

ASME BOILER AND PRESSURE VESSEL CODE
AN AMERICAN NATIONAL STANDARD
ANSI/ASME BPV-IIIC

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SECTION II

Material Specifications

Part C — Welding Rods, Electrodes, and Filler Metals

1980 EDITION

JULY 1, 1980



ASME BOILER AND PRESSURE VESSEL COMMITTEE
SUBCOMMITTEE ON MATERIALS

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
United Engineering Center 345 East 47th Street New York, N. Y. 10017

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1980 ASME
BOILER AND PRESSURE VESSEL CODE
An American National Standard

Sections*

- I Power Boilers
- II Material Specifications
 - Part A — Ferrous Materials
 - Part B — Nonferrous Materials
 - Part C — Welding Rods, Electrodes and Filler Metals
- III Subsection NCA — General Requirements for Division 1 and Division 2
- III Division 1
 - Subsection NB — Class 1 Components
 - Subsection NC — Class 2 Components
 - Subsection ND — Class 3 Components
 - Subsection NE — Class MC Components
 - Subsection NF — Component Supports
 - Subsection NG — Core Support Structures
 - Appendices
- III Division 2 — Code for Concrete Reactor Vessels and Containers
- IV Heating Boilers
- V Nondestructive Examination
- VI Recommended Rules for Care and Operation of Heating Boilers
- VII Recommended Rules for Care of Power Boilers
- VIII Pressure Vessels
 - Division 1
 - Division 2 — Alternative Rules
- IX Welding and Brazing Qualifications
- X Fiberglass-Reinforced Plastic Pressure Vessels
- XI Rules for Inservice Inspection of Nuclear Power Plant Components — Division 1

*Available in bound and loose-leaf versions. Either version may be used for ASME Certification.

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 1980 Code Cases books—(1) Boilers and Pressure Vessels and (2) Nuclear Components. Supplements will be sent automatically to the purchasers of one or both of the Code Cases books up to the publication of the 1983 edition.

Interpretations

Each issue of the Interpretations includes all of the written replies issued during successive month intervals by the Secretarial Staff, speaking on behalf of the ASME Boiler and Pressure Vessel Committee, to inquiries concerning interpretations of technical aspects of the Code. The inquiries and replies are presented chronologically in groupings determined by the Code Sections to which they apply. Issues are published twice a year. Purchasers of the Interpretations will receive the six issues (Nos. 6-11) that will be published up to the publication of the 1983 Code.

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 1983 Code. Purchasers of the bound versions of the Sections will receive bound Addenda. Purchasers of the loose-leaf versions of the Sections will receive replacement pages.

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Each issue of the Interpretations includes all of the written replies issued during successive 6-month intervals by the Secretarial Staff, speaking on behalf of the ASME Boiler and Pressure Vessel Committee, to inquiries concerning interpretations of technical aspects of the Code. The inquiries and replies are presented chronologically in groupings determined by the Code Sections to which they apply. Issues are published twice a year. Purchasers of the Interpretations will receive the six issues (Nos. 6-11) that will be published up to the publication of the 1983 Code.

Addenda

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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 special 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 approved 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. Its function is clearly recognized and, as a result, inquiries received which bear on the administration or application of the rules are referred directly to the National Board. Such handling of this type of inquiry not only simplifies the work of the Boiler and Pressure Vessel Committee, but action on the problem for the inquirer is thereby expedited. Where an inquiry is neither clearly an interpretation of the rules nor a problem of application or administration, it may be considered both by the Boiler and Pressure Vessel Committee and the National Board.

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.

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, construction, 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, 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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PREFACE

On January 3, 1919, the ASME participated with several other organizations in a meeting to discuss the continuation of wartime research in welding. Out of that meeting, the American Welding Society was established and since that time there has been a constant and interwoven record of development by the American Welding Society and The American Society of Mechanical Engineers of the techniques of welding. Through all of these great years of growth, many of the leaders in the field of engineering had the common interest of pressure equipment design and manufacture and the development of welding as a powerful tool in that manufacture. The evolution of this cooperative effort is contained in Professor A. M. Greene's "History of the ASME Boiler Code" which was published as a series of articles in *Mechanical Engineering* from July 1952 through August 1953 and is now available from ASME in a special bound edition. The following quotation from this history based on the minutes of the Committee notes the cooperative nature of the work done in the area of welding:

"During 1919, a number of cases involving welding were referred by the Boiler Code Committee to the Subcommittee on Welding.

"As the National Welding Council was to be discontinued, a new organization was to be formed to be known as the American Welding Society with which the American Bureau of Welding was to be affiliated. This was to be a body representing the entire industry and would eliminate commercial aspects, undertake research and standardization, and act as a judicial body

providing a medium for advancing the science and art of welding."

In 1935 the AWS-ASTM Joint Committee on Filler Metal was organized to provide standard specifications for welding rods, electrodes, filler metals and fluxes for this developing U.S. industry.

In 1969 these two sponsors agreed to dissolve this joint activity and to permit the American Welding Society to assume sole responsibility for the family of welding rods, electrodes, filler metal, and flux specifications then in being.

Section II, Part C, currently contains material specifications most of which are identical to corresponding specifications published by AWS. The ASME Committee reviews all material specifications submitted to it and if it is felt that there is any need to adapt them for Code purposes, revisions are made to them. However, there is constant liaison between ASME and AWS and there will be continuing effort to see that the specifications as produced by AWS and those printed in the ASME Code are identical.

To assure that there will be a clear understanding on the part of the users of Section II, ASME publishes both the identical specifications and those amended for Code usage in three parts every three years, in the same page size to match the other Sections of the Code, and Addenda are issued every six months to provide the latest changes in Section II specifications.

The ASME Boiler and Pressure Vessel Code has been adopted into law by 45 states and many municipalities in the United States and by all of the Canadian Provinces.

CONTENTS

WELDING RODS, ELECTRODES AND FILLER METALS

SFA-5.1	Carbon Steel Covered Arc Welding Electrodes	1
SFA-5.2	Iron and Steel Gas Welding Rods	35
SFA-5.4	Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes	45
SFA-5.5	Low Alloy Steel Covered Arc Welding Electrodes	67
SFA-5.6	Copper and Copper Alloy Covered Electrodes	97
SFA-5.7	Copper and Copper Alloy Bare Welding Rods and Electrodes	115
SFA-5.8	Brazing Filler Metal	125
SFA-5.9	Corrosion-Resisting Chromium and Chromium-Nickel Steel Bare and Composite Metal Cored and Standard Arc Welding Electrodes and Welding Rods	151
SFA-5.10	Aluminum and Aluminum Alloy Welding Rods and Bare Electrodes	167
SFA-5.11	Nickel and Nickel Alloy Covered Welding Electrodes	181
SFA-5.13	Surfacing Welding Rods and Electrodes	205
SFA-5.14	Nickel and Nickel Alloy Bare Welding Rods and Electrodes	235
SFA-5.16	Titanium and Titanium Alloy Bare Welding Rods and Electrodes	245
SFA-5.17	Bare Carbon Steel Electrodes and Fluxes for Submerged-Arc Welding	261
SFA-5.18	Carbon Steel Filler Metals for Gas Shielded Arc Welding	279
SFA-5.20	Carbon Steel Electrodes for Flux Cored Arc Welding	297
SFA-5.22	Flux Cored Corrosion-Resisting Chromium and Chromium-Nickel Steel Electrodes	317
SFA-5.23	Bare Low Alloy Steel Electrodes and Fluxes for Submerged Arc Welding	343
SFA-5.24	Zirconium and Zirconium Alloy Bare Welding Rods and Electrodes	367
SFA-5.25	Consumables Used for Electroslag Welding of Carbon and High Strength Low Alloy Steels	375
SFA-5.26	Consumables Used for Electrogas Welding of Carbon and High Strength Low Alloy Steels	395
SFA-5.27	Copper and Copper Alloy Gas Welding Rods	415
SFA-5.28	Low Alloy Steel Filler Metals	425

SPECIFICATION FOR CARBON STEEL COVERED ARC WELDING ELECTRODES



SFA-5.1



(Identical with AWS Specification A5.1-78)

Scope: This specification prescribes requirements for carbon steel covered electrodes for shielded metal arc welding of carbon and low alloy steels.

Note: The values stated in U.S. customary units are to be regarded as the standard. The SI units are given as equivalent values to the U.S. customary units. The published sizes and dimensions in the two systems are not identical, and for this reason conversion from a published size or dimension in one system will not always coincide with the published size or dimension in the other. Suitable conversions, encompassing published sizes of both, can be made, however, if appropriate tolerances are applied in each case.

1. Classification and Acceptance

1.1 Classification¹

1.1.1 The electrodes are classified on the basis of the mechanical properties of the weld metal in the as-welded condition, type of covering, welding position of the electrode, and type of current (see Table 1).

1.1.2 Any electrode classified under one classification shall not be classified under any other classification of this specification.

1.2 **Acceptance.** At the option and expense of the purchaser, any or all of the test requirements of this specification may be used as a basis for acceptance of the products covered by this specification.

1.3 **Chemical Composition Limits.** The chemical composition of the weld metal deposited by the electrodes shall conform to the limits of Table 2. The details of the test are specified in 3.4.

1. For an explanation of the system of classification of electrodes in this specification, see A1.2 in the Appendix.

1.4 **Mechanical, Usability, and Soundness Tests and Requirements.** When required in Table 8, the following tests are prescribed to demonstrate (1) the usability of electrodes classified herein, and (2) the mechanical properties and soundness of welds deposited with those electrodes. The tests are conducted in the as-welded condition.

1.4.1 **All-Weld-Metal Tension Test.** The tension test specimens made from weld metal deposited by the electrodes classified herein shall yield results conforming to the mechanical property requirements prescribed in Table 3. The details of the test are specified in 3.5 and 3.7.

1.4.2 **Impact Test.** The Charpy V-notch impact test specimens made from weld metal deposited by the electrodes classified herein shall yield results conforming to the impact requirements prescribed in Table 4. The details of the test are specified in 3.5 and 3.8.

1.4.3 **Soundness Test.** The radiographs of test assemblies shall indicate no cracks or zones of incomplete fusion nor any porosity or slag inclusion in excess of that allowed in Table 5 and Fig. 1. The details of the test are specified in 3.5 and 3.6.

1.4.4 **Transverse Tension Test.** The transverse tension test specimens shall yield results conforming to the requirements prescribed in Table 3. A specimen that breaks in the base metal shall be considered satisfactory provided the tensile strength obtained in the test is equal to or greater than the tensile strength required in Table 3 for the electrode being tested. The details of the test are specified in 3.9 and 3.10.

1.4.5 **Longitudinal Guided Bend Test.** The longitudinal guided bend test specimens shall, after bending, show no cracks or other open defect in the weld metal exceeding 1/8 in. (3 mm)* measured in any direction. The details of the test are specified in 3.9 and 3.11.

1.4.6 **Fillet Weld Test.** The fillet weld test specimen shall conform to the following requirements (see 3.12 for details of the test).

*See Note above.