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ASME BOILER AND PRESSURE VESSEL CODE
AN AMERICAN NATIONAL STANDARD

ANSI/ASME BPV-IX

SECTION IX

Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators

1983 EDITION

JULY 1, 1983

ASME BOILER AND PRESSURE VESSEL COMMITTEE
SUBCOMMITTEE ON WELDING

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
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This code or standard was developed under procedures accredited as meeting the criteria for American National Standards. The Consensus Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed code or standard was made available for public review and comment which provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

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The footnotes in this document are part of this American National Standard.

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1983 ASME
BOILER AND PRESSURE VESSEL CODE

An American National Standard

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ADDENDA

Colored-sheet Addenda, which include additions and revisions to individual Sections of the Code, are published twice a year and will be sent automatically to purchasers of the applicable Sections up to the publication of the 1986 Code. Both Editions of the 1983 Code are available only in the loose-leaf format; accordingly, the Addenda will be issued only in the loose-leaf, replacement-page format.

Interpretations

ASME issues written replies to inquiries concerning interpretation of technical aspects of the Code. With the 1983 Edition, the Interpretations for each individual Section will be published separately and will be included with the Addenda service to that Section. Interpretations of Section III, Divisions 1 and 2, will be included with the Addenda service to Subsection NCA. Interpretations are not part of the Addenda to the Code.

CODE CASES

The Boiler and Pressure Vessel Committee meets 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 which have been adopted appear in one or both of the 1983 Code Cases books: (1) Boilers and Pressure Vessels and (2) Nuclear Components. Supplements will be sent automatically to the purchasers of one or both the Code Cases books up to the publication of the 1986 Edition. The Code Cases books are not available in a separate SI Edition.

FOREWORD

The American Society of Mechanical Engineers set up a committee in 1911 for the purpose of formulating standard rules for the construction of steam boilers and other pressure vessels. This committee is now called the Boiler and Pressure Vessel Committee.

The Committee's function is to establish rules of safety governing the design, fabrication, and inspection during construction of boilers and pressure vessels, and to interpret these rules when questions arise regarding their intent. 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 so as to give a reasonably long safe period of usefulness. Advancements in design and material and the evidence of experience have been recognized.

The Boiler and Pressure Vessel Committee deals with the care and inspection of boilers and pressure vessels in service only to the extent of providing suggested rules of good practice as an aid to owners and their inspectors.

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 Boiler and Pressure Vessel Committee meets regularly to consider requests for interpretations and revisions of the rules, and to develop new rules as dictated by technological development. Inquiries must be addressed to the Secretary in writing and must give full particulars in order to receive consideration and a written interpretation. Proposed revisions to the Code resulting from inquiries will be presented to the Main Committee for appropriate action. The action of the Main Committee becomes effective only after confirmation by letter ballot of the Committee and approval by the Council of the Society.

Proposed revisions to the Code approved by the Committee are submitted to the American National Standards Institute and published in *Mechanical Engineering* to invite comments from all interested persons. After the allotted time for public review and final approval by ASME Council, revisions are published semiannually in Addenda to the Code.

Code Cases may be used in the construction of components to be stamped with the ASME Code symbol beginning with the date of their approval by the ASME Council.

After Code revisions are approved by Council they may be used beginning with the date of issuance shown on the Addenda. Revisions become mandatory as minimum requirements six months after such date of issuance, except for boilers or pressure vessels contracted for prior to the end of the six-month period.

Manufacturers and users of components are cautioned against making use of revisions and Cases that are less restrictive than former requirements without having assurance that they have been accepted by the proper authorities in the jurisdiction where the component is to be installed.

Each state and municipality in the United States and each province in the Dominion of Canada that adopts or accepts one or more Sections of the Boiler and Pressure Vessel Code is invited to appoint a representative to act on the Conference Committee to the Boiler and Pressure Vessel Committee. Since the members of the Conference Committee are in active contact with the administration and enforcement of the rules, the requirements for inspection in this Code correspond with those in effect in their respective jurisdictions. The required qualifications for an Authorized Inspector or an Authorized Nuclear Inspector under these rules may be obtained from the administrative authority of any state, municipality, or province which has adopted these rules.

The Boiler and Pressure Vessel Committee in the formulation of its rules and in the establishment of maximum design and operating pressures considers materials, construction, methods of fabrication, inspection, and safety devices. Permission may be granted to regulatory bodies and organizations pub-

lishing safety standards to use a complete Section of the Code by reference. If usage of a Section, such as Section IX, involves exceptions, omissions, or changes in provisions, the intent of the Code might not be attained.

Where a state or other regulatory body, in the printing of any Section of the Boiler and Pressure Vessel Code, makes additions or omissions, it is recommended that such changes be clearly indicated.

The National Board of Boiler and Pressure Vessel Inspectors is composed of chief inspectors of states and municipalities in the United States and of provinces in the Dominion of Canada that have adopted the Boiler and Pressure Vessel Code. This Board, since its organization in 1919, has functioned to uniformly administer and enforce the rules of the Boiler and Pressure Vessel Code. The cooperation of that organization with the Boiler and Pressure Vessel Committee has been extremely helpful.

It should be pointed out that the state or municipality where the Boiler and Pressure Vessel Code has been made effective has definite jurisdiction over any particular installation. Inquiries dealing with problems of local character should be directed to the proper authority of such state or municipality. Such authority may, if there is any question or doubt as to the proper interpretation, refer the question to the Boiler and Pressure Vessel Committee.

The Specifications for base materials given in Section II, Parts A and B, are identical with or similar to those of The American Society for Testing and Materials. The Specifications for welding materials given in Section II, Part C, are identical with or similar to those of the American Welding Society. Use of the materials described in these Specifications is covered by the rules in one or more Sections of the Boiler and Pressure Vessel Code. All materials allowed by these various Sections and used for construction within the scope of their rules shall be furnished in accordance with ASME Material Specifications contained in Section II except where otherwise provided in Code Cases or in the applicable Section of the Code. Materials covered by these Specifications are acceptable for use in items covered by the Code Sections only to the degree indicated in the applicable Section. Materials for Code use should preferably be ordered, produced, and documented on this basis; however, material produced under an ASTM Specification may be used in lieu of the corresponding ASME Specification, provided that the requirements of the ASTM Specification are identical (excluding editorial differences) or more stringent than the ASME Specification for the Grade, Class, or Type produced and provided that the material is confirmed as complying with the ASTM Specification. Material produced to an ASTM specification with requirements different from the requirements of the corresponding ASME Specification may also be used in accordance with the above, provided the material manufacturer or vessel manufacturer certifies with evidence acceptable to the Authorized Inspector or Authorized Nuclear Inspector that the corresponding ASME Specification requirements have been met. Material produced to an ASME or ASTM Material Specification is not limited as to country of origin.

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.

STATEMENT OF POLICY ON THE USE OF CODE SYMBOLS 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 Code Symbols for marking items or constructions which 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 Code Symbols for the benefit of the users, the enforcement jurisdictions, and the holders of the symbols who comply with all requirements.

Based on these objectives, the following policy has been established on the usage in advertising of facsimiles of the symbols, 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 which might so indicate. An organization holding a Code Symbol 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."

The ASME Symbol 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 a Code Symbol who may also use the facsimile in advertising to show that clearly specified items will carry the symbol. General usage is permitted only when all of a manufacturer's items are constructed under the Rules.

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 official Code Symbol Stamp described in the governing Section of the Code.

Markings such as "ASME," "ASME Standard," or any other marking including "ASME" or the various Code Symbols shall not be used on any item which 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 which 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.

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CONTENTS

PART QB — BRAZING

INTRODUCTION

The following is a brief introduction to the 1983 Edition of Section IX, general in nature, and cannot be considered as a substitute for actual review of appropriate sections of the document. However, this will give the reader a better understanding of the purpose and organization of Section IX.

Section IX of the ASME Boiler and Pressure Vessel Code relates to the qualification of welders, welding operators, brazers, and brazing operators, and the procedures which they employ in welding or brazing according to the ASME Code. As such, this is an active document subject to constant review, interpretation, and improvement.

The format of Section IX was revised in 1974, and this format was substantially different from that of previous editions. Section IX establishes basic criteria for welding which are observed in the preparation of welding requirements that affect procedure and performance. It is important that the user of the 1983 Edition of Section IX understand these basic criteria in his review of the requirements which have been established.

The purpose of the Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) is to determine that the weldment proposed for construction is capable of having the required properties for its intended application. It is presupposed that the welder or welding operator performing the welding procedure qualification test is a skilled workman. That is, the welding procedure qualification test is to establish the properties of the weldment, not the skill of the welder or welding operator. In addition to this general requirement, special consideration was given when notch toughness is required by other Sections of the Code.

In performance qualification, the basic criterion established for the welder is to determine ability to deposit sound weld metal. The purpose of the performance qualification test for the welding operator is to determine mechanical ability to operate the welding machine.

In developing the revision of Section IX, each welding process to be included was reviewed with regard to those items (called variables) which have effect upon the welding operations as applied to procedure or performance criteria. It became apparent early in this review that the previous distinction between ferrous and nonferrous metals, with very few exceptions, would not be required as all metals in the welding processes have essentially similar variables in the production of weldments. For this reason, the document is established in two major parts: welding, to cover all metals involved in welding, and the present brazing document.

Welding

The welding part of the document consists of the following four Articles:

I. General Requirements
II. Procedure Qualifications
III. Performance Qualifications
IV. Welding Data

Article I General Requirements

This Article contains general references and guides which apply to procedure and performance requirements such as: weld orientations, more generally known as positions; the type of mechanical test employed with its acceptance criteria; and macroexamination with its acceptance criteria. It will be noted that this Article, as well as the following two Articles, contains written information only in paragraph form with reference data, tables, and figures in Article IV Welding Data. This will aid the user of the document in continuity of reading paragraphs, without interruption by tabulations or tables.

Article II Procedure Qualifications

Each process is listed separately with the essential and nonessential variables as applied to that particular process. In general, the new procedure requirements are that the manufacturer or contractor prepare written Welding Procedure Specifications (WPSs), which are greater in detail, to give guidance to the

welder or welding operator performing production weldments. Both the essential and nonessential variables for each welding process shall be included in the written Welding Procedure Specification. If a change is made in one or more of the essential variables, as has been in the past, preparation of a new or revised Welding Procedure Specification and requalification is required. If a change is made to one or more of the nonessential variables listed in the qualified Welding Procedure Specification, a new or revised Welding Procedure Specification is required; but the previous procedure qualification test will still be applicable. The types of tests for qualification of a Welding Procedure Specification are the same as those employed in the past: tension tests, bend tests, and when required, notch-toughness tests.

Each welding process is identified by a separate paragraph number. This paragraph is further divided into: essential variables, supplementary essential variables for notch toughness, and nonessential variables. The same variable may appear in both the supplementary essential variable paragraphs and nonessential variable paragraphs, and are considered as essential only when notch-toughness requirements are established by other Sections of the Code. In general, notch-toughness requirements are mandatory for all P-No. 11 quenched and tempered metals, for low temperature applications of other metals as applied to Section VIII, and for various classes of construction required by Section III. Acceptance criteria for the notch-toughness tests are as established in the other Sections of the Code. This Article refers to variables as QW-400 paragraph numbers in Article IV Welding Data. As a handy reference, the Welding Procedure Specification variables are contained in tabular form in QW-415.

In addition to covering various welding processes, rules are also included to cover special processes. Corrosion-resistant weld metal overlay and hard-facing weld metal overlay are the only special processes now included.

Article III Performance Qualifications

This Article lists the welding processes separately, with the essential variables which apply to welder performance qualifications. The welder qualification is limited by the essential variables given for each process. These essential variables are listed in Article IV Welding Data and are summarized in tabular form in QW-416.

A welding operator may be qualified by radiography of a test plate, radiography of his initial production welding, or by bend tests taken from a test plate. The welding operator qualifies by process only, with no specific limits. The lists of essential variables do not apply to welding operator qualifications. A significant change in welding operator qualification requirements is the deletion of sectioning.

Article IV Welding Data

The Welding Data Article includes the welding variables grouped as joints, base metals, filler metals, positions, preheat, postweld heat treatment, gas, electrical characteristics, and technique.

The P-Number tables are included as general groupings. The P-Numbers have been further divided into group numbers to classify metals, generally along strength levels, for the purpose of procedure qualification where notch-toughness requirements are a factor. The P-Number tables have both the ferrous and nonferrous metals.

The F-Number and A-Number tables were revised in the 1974 Edition to consolidate the ferrous and nonferrous metals in each table.

The tables concerned with tests and qualification limits are in QW-451 and QW-452 of the 1983 Edition. Two new tables, QW-451.3 and QW-451.4, were added to the 1977 Edition. These give the ranges qualifed and the tests required for fillet welds. QW-461.7 lists performance qualification position limitations.

The Graphics are similar to the Figures in the previous Section IX, with the inclusion of a new figure showing the test plate required for welders to be qualified for composite welds. Order of removal figures are shown for both procedure and performance qualifications.

PART QW WELDING

ARTICLE I
WELDING GENERAL REQUIREMENTS

QW-100 GENERAL

Section IX of the ASME Boiler and Pressure Vessel Code relates to the qualification of welders, welding operators, brazers, and brazing operators, and the procedures that they employ in welding and brazing according to the ASME Boiler and Pressure Vessel Code and the ASME B31 Code for Pressure Piping. It is divided into two parts: Part QW gives requirements for welding and Part QB contains requirements for brazing.

QW-100.1 The purpose of the Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) is to determine that the weldment proposed for construction is capable of providing the required properties for its intended application. It is presupposed that the welder or welding operator performing the welding procedure qualification test is a skilled workman. That is, the welding procedure qualification test establishes the properties of the weldment, not the skill of the welder or welding operator. In addition to this general requirement, special considerations for notch toughness are required by other Sections of the Code. Briefly, a WPS lists the variables, both essential and nonessential, and the acceptable ranges of these variables when using the WPS. The WPS is intended to provide direction for the welder. The PQR lists what was used in qualifying the WPS and the test results.

QW-100.2 In performance qualification, the basic criterion established for welder qualification is to determine the welder's ability to deposit sound weld metal. The purpose of the performance qualification test for the welding operator is to determine the operator's mechanical ability to operate the welding equipment.

QW-100.3 Welding Procedure Specifications (WPS) written and qualified in accordance with the rules of this Section, and welders and operators of automatic and machine welding equipment also qualified in accordance with these rules may be used in any construction built to the requirements of the ASME Boiler and Pressure Vessel Code or the ASME B31 Code for Pressure Piping.

However, other Sections of the Code state the conditions under which Section IX requirements are mandatory, in whole or in part, and give additional requirements. The reader is advised to take these provisions into consideration when using this Section.

Welding Procedure Specifications, Procedure Qualification Records, and Records of Performance Qualification made in accordance with the requirements of the 1962 Edition or any later Edition of Section IX may be used in any construction built to the ASME Boiler and Pressure Vessel Code or the ASME B31 Code for Pressure Piping.

Welding Procedure Specifications, Procedure Qualification Records, and Records of Performance Qualification made in accordance with the requirements of the Editions of Section IX prior to 1962, in which all of the requirements of the 1962 Edition or later Editions are met, may also be used.

Welding Procedure Specifications meeting the above requirements do not need to be amended to include any variables required by later Editions and Addenda.

Qualification of new Welding Procedure Specifications and requalification of existing Welding Procedure Specifications shall be in accordance with the current Edition (see Foreword) and Addenda of Section IX.