) through (34) added
266	Mandatory Appendix D	Deleted
267	Mandatory Appendix F	Updated
271	Mandatory Appendix G	(1) References to Figure D-1, Table D-1, and Mandatory Appendix D deleted (2) Symbols alphabetically reordered (3) Second definition of d added and P_o deleted (4) Reference for S_{lp} updated
277	Mandatory Appendix H	Information moved to the Correspondence With the B31 Committee page
282	N-101.1.2	First sentence revised
283	Table N-102.2.1-1	ASTM F2389 added
286	Table N-102.2.1-3	Note (1) revised
287	N-102.2.5	Last sentence revised
287	N-102.3.1	Subparagraphs (b)(3)(-c) and (b)(3)(-d) revised
289	N-104.1.1	Definition of c revised
290	N-104.3.1	Subparagraph (a) revised
291	N-104.7.2	Second sentence revised
292	N-114.2.1	Subparagraph (d) revised
292	N-119.1.1	Last sentence revised
293	N-119.1.2	Last sentence revised
293	N-119.5.2	First sentence revised

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293	N-119.5.3	First sentence revised
295	N-121.11	Last sentence revised
295	N-122.7.1	First sentence and subpara. (a) revised
302	N-127.5.2	Revised
302	N-127.5.3	Subparagraphs (a), (a)(1), and (a)(2) revised
303	N-127.6	Revised
306	N-135.3.5	Second sentence revised
308	Table N-136.4.1-1	Revised
316	Mandatory Appendix Q	Added
320	Mandatory Appendix R	Added
329	II-1.1	Third paragraph revised
332	II-2.2	Second paragraph revised
332	II-2.2.1	First paragraph revised
336	II-2.2.2	Revised
336	II-2.3.1.2	Revised
337	II-2.3.2	Last sentence revised
337	II-2.4	First sentence revised
337	II-3.2	Second sentence revised
337	II-3.4	Revised
340	II-4.2.1	Subparagraphs (a), (c), and (d) revised
340	II-4.2.2	First sentence revised
341	II-4.2.2.1	Subparagraphs (a) and (b) revised in their entirety
341	II-4.2.4	Revised
341	II-5.2.2	Revised in its entirety
341	II-5.3.1	Third paragraph revised
342	II-5.3.2	Revised
342	II-5.7	Subparagraph (b) revised
343	II-5.7.2	Revised
343	II-5.8	Second paragraph revised
354	Nonmandatory Appendix V, Foreword	Subparagraphs (a) and (c) revised
354	V-1	Definition of *critical piping systems* deleted
357	V-6.2.2	Last sentence added
358	V-8.1.1	First sentence revised
364	V-12	First sentence revised
366	V-14.1	First paragraph and subparas. (b), (d), (e), and (g) revised
367	V-15.1	References reformatted and footnote 1 added
368	Nonmandatory Appendix VII, Foreword	Second paragraph revised
369	VII-1.3	Revised
369	VII-2	Paragraphs VII-2.1.2 through VII-2.1.4 revised
370	VII-2.2	Paragraphs VII-2.2.1 and VII-2.2.2 revised
370	VII-3.1	First paragraph revised and SI units added throughout
370	VII-3.2	First paragraph revised and SI units added throughout

Page	*Location*	*Change*
371	VII-3.3	(1) SI units added throughout (2) In VII-3.3.3, second paragraph and nomenclature revised
374	VII-4.2	Paragraphs VII-4.2.1 through VII-4.2.3 revised
374	VII-4.4	Revised
374	VII-4.5	SI Units added
375	Figure VII-5-1	Revised
375	VII-6	Paragraphs VII-6.1 through VII-6.6 revised
379	Figure VII-6.4.4-1	Revised
380	Figure VII-6.6-1	Revised

Chapter I
Scope and Definitions

100 GENERAL

This Power Piping Code is one of several Sections of The American Society of Mechanical Engineers (ASME) 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 126.1-1. 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 Mandatory Appendix F.

100.1 Scope

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

(24) **100.1.1** This Code prescribes requirements for the design, materials, fabrication, erection, examination, testing, inspection, operation, and maintenance of piping systems. Where service requirements necessitate measures beyond those required by this Code, such measures shall be specified by the engineering design.

Piping as used in this Code includes pipe, flanges, bolting, gaskets, valves, pressure-relieving valves/devices, fittings, and the pressure-containing portions of other piping components, whether manufactured in accordance with standards listed in Table 126.1-1 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, and gage glasses, are included within the scope of this Code, but the requirements for boiler appurtenances shall be in accordance with ASME Boiler and Pressure Vessel Code (BPVC), Section I, 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 the inspection responsibilities specified in para. 136.1.

(24) **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 piping that 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 that 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 Figures 100.1.2-1 through 100.1.2-10.

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 ASME BPVC, Section I. All welding and brazing of this piping shall be performed by manufacturers or contractors authorized to use the ASME Certification Mark and appropriate Designators shown in ASME CA-1. The installation of boiler external piping by mechanical means may be performed by an organization not holding an ASME Certification Mark. However, the holder of a valid ASME Certification Mark, Certificate of Authorization, with an "S," "A," or "PP" Designator shall be responsible for the documentation and hydrostatic test, regardless of the method of assembly. The quality control system requirements of ASME BPVC, Section I; ASME CA-1; and ASME QAI-1shall apply.

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