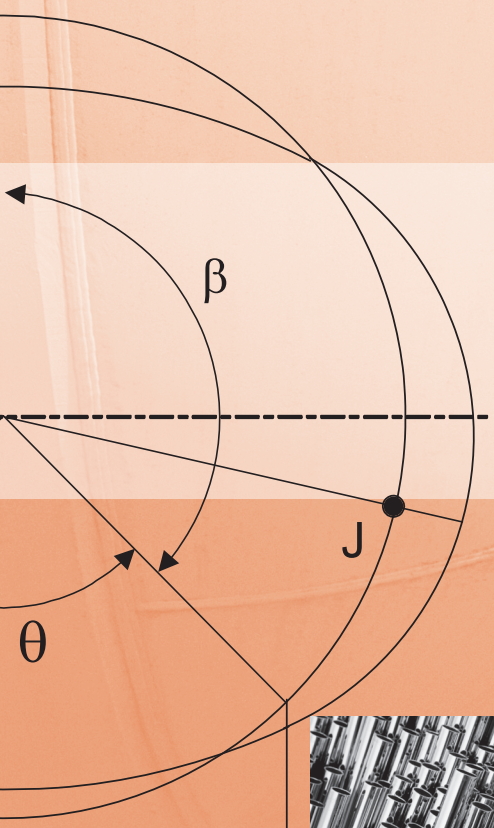
2010 ASME Boiler and Pressure Vessel Code

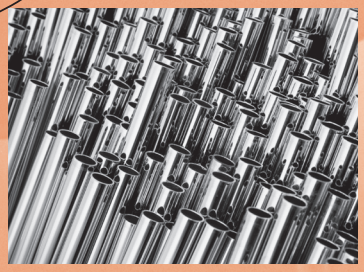
AN INTERNATIONAL CODE

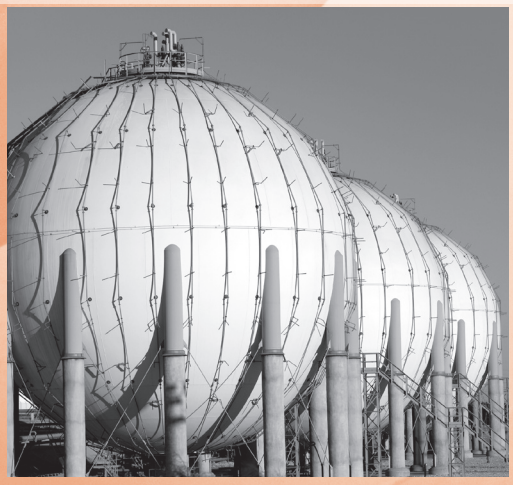
IX

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



Welding and Brazing Qualifications





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2010 ASME Boiler & Pressure Vessel Code

2010 Edition July 1, 2010

IX

QUALIFICATION STANDARD FOR WELDING AND BRAZING PROCEDURES, WELDERS, BRAZERS, AND WELDING AND BRAZING OPERATORS

ASME Boiler and Pressure Vessel Committee on Welding and Brazing

ASME
SETTING THE STANDARD
Three Park Avenue • New York, NY • 10016 USA

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(Includes all Addenda dated July 2009 and earlier)

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 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 that provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

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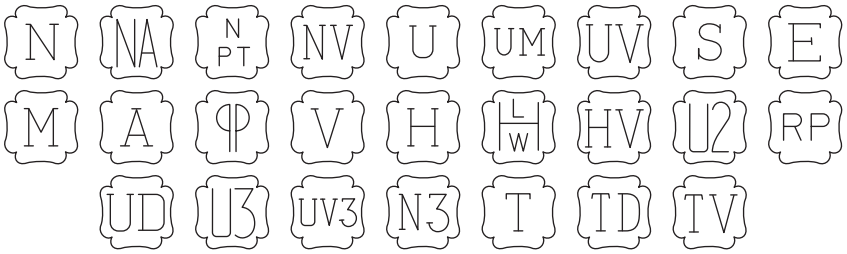

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The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

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2010 ASME
BOILER AND PRESSURE VESSEL CODE

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ADDENDA

Addenda, which include additions and revisions to individual Sections of the Code, will be sent automatically to purchasers of the applicable Sections up to the publication of the 2013 Code. The 2010 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. Interpretations of Section III, Divisions 1 and 2, will be included with the update service to Subsection NCA.

Interpretations of the Code are posted in January and July at www.cstools.asme.org/interpretations.

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 that have been adopted will appear in the appropriate 2010 Code Cases book: "Boilers and Pressure Vessels" and "Nuclear Components." Supplements will be sent automatically to the purchasers of the Code Cases books up to the publication of the 2013 Code.

FOREWORD

(10)

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, relating only to pressure integrity, governing the construction[1] of boilers, pressure vessels, transport tanks and nuclear components, and inservice inspection for pressure integrity of nuclear components and transport tanks, and to interpret these rules when questions arise regarding their intent. This code does not address other safety issues relating to the construction of boilers, pressure vessels, transport tanks and nuclear components, and the inservice inspection of nuclear components and transport tanks. The user of the Code should refer to other pertinent codes, standards, laws, regulations, or other relevant documents. With few 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. Recognizing this, the Committee has approved a wide variety of construction rules in this Section to allow the user or his designee to select those which will provide a pressure vessel having a margin for deterioration in service so as to give a reasonably long, safe period of usefulness. Accordingly, it is not intended that this Section be used as a design handbook; rather, engineering judgment must be employed in the selection of those sets of Code rules suitable to any specific service or need.

This Code contains mandatory requirements, specific prohibitions, and nonmandatory guidance for construction activities. The Code does not address all aspects of these activities and those aspects which 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 designers 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 they are responsible for the application of these programs to their design.

The Code does not fully address tolerances. When dimensions, sizes, or other parameters are not specified with tolerances, the values of these parameters are considered nominal and allowable tolerances or local variances may be considered acceptable when based on engineering judgment and standard practices as determined by the designer.

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. Only the Boiler and Pressure Vessel 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 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.

[1] *Construction*, as used in this Foreword, is an all-inclusive term comprising materials, design, fabrication, examination, inspection, testing, certification, and pressure relief.

Proposed revisions to the Code approved by the Committee are submitted to the American National Standards Institute and published at *http://cstools.asme.org/csconnect/public/index.cfm?PublicReview=Revisions* to invite comments from all interested persons. After the allotted time for public review and final approval by ASME, revisions are published in updates 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. Revisions, except for revisions to material specifications in Section II, Parts A and B, become mandatory six months after such date of issuance, except for boilers or pressure vessels contracted for prior to the end of the six-month period. Revisions to material specifications are originated by the American Society for Testing and Materials (ASTM) and other recognized national or international organizations, and are usually adopted by ASME. However, those revisions may or may not have any effect on the suitability of material, produced to earlier editions of specifications, for use in ASME construction. ASME material specifications approved for use in each construction Code are listed in the Guidelines for Acceptable ASTM Editions and in the Guidelines for Acceptable Non-ASTM Editions, in Section II, Parts A and B. These Guidelines list, for each specification, the latest edition adopted by ASME, and earlier and later editions considered by ASME to be identical for ASME construction.

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.

The Code 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 ASME Boiler and Pressure Vessel Committee. ASME is to be notified should questions arise concerning improper use of an ASME Code symbol.

The specifications for materials given in Section II are identical with or similar to those of specifications published by ASTM, AWS, and other recognized national or international organizations. When reference is made in an ASME material specification to a non-ASME specification for which a companion ASME specification exists, the reference shall be interpreted as applying to the ASME material specification. Not all materials included in the 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 material specifications contained in Section II or referenced in the Guidelines for Acceptable Editions in Section II, Parts A and B, 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; Guidelines for Acceptable Editions in Section II, Part A and Guidelines for Acceptable Editions in Section II, Part B list editions of ASME and year dates of specifications that meet ASME requirements and which may be used in Code construction. Material produced to an acceptable specification with requirements different from the requirements of the corresponding specifications listed in the Guidelines for Acceptable Editions in Part A or Part B may also be used in accordance with the above, provided the material manufacturer or vessel manufacturer certifies with evidence acceptable to the Authorized Inspector that the corresponding requirements of specifications listed in the Guidelines for Acceptable Editions in Part A or Part B have been met. Material produced to an acceptable 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

(10)

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 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 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 that 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." An ASME corporate logo shall not be used by any organization other than ASME.

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 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.

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INTRODUCTION

The following is a brief introduction to the 2007 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 2007 Edition of Section IX understand the basic criteria in reviewing the requirements which have been established.

Section IX does not contain rules to cover all welding and brazing factors affecting production weld or braze properties under all circumstances. Where such welding or brazing factors are determined by the Manufacturer to affect weld or braze properties, the Manufacturer shall address those welding or brazing factors to ensure that the required properties are achieved in the production weldment or brazement.

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 effect 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 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)

(e) standard welding procedures (Article V Welding)

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-resistant weld metal overlay and hard-facing weld metal overlay.

Beginning with the 2000 Addenda, the use of Standard Welding Procedure Specifications (SWPSs) was permitted. Article V provides the requirements and limitations that govern the use of these documents. The SWPSs approved for use are listed in Appendix E.

In the 2004 Edition, rules for temper bead welding were added.

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, welding operator, brazer, and brazing operator qualifications are limited by essential variables.

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. QW-360 lists the additional essential variables for welding operators.

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

WELDING AND BRAZING DATA

The welding and brazing data articles include the variables grouped into categories such as joints, base materials and filler materials, positions, preheat/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 for welding and Article XII or Article XIII for brazing. The user of Section IX should not try to apply any variable which is not referenced for that process in QW-250, QW-350, QW-360, 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.

Beginning with the 1994 Addenda, the welding P-Numbers, brazing P-Numbers, and nonmandatory S-Numbers were consolidated into one table identified as QW/QB-422. Both the QB-422 table (brazing P-Numbers) and Appendix C table (S-Numbers) were deleted. The new QW/QB-422 table was divided into ferrous and nonferrous sections. Metals were listed in numerical order by material specification number to aid users in locating the appropriate grouping number. An abbreviated listing of metals grouped by P-Numbers, Nonmandatory Appendix D, has been included for users still wishing to locate groupings of metals by welding P-Number.

In the 2009 Addenda, S-Number base metals listed in the QW/QB-422 table were reassigned as P-Numbers and the S-Number listings and references were deleted.

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.

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 welding and brazing procedure and performance qualifications appear in Appendix B. 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.

With the incorporation of the new Creep-Strength Enhanced Ferritic (CSEF) alloys into the Code, using the existing P-Number groupings to specify PWHT parameters can lead to variations in heat treatments that may significantly degrade the mechanical properties of these alloys.

CSEF alloys are a family of ferritic steels whose creep strength is enhanced by the creation of a precise condition of microstructure, specifically martensite or bainite, which is stabilized during tempering by controlled precipitation of temper-resistant carbides, carbo-nitrides, or other stable phases.

In the 2007 Edition of the Code, only P-No. 5B, Group 2 Base metals met this definition and was approved for Code construction. Looking forward, a number of CSEF alloys are already in use in Code Cases and drawing near to incorporation. To facilitate addressing their special requirements, P-Numbers 15A through P-Number 15F have been established for CSEF alloys.