

ASME BOILER AND PRESSURE VESSEL CODE  
AN AMERICAN NATIONAL STANDARD

**SECTION IX**  
**Qualification Standard for Welding  
and Brazing Procedures, Welders,  
Brazers, and Welding  
and Brazing Operators**

1986 EDITION

JULY 1, 1986



ASME BOILER AND PRESSURE VESSEL COMMITTEE  
SUBCOMMITTEE ON WELDING

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS  
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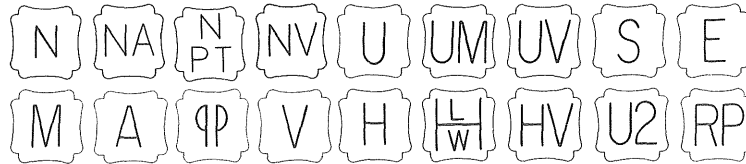
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# 1986 ASME BOILER AND PRESSURE VESSEL CODE

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## ADDENDA

Colored-sheet Addenda, which include additions and revisions to individual Sections of the Code, are published annually and will be sent automatically to purchasers of the applicable Sections up to the publication of the 1989 Code. The 1986 Code is available only in the loose-leaf format; accordingly, the Addenda will be issued in the loose-leaf, replacement-page format.

## INTERPRETATIONS

ASME issues written replies to inquiries concerning interpretation of technical aspects of the Code. The Interpretations for each individual Section will be published separately and will be included as part of the update service to that Section. They will be issued semiannually (July and December) up to the publication of the 1989 Code. Interpretations of Section III, Divisions 1 and 2, will be included with the update service to Subsection NCA. Interpretations are not part of the Code or the Addenda.

## 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 will appear in the appropriate 1986 Code Cases book: (1) Boilers and Pressure Vessels and (2) Nuclear Components. Supplements will be sent automatically to the purchasers of the Code Cases books up to the publication of the 1989 Code.

## 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 revisions of the rules, new rules as dictated by technological development, Code Cases, and requests for interpretations. Requests for interpretation must be addressed to the Secretary in writing and must give full particulars in order to receive consideration and a written interpretation (see Mandatory Appendix covering preparation of technical inquiries). 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 ASME.

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, revisions are published annually 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 ASME.

After Code revisions are approved by ASME, 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, in-

spection, and safety devices. Permission may be granted to regulatory bodies and organizations publishing 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. When reference is made in an ASME Material Specification to an ASTM Specification for which a companion ASME Specification exists, the reference shall be interpreted as applying to the ASME Material Specification. Specifications for welding materials given in Section II, Part C, are identical

with or similar to those of the American Welding Society. Not all materials included in the ASME Material Specifications in Section II have been adopted for Code use. Usage is limited to those materials and grades adopted by at least one of the other Sections of the Code for application under rules of that Section. 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 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 Ameri-

can 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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# INTRODUCTION

The following is a brief introduction to the 1986 Edition of Section IX and cannot be considered as a substitute for the actual review of appropriate sections of the document. However, this introduction is intended to 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 employed in welding or brazing in accordance with the ASME Boiler and Pressure Vessel Code and the ASME B31 Code for Pressure Piping. As such, this is an active document subject to constant review, interpretation, and improvement to recognize new developments and research data. Section IX is a document referenced for qualification by various construction codes such as Section I, III, IV, VIII, etc. These particular construction codes apply to specific types of fabrication and may impose additional welding requirements or exemptions to Section IX qualifications. Qualification in accordance with Section IX is not a guarantee that procedures and performance qualifications will be acceptable to a particular construction code.

Section IX establishes the basic criteria for welding and brazing which are observed in the preparation of welding and brazing requirements that affect procedure and performance. It is important that the user of the 1986 Edition of Section IX understand the basic criteria in reviewing 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. This also applies to the Brazing Procedure Specifications (BPS) and the brazer and brazing operator qualifications. The procedure qualification test is to establish the properties of the weldment or brazement and not the skill of the personnel performing the welding or

brazing. In addition, special consideration is given when notch toughness is required by other Sections of the Code. The notch-toughness variables do not apply unless referenced by the construction codes.

In Welder or Brazer/Brazing Operator Performance Qualification, the basic criterion is to determine the ability to deposit sound weld metal, or to make a sound braze. In Welding Operator Performance Qualification, the basic criterion is to determine the mechanical ability of the welding operator to operate the equipment.

In developing the present Section IX, each welding process and brazing process that was included was reviewed with regard to those items (called variables) which have an affect upon the welding or brazing operations as applied to procedure or performance criteria.

The user of Section IX should be aware of how Section IX is organized. It is divided into two parts: welding and brazing. Each part is then divided into four articles. These articles deal with the following:

- (a) general requirements (Article I Welding and Article XI Brazing)
- (b) procedure qualifications (Article II Welding and Article XII Brazing)
- (c) performance qualifications (Article III Welding and Article XIII Brazing)
- (d) data (Article IV Welding and Article XIV Brazing)

These articles contain general references and guides that apply to procedure and performance qualifications such as positions, type and purpose of various mechanical tests, acceptance criteria, and the applicability of Section IX, which was in the Preamble of the 1980 Section IX (the Preamble has been deleted). The general requirement articles reference the data articles for specifics of the testing equipment and removal of the mechanical test specimens.

## PROCEDURE QUALIFICATIONS

Each process that has been evaluated by Section IX is listed separately with the essential and nonessential

variables as they apply to that particular process. In general, the Welding Procedure Specifications (WPS) and the Brazing Procedure Specifications (BPS) are to list all essential and nonessential variables for each process that is included under that particular procedure specification. If a change is made in any essential variable, requalification of the procedure is required. If a change is made in a nonessential variable, the procedure need only be revised or amended to address the nonessential variable change. When notch toughness is required by the construction code, the supplementary essential variables become additional essential variables and a change requires requalification of the procedure.

In addition to covering various processes, there are also rules for procedure qualification of corrosion resistance, weld metal overlay, and hard-facing weld metal overlay.

## PERFORMANCE QUALIFICATIONS

These articles list separately the various welding and brazing processes with the essential variables that apply to the performance qualifications of each process. The welder, brazer, and brazing operator qualifications are limited by essential variables. In general, the welding operator has only one essential variable change in process.

The performance qualification articles have numerous paragraphs describing general applicable variables for all processes. QW-350 and QB-350 list additional essential variables which are applicable for specific processes. The QW-350 variables do not apply to welding operators.

Generally, a welder or welding operator may be qualified by mechanical bending tests, radiography of a test plate, or radiography of the initial production weld. Brazers or brazing operators may not be qualified by radiography.

## WELDING AND BRAZING DATA

The welding and brazing data articles include the variables grouped into categories such as joints, base materials and filler materials, solutions, pre-

heat/postweld heat treatment, gas, electrical characteristics, and technique. They are referenced from other articles as they apply to each process.

These articles are frequently misused by selecting variables that do not apply to a particular process. Variables (QW-402 to QW-410 and QB-402 to QB-410) only apply as referenced for the applicable process in Article II or Article III. The user of Section IX should not try to apply any variable which is not referenced by the particular table for that process in QW-250, QW-350, QB-250, or QB-350.

These articles also include assignments of P-Numbers and F-Numbers to particular base materials and filler materials. Article IV also includes A-Number tables for reference by the manufacturer.

The QW-451 and QB-451 tables for procedure qualification thickness requirements and the QW-452 and QB-452 tables for performance thickness qualifications are given and may only be used as referenced by other paragraphs. Generally, the appropriate essential variables reference these tables.

Revisions to the 1980 Edition of Section IX introduced new definitions for position and added a fillet weld orientation sketch to complement the groove-weld orientation sketch. The new revision to position indicates that a welder qualifies in the 1G, 2G, 3G, etc., position and is then qualified to weld, in production, in the F, V, H, or O positions as appropriate. QW-461.9 is a revised table that summarizes these new qualifications.

The data articles also give sketches of coupon orientations, removal of test specimens, and test jig dimensions. These are referenced by Articles I and XI.

QW-470 describes etching processes and reagents; QB-470 lists H-Numbers.

At the end of Articles IV and XIV is a list of general definitions applicable to Section IX, welding and brazing, respectively. These may differ slightly from other welding documents.

Nonmandatory Forms for procedure and performance qualifications appear in Appendix A (QW) for welding and Appendix A (QB) for brazing. These forms are provided for the aid of those who do not wish to design their own forms. Any form(s) that address all applicable requirements of Section IX may be used.

# 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 Welder/Welding Operator 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 Welder/Welding Operator 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