

SECTION VII

2021

ASME Boiler and
Pressure Vessel Code
An International Code

**Recommended Guidelines
for the Care of Power Boilers**

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AN INTERNATIONAL CODE

2021 ASME Boiler & Pressure Vessel Code

2021 Edition

July 1, 2021

VII RECOMMENDED GUIDELINES FOR THE CARE OF POWER BOILERS

ASME Boiler and Pressure Vessel Committee
on Power Boilers



The American Society of
Mechanical Engineers

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* In the 2021 Edition, Subsections NC and ND have been incorporated into one publication, Subsection NCD (BPVC.III.1.NCD), Class 2 and Class 3 Components.

INTERPRETATIONS

Interpretations are issued in real time in ASME's Interpretations Database at <http://go.asme.org/Interpretations>. Historical BPVC interpretations may also be found in the Database.

CODE CASES

The Boiler and Pressure Vessel Code committees meet regularly to consider proposed additions and revisions to the Code and to formulate Cases to clarify the intent of existing requirements or provide, when the need is urgent, rules for materials or constructions not covered by existing Code rules. Those Cases that have been adopted will appear in the appropriate 2021 Code Cases book: "Boilers and Pressure Vessels" or "Nuclear Components." Each Code Cases book is updated with seven Supplements. Supplements will be sent or made available automatically to the purchasers of the Code Cases books up to the publication of the 2023 Code. Annulments of Code Cases become effective six months after the first announcement of the annulment in a Code Case Supplement or Edition of the appropriate Code Case book. Code Case users can check the current status of any Code Case at <http://go.asme.org/BPVCCDatabase>. Code Case users can also view an index of the complete list of Boiler and Pressure Vessel Code Cases and Nuclear Code Cases at <http://go.asme.org/BPVCC>.

FOREWORD*

In 1911, The American Society of Mechanical Engineers established the Boiler and Pressure Vessel Committee to formulate standard rules for the construction of steam boilers and other pressure vessels. In 2009, the Boiler and Pressure Vessel Committee was superseded by the following committees:

- (a) Committee on Power Boilers (I)
- (b) Committee on Materials (II)
- (c) Committee on Construction of Nuclear Facility Components (III)
- (d) Committee on Heating Boilers (IV)
- (e) Committee on Nondestructive Examination (V)
- (f) Committee on Pressure Vessels (VIII)
- (g) Committee on Welding, Brazing, and Fusing (IX)
- (h) Committee on Fiber-Reinforced Plastic Pressure Vessels (X)
- (i) Committee on Nuclear Inservice Inspection (XI)
- (j) Committee on Transport Tanks (XII)
- (k) Committee on Overpressure Protection (XIII)
- (l) Technical Oversight Management Committee (TOMC)

Where reference is made to “the Committee” in this Foreword, each of these committees is included individually and collectively.

The Committee’s function is to establish rules of safety relating to pressure integrity, which govern the construction** of boilers, pressure vessels, transport tanks, and nuclear components, and the inservice inspection of nuclear components and transport tanks. The Committee also interprets these rules when questions arise regarding their intent. The technical consistency of the Sections of the Code and coordination of standards development activities of the Committees is supported and guided by the Technical Oversight Management Committee. This Code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks, or nuclear components, or the inservice inspection of nuclear components or transport tanks. Users of the Code should refer to the pertinent codes, standards, laws, regulations, or other relevant documents for safety issues other than those relating to pressure integrity. Except for Sections XI and XII, and with a few other exceptions, the rules do not, of practical necessity, reflect the likelihood and consequences of deterioration in service related to specific service fluids or external operating environments. In formulating the rules, the Committee considers the needs of users, manufacturers, and inspectors of pressure vessels. The objective of the rules is to afford reasonably certain protection of life and property, and to provide a margin for deterioration in service to give a reasonably long, safe period of usefulness. Advancements in design and materials and evidence of experience have been recognized.

This Code contains mandatory requirements, specific prohibitions, and nonmandatory guidance for construction activities and inservice inspection and testing activities. The Code does not address all aspects of these activities and those aspects that are not specifically addressed should not be considered prohibited. The Code is not a handbook and cannot replace education, experience, and the use of engineering judgment. The phrase *engineering judgment* refers to technical judgments made by knowledgeable engineers experienced in the application of the Code. Engineering judgments must be consistent with Code philosophy, and such judgments must never be used to overrule mandatory requirements or specific prohibitions of the Code.

The Committee recognizes that tools and techniques used for design and analysis change as technology progresses and expects engineers to use good judgment in the application of these tools. The designer is responsible for complying with Code rules and demonstrating compliance with Code equations when such equations are mandatory. The Code neither requires nor prohibits the use of computers for the design or analysis of components constructed to the requirements of the Code. However, designers and engineers using computer programs for design or analysis are cautioned that they are responsible for all technical assumptions inherent in the programs they use and the application of these programs to their design.

* The information contained in this Foreword is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI’s requirements for an ANS. Therefore, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Code.

** *Construction*, as used in this Foreword, is an all-inclusive term comprising materials, design, fabrication, examination, inspection, testing, certification, and overpressure protection.

The rules established by the Committee are not to be interpreted as approving, recommending, or endorsing any proprietary or specific design, or as limiting in any way the manufacturer's freedom to choose any method of design or any form of construction that conforms to the Code rules.

The Committee meets regularly to consider revisions of the rules, new rules as dictated by technological development, Code Cases, and requests for interpretations. Only the Committee has the authority to provide official interpretations of this Code. Requests for revisions, new rules, Code Cases, or interpretations shall be addressed to the Secretary in writing and shall give full particulars in order to receive consideration and action (see Submittal of Technical Inquiries to the Boiler and Pressure Vessel Standards Committees). Proposed revisions to the Code resulting from inquiries will be presented to the Committee for appropriate action. The action of the Committee becomes effective only after confirmation by ballot of the Committee and approval by ASME. Proposed revisions to the Code approved by the Committee are submitted to the American National Standards Institute (ANSI) and published at <http://go.asme.org/BPVCPublicReview> to invite comments from all interested persons. After public review and final approval by ASME, revisions are published at regular intervals in Editions of the Code.

The Committee does not rule on whether a component shall or shall not be constructed to the provisions of the Code. The scope of each Section has been established to identify the components and parameters considered by the Committee in formulating the Code rules.

Questions or issues regarding compliance of a specific component with the Code rules are to be directed to the ASME Certificate Holder (Manufacturer). Inquiries concerning the interpretation of the Code are to be directed to the Committee. ASME is to be notified should questions arise concerning improper use of the ASME Single Certification Mark.

When required by context in this Section, the singular shall be interpreted as the plural, and vice versa, and the feminine, masculine, or neuter gender shall be treated as such other gender as appropriate.

The words "shall," "should," and "may" are used in this Standard as follows:

- *Shall* is used to denote a requirement.
- *Should* is used to denote a recommendation.
- *May* is used to denote permission, neither a requirement nor a recommendation.

STATEMENT OF POLICY ON THE USE OF THE ASME SINGLE CERTIFICATION MARK AND CODE AUTHORIZATION IN ADVERTISING

ASME has established procedures to authorize qualified organizations to perform various activities in accordance with the requirements of the ASME Boiler and Pressure Vessel Code. It is the aim of the Society to provide recognition of organizations so authorized. An organization holding authorization to perform various activities in accordance with the requirements of the Code may state this capability in its advertising literature.

Organizations that are authorized to use the ASME Single Certification Mark for marking items or constructions that have been constructed and inspected in compliance with the ASME Boiler and Pressure Vessel Code are issued Certificates of Authorization. It is the aim of the Society to maintain the standing of the ASME Single Certification Mark for the benefit of the users, the enforcement jurisdictions, and the holders of the ASME Single Certification Mark who comply with all requirements.

Based on these objectives, the following policy has been established on the usage in advertising of facsimiles of the ASME Single Certification Mark, Certificates of Authorization, and reference to Code construction. The American Society of Mechanical Engineers does not “approve,” “certify,” “rate,” or “endorse” any item, construction, or activity and there shall be no statements or implications that might so indicate. An organization holding the ASME Single Certification Mark and/or a Certificate of Authorization may state in advertising literature that items, constructions, or activities “are built (produced or performed) or activities conducted in accordance with the requirements of the ASME Boiler and Pressure Vessel Code,” or “meet the requirements of the ASME Boiler and Pressure Vessel Code.” An ASME corporate logo shall not be used by any organization other than ASME.

The ASME Single Certification Mark shall be used only for stamping and nameplates as specifically provided in the Code. However, facsimiles may be used for the purpose of fostering the use of such construction. Such usage may be by an association or a society, or by a holder of the ASME Single Certification Mark who may also use the facsimile in advertising to show that clearly specified items will carry the ASME Single Certification Mark.

STATEMENT OF POLICY ON THE USE OF ASME MARKING TO IDENTIFY MANUFACTURED ITEMS

The ASME Boiler and Pressure Vessel Code provides rules for the construction of boilers, pressure vessels, and nuclear components. This includes requirements for materials, design, fabrication, examination, inspection, and stamping. Items constructed in accordance with all of the applicable rules of the Code are identified with the ASME Single Certification Mark described in the governing Section of the Code.

Markings such as “ASME,” “ASME Standard,” or any other marking including “ASME” or the ASME Single Certification Mark shall not be used on any item that is not constructed in accordance with all of the applicable requirements of the Code.

Items shall not be described on ASME Data Report Forms nor on similar forms referring to ASME that tend to imply that all Code requirements have been met when, in fact, they have not been. Data Report Forms covering items not fully complying with ASME requirements should not refer to ASME or they should clearly identify all exceptions to the ASME requirements.

SUBMITTAL OF TECHNICAL INQUIRIES TO THE BOILER AND PRESSURE VESSEL STANDARDS COMMITTEES (21)

1 INTRODUCTION

(a) The following information provides guidance to Code users for submitting technical inquiries to the applicable Boiler and Pressure Vessel (BPV) Standards Committee (hereinafter referred to as the Committee). See the guidelines on approval of new materials under the ASME Boiler and Pressure Vessel Code in Section II, Part D for requirements for requests that involve adding new materials to the Code. See the guidelines on approval of new welding and brazing materials in Section II, Part C for requirements for requests that involve adding new welding and brazing materials (“consumables”) to the Code.

Technical inquiries can include requests for revisions or additions to the Code requirements, requests for Code Cases, or requests for Code Interpretations, as described below:

(1) *Code Revisions*. Code revisions are considered to accommodate technological developments, to address administrative requirements, to incorporate Code Cases, or to clarify Code intent.

(2) *Code Cases*. Code Cases represent alternatives or additions to existing Code requirements. Code Cases are written as a Question and Reply, and are usually intended to be incorporated into the Code at a later date. When used, Code Cases prescribe mandatory requirements in the same sense as the text of the Code. However, users are cautioned that not all regulators, jurisdictions, or Owners automatically accept Code Cases. The most common applications for Code Cases are as follows:

(-a) to permit early implementation of an approved Code revision based on an urgent need

(-b) to permit use of a new material for Code construction

(-c) to gain experience with new materials or alternative requirements prior to incorporation directly into the Code

(3) *Code Interpretations*

(-a) Code Interpretations provide clarification of the meaning of existing requirements in the Code and are presented in Inquiry and Reply format. Interpretations do not introduce new requirements.

(-b) Interpretations will be issued only if existing Code text is ambiguous or conveys conflicting requirements. If a revision of the requirements is required to support the Interpretation, an Intent Interpretation will be issued in parallel with a revision to the Code.

(b) Code requirements, Code Cases, and Code Interpretations established by the Committee 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 requirements.

(c) Inquiries that do not comply with the following guidance or that do not provide sufficient information for the Committee’s full understanding may result in the request being returned to the Inquirer with no action.

2 INQUIRY FORMAT

Submittals to the Committee should include the following information:

(a) *Purpose*. Specify one of the following:

(1) request for revision of present Code requirements

(2) request for new or additional Code requirements

(3) request for Code Case

(4) request for Code Interpretation

(b) *Background*. The Inquirer should provide the information needed for the Committee’s understanding of the Inquiry, being sure to include reference to the applicable Code Section, Division, Edition, Addenda (if applicable), paragraphs, figures, and tables. This information should include a statement indicating why the included paragraphs, figures, or tables are ambiguous or convey conflicting requirements. Preferably, the Inquirer should provide a copy of, or relevant extracts from, the specific referenced portions of the Code.

(c) *Presentations.* The Inquirer may desire to attend or be asked to attend a meeting of the Committee to make a formal presentation or to answer questions from the Committee members with regard to the Inquiry. Attendance at a BPV Standards Committee meeting shall be at the expense of the Inquirer. The Inquirer's attendance or lack of attendance at a meeting will not be used by the Committee as a basis for acceptance or rejection of the Inquiry by the Committee. However, if the Inquirer's request is unclear, attendance by the Inquirer or a representative may be necessary for the Committee to understand the request sufficiently to be able to provide an Interpretation. If the Inquirer desires to make a presentation at a Committee meeting, the Inquirer should provide advance notice to the Committee Secretary, to ensure time will be allotted for the presentation in the meeting agenda. The Inquirer should consider the need for additional audiovisual equipment that might not otherwise be provided by the Committee. With sufficient advance notice to the Committee Secretary, such equipment may be made available.

3 CODE REVISIONS OR ADDITIONS

Requests for Code revisions or additions should include the following information:

(a) *Requested Revisions or Additions.* For requested revisions, the Inquirer should identify those requirements of the Code that they believe should be revised, and should submit a copy of, or relevant extracts from, the appropriate requirements as they appear in the Code, marked up with the requested revision. For requested additions to the Code, the Inquirer should provide the recommended wording and should clearly indicate where they believe the additions should be located in the Code requirements.

(b) *Statement of Need.* The Inquirer should provide a brief explanation of the need for the revision or addition.

(c) *Background Information.* The Inquirer should provide background information to support the revision or addition, including any data or changes in technology that form the basis for the request, that will allow the Committee to adequately evaluate the requested revision or addition. Sketches, tables, figures, and graphs should be submitted, as appropriate. The Inquirer should identify any pertinent portions of the Code that would be affected by the revision or addition and any portions of the Code that reference the requested revised or added paragraphs.

4 CODE CASES

Requests for Code Cases should be accompanied by a statement of need and background information similar to that described in 3(b) and 3(c), respectively, for Code revisions or additions. The urgency of the Code Case (e.g., project underway or imminent, new procedure) should be described. In addition, it is important that the request is in connection with equipment that will bear the ASME Single Certification Mark, with the exception of Section XI applications. The proposed Code Case should identify the Code Section and Division, and should be written as a Question and a Reply, in the same format as existing Code Cases. Requests for Code Cases should also indicate the applicable Code Editions and Addenda (if applicable) to which the requested Code Case applies.

5 CODE INTERPRETATIONS

(a) Requests for Code Interpretations should be accompanied by the following information:

(1) *Inquiry.* The Inquirer should propose a condensed and precise Inquiry, omitting superfluous background information and, when possible, composing the Inquiry in such a way that a "yes" or a "no" Reply, with brief limitations or conditions, if needed, can be provided by the Committee. The proposed question should be technically and editorially correct.

(2) *Reply.* The Inquirer should propose a Reply that clearly and concisely answers the proposed Inquiry question. Preferably, the Reply should be "yes" or "no," with brief limitations or conditions, if needed.

(3) *Background Information.* The Inquirer should include a statement indicating why the included paragraphs, figures, or tables are ambiguous or convey conflicting requirements. The Inquirer should provide any need or background information, such as described in 3(b) and 3(c), respectively, for Code revisions or additions, that will assist the Committee in understanding the proposed Inquiry and Reply.

If the Inquirer believes a revision of the Code requirements would be helpful to support the Interpretation, the Inquirer may propose such a revision for consideration by the Committee. In most cases, such a proposal is not necessary.

(b) Requests for Code Interpretations should be limited to an Interpretation of a particular requirement in the Code or in a Code Case. Except with regard to interpreting a specific Code requirement, the Committee is not permitted to consider consulting-type requests such as the following:

(1) a review of calculations, design drawings, welding qualifications, or descriptions of equipment or parts to determine compliance with Code requirements

(2) a request for assistance in performing any Code-prescribed functions relating to, but not limited to, material selection, designs, calculations, fabrication, inspection, pressure testing, or installation

(3) a request seeking the rationale for Code requirements

6 SUBMITTALS

(a) *Submittal.* Requests for Code Interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at <http://go.asme.org/InterpretationRequest>. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt. If the Inquirer is unable to use the online form, the Inquirer may mail the request to the following address:

Secretary
ASME Boiler and Pressure Vessel Committee
Two Park Avenue
New York, NY 10016-5990

All other Inquiries should be mailed to the Secretary of the BPV Committee at the address above. Inquiries are unlikely to receive a response if they are not written in clear, legible English. They must also include the name of the Inquirer and the company they represent or are employed by, if applicable, and the Inquirer's address, telephone number, fax number, and e-mail address, if available.

(b) *Response.* The Secretary of the appropriate Committee will provide a written response, via letter or e-mail, as appropriate, to the Inquirer, upon completion of the requested action by the Committee. Inquirers may track the status of their Interpretation Request at <http://go.asme.org/Interpretations>.

PERSONNEL

(21)

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January 1, 2021

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ORGANIZATION OF SECTION VII

1 GENERAL

The purpose of Section VII, Recommended Guidelines for the Care of Power Boilers, is to promote safety in the use of power boilers. These guidelines are intended for use by those directly responsible for operating, maintaining, and examining power boilers.

With respect to the application of these guidelines, a power boiler is a pressure vessel constructed in compliance with Section I in which, due to the application of heat, steam is generated at a pressure exceeding 15 psig (100 kPa) for use external to the boiler. The heat may be derived from the combustion of fuel (solids, liquids, or gases), from the hot waste gases of other chemical reactions, or from the application of electrical energy. The term *power boiler* in this Section includes stationary, portable, and traction types, but does not include locomotive and high-temperature water boilers or miniature boilers (Section I), nuclear power plant boilers (Section III), heating boilers (Section IV), pressure vessels (Section VIII), or marine boilers.

These guidelines apply to the boiler proper, pipe connections and piping up to and including the valve or valves as required by the Code, superheaters, reheaters, economizers, and appurtenances that are directly associated with the boiler.

Guidelines are also provided for operation of auxiliary equipment that affects the safe and reliable operation of power boilers.

Formulating a set of guidelines that is applicable to all sites and types of plants is difficult; therefore, it may be advisable to depart from these guidelines in specific cases. Manufacturer's operating instructions should always be adhered to. Other industry-accepted codes and procedures, such as the National Fire Protection Association's codes covering prevention of furnace explosions, are recommended for additional guidance.

2 SUBSECTIONS AND ARTICLES

Section VII consists of [Subsections 1](#) through [5](#); Subsections are divided into Articles.

- [Subsection 1](#) — Watertube Drum-Type Industrial Steam Boilers: this Subsection focuses primarily on watertube drum-type industrial steam boilers fired with natural gas or fuel oil at steam conditions up to 600 psig and 750°F (4 MPa and 400°C), because of their extensive use.
 - [Article 100](#), Fundamentals of Watertube Boilers — a general description of boiler fundamentals, including steam generation, boiler assembly types, typically connected pressure parts, combustion, boiler efficiency, and emissions.
 - [Article 101](#), Boiler Operation — guidelines for routine boiler operation, including start-up, normal operation, and shutdown, as well as operator training for safe and reliable operation.
 - [Article 102](#), Boiler Auxiliaries — guidelines for normal and some emergency operations of fuel-burning equipment, air heaters, boiler feed pumps, fans, and other auxiliaries commonly used in the operation of boilers. Emphasis is placed on operating the auxiliaries to avoid an unsafe condition in a boiler.
 - [Article 103](#), Appurtenances — operating guidelines and descriptions for frequently used boiler appurtenances, such as pressure relief valves (safety valves), water columns, gage glasses, drum water-level transmitters, blowdown systems, pressure gages, feedwater regulator valves, and soot blowers.
 - [Article 104](#), Instrumentation, Controls, and Interlocks — brief description and listing of recommended instrumentation for monitoring boiler status and drum water level, controls for boiler operation, and interlocks to prevent unsafe conditions.
 - [Article 105](#), Examinations — guidelines for examination of boilers to ensure that the boiler is capable of safe and reliable operation. These guidelines apply only to those who are responsible for the examination, operation, and maintenance of boiler plants and must not be considered as applying to the state, municipal, or insurance companies' inspectors. Consideration should be given to the importance of continual examination as compared

with periodic examination. These guidelines are not intended to define or limit the extent of inspection by the Authorized Inspector.

- [Article 106](#), Repairs, Alterations, and Maintenance — guidelines for boiler repairs and alterations to return the boiler to a safe condition, and for routine maintenance programs to improve boiler availability and keep boilers in a safe operating condition.
- [Subsection 2](#) — Pertaining to All Steam Boilers: this Subsection is intended to apply to boilers described in Subsection 1 and is likely to apply to all Section I steam boilers.
 - [Article 200](#), Protecting Heat Transfer Surfaces — guidelines addressing internal cleaning, laying up, deposits, corrosion, steam contamination, water chemistry, and fire-side conditions
 - [Article 201](#), Preventing Boiler Failures — guidelines for operation of protective equipment, and precautions to prevent causes of boiler failures, such as overpressure, high or low water level, weakening of structure, explosions, and implosions
 - [Article 202](#), Documents, Records, and References — a description of typically required Code documentation and where to obtain copies; information regarding other sources of documents relative to a specific boiler installation, and guidelines for maintaining up-to-date records; and a listing of references cited in this Section
- [Subsection 3](#) — Other Boiler Types: this Subsection contains information regarding other boiler types as they differ from the watertube drum-type industrial steam boilers discussed in [Subsections 1](#) and [2](#).
 - [Article 300](#), Firetube Boilers
 - [Article 301](#), Electric Steam Boilers
 - [Article 302](#), Utility Boilers
- [Subsection 4](#) — Coal-Fired and Other Solid-Fuel-Fired Boilers: this Subsection includes guidelines unique to boilers fired by coal and other solid fuels.
 - [Article 400](#), Stoker-Fired Boilers
 - [Article 401](#), Pulverized-Coal-Fired Boilers
 - [Article 402](#), Ash Removal
 - [Article 403](#), Maintenance
- [Subsection 5](#) — Glossary. This Subsection is a glossary of words contained in Section VII or likely to be used regarding a boiler.

3 APPENDICES

[Mandatory Appendix I](#) — Standard Units for Use in Equations

[Nonmandatory Appendix A](#) — Checklists for Maintenance Examinations. This Nonmandatory Appendix contains checklists for the maintenance examinations of boilers.

[Nonmandatory Appendix B](#) — Guidance for the Use of U.S. Customary and SI Units in the ASME Boiler and Pressure Vessel Code

SUMMARY OF CHANGES

Errata to the BPV Code may be posted on the ASME website to provide corrections to incorrectly published items, or to correct typographical or grammatical errors in the BPV Code. Such Errata shall be used on the date posted.

Information regarding Special Notices and Errata is published by ASME at <http://go.asme.org/BPVCerrata>.

Changes given below are identified on the pages by a margin note, **(21)**, placed next to the affected area.

<i>Page</i>	<i>Location</i>	<i>Change</i>
viii	List of Sections	(1) Listing for Section III updated (2) Section XIII added (3) Code Case information updated
x	Foreword	(1) Subparagraph (k) added and subsequent subparagraph redesignated (2) Second footnote revised (3) Last paragraph added
xiii	Submittal of Technical Inquiries to the Boiler and Pressure Vessel Standards Committees	Paragraphs 1(a)(3)(-b), 2(b), and 5(a)(3) revised
xvi	Personnel	Updated
1	Article 100	(1) 100.2 revised in its entirety (2) 100.3 merged with 100.2 (3) New 100.3 and related figures added
46	103.4	(1) In title, "Classes" corrected by errata to "Glasses" (2) In first paragraph, third sentence added

LIST OF CHANGES IN RECORD NUMBER ORDER

DELETED

CROSS-REFERENCING AND STYLISTIC CHANGES IN THE BOILER AND PRESSURE VESSEL CODE

There have been structural and stylistic changes to BPVC, starting with the 2011 Addenda, that should be noted to aid navigating the contents. The following is an overview of the changes:

Subparagraph Breakdowns/Nested Lists Hierarchy

- First-level breakdowns are designated as (a), (b), (c), etc., as in the past.
- Second-level breakdowns are designated as (1), (2), (3), etc., as in the past.
- Third-level breakdowns are now designated as (-a), (-b), (-c), etc.
- Fourth-level breakdowns are now designated as (-1), (-2), (-3), etc.
- Fifth-level breakdowns are now designated as (+a), (+b), (+c), etc.
- Sixth-level breakdowns are now designated as (+1), (+2), etc.

Footnotes

With the exception of those included in the front matter (roman-numbered pages), all footnotes are treated as endnotes. The endnotes are referenced in numeric order and appear at the end of each BPVC section/subsection.

Submittal of Technical Inquiries to the Boiler and Pressure Vessel Standards Committees

Submittal of Technical Inquiries to the Boiler and Pressure Vessel Standards Committees has been moved to the front matter. This information now appears in all Boiler Code Sections (except for Code Case books).

Cross-References

It is our intention to establish cross-reference link functionality in the current edition and moving forward. To facilitate this, cross-reference style has changed. Cross-references within a subsection or subarticle will not include the designator/identifier of that subsection/subarticle. Examples follow:

- *(Sub-)Paragraph Cross-References.* The cross-references to subparagraph breakdowns will follow the hierarchy of the designators under which the breakdown appears.
 - If subparagraph (-a) appears in X.1(c)(1) and is referenced in X.1(c)(1), it will be referenced as (-a).
 - If subparagraph (-a) appears in X.1(c)(1) but is referenced in X.1(c)(2), it will be referenced as (1)(-a).
 - If subparagraph (-a) appears in X.1(c)(1) but is referenced in X.1(e)(1), it will be referenced as (c)(1)(-a).
 - If subparagraph (-a) appears in X.1(c)(1) but is referenced in X.2(c)(2), it will be referenced as X.1(c)(1)(-a).
- *Equation Cross-References.* The cross-references to equations will follow the same logic. For example, if eq. (1) appears in X.1(a)(1) but is referenced in X.1(b), it will be referenced as eq. (a)(1)(1). If eq. (1) appears in X.1(a)(1) but is referenced in a different subsection/subarticle/paragraph, it will be referenced as eq. X.1(a)(1)(1).

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SUBSECTION 1

WATERTUBE DRUM-TYPE INDUSTRIAL STEAM BOILERS

ARTICLE 100

FUNDAMENTALS OF WATERTUBE BOILERS

(21)

100.1 STEAM GENERATION

The primary function of a boiler is to generate steam. This is done by applying heat to the water in the boiler. The heat can be generated by electrical means or by combustion, i.e., burning fuel in a furnace.

Electric boilers are discussed in [Article 301](#).

In the fuel-burning method, the heat generated by combustion is conducted through the metal of the boiler or boiler tubes to the water on the other side.

100.2 WATERTUBE BOILERS

100.2.1 Watertube Boilers. In the watertube boiler, the water is inside the tubes and the gases of combustion pass around the outside of the tubes ([Figure 100.2.1-1](#)). The advantages of a watertube boiler versus a firetube boiler (see [Article 300](#)) are as follows:

- (a) a lower unit weight per pound (kilogram) of steam generated
- (b) less time required to raise steam pressure
- (c) a greater flexibility for responding to load changes
- (d) a greater ability to operate at higher steam pressures and at high rates of steam generation (This is due to the better circulation of water that carries heat away from the heating surfaces.)

The natural circulation of water through a watertube boiler depends solely on the difference in density of the steam and water mixture in the generating tubes, compared to the density of water in the downcomers. As the water is heated in the generating tubes, steam bubbles are formed and the heated mixture of steam and water rises as the weight of the denser water in the downcomers forces the heated mixture up the tubes, establishing circulation. To ensure that this circulation continues unimpaired, it is essential that the required level of water be maintained in the steam drum at all times.

100.2.2 Shop-Assembled (Package) Boilers. Small-size power boilers can be completely assembled in the boiler manufacturer's shop, including burners, fans, controls, soot blowers, etc. These boilers are shipped to the operating site by barge, rail, or over-the-road vehicles. They are called package boilers ([Figure 100.2.2-1](#)) and can be designed to operate at high pressures and capacities. Operating pressures of 1,000 psig (7 MPa) and capacities of 300,000 lb/hr (140 000 kg/hr) and steam temperatures of 950°F (510°C) can be achieved.

100.2.3 Field-Assembled Boilers. Boilers that are too large to ship completely assembled must be field erected. Frequently an economizer and its ductwork are shipped separately from the boiler. The boiler burners may also be separately shipped and installed at the site.

100.3 STEAM DRUMS

Features that make up a simple steam drum include a connection to introduce feedwater, downcomers to allow the distribution of water from the drum to downstream components, a system of risers to allow steam to re-enter the drum from saturated and/or superheated steam circuits (outlet headers) and a steam outlet connection (to the turbine, economizer recirculating system, etc., depending on boiler type) ([Figure 100.3-1](#)). In operation, the function of the steam drum