AWS A5.1/A5.1M:2025
An American National Standard

Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding

American Welding Society®

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An American National Standard

Approved by the
American National Standards Institute
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Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding

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Prepared by the
American Welding Society (AWS) A5 Committee on Filler Metals and Allied Materials

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

Abstract

This specification prescribes the requirements for classification of carbon steel covered electrodes used for shielded metal arc welding. The requirements include chemical composition and mechanical properties of weld metal, weld metal soundness, usability tests of electrodes, and moisture tests of the low-hydrogen electrode covering. Requirements for standard sizes and lengths, marking, manufacturing, and packaging are also included.

Optional supplemental requirements include tests for improved toughness and ductility, lower absorbed moisture in the electrode covering, and for diffusible hydrogen in the weld metal.

This specification makes use of both U.S. Customary Units and the International System of Units (SI). Since these are not equivalent, each system must be used independently of the other.



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This standard is subject to revision at any time by the AWS A5 Committee on Filler Metals and Allied Materials. It must be reviewed every five years, and if not revised, it must be either reaffirmed or withdrawn. Comments (recommendations, additions, or deletions) and any pertinent data that may be of use in improving this standard are requested and should be addressed to AWS Headquarters. Such comments will receive careful consideration by the AWS A5 Committee on Filler Metals and Allied Materials and the author of the comments will be informed of the Committee's response to the comments. Guests are invited to attend all meetings of the AWS A5 Committee on Filler Metals and Allied Materials to express their comments verbally. Procedures for appeal of an adverse decision concerning all such comments are provided in the Rules of Operation of the Technical Activities Committee. A copy of these Rules can be obtained from the American Welding Society, 8669 NW 36 St, # 130, Miami, FL 33166.

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Foreword

This foreword is not part of this standard but is included for informational purposes only.

This document makes use of both U.S. Customary Units and the International System of Units (SI). The measurements are not exact equivalents; therefore, each system must be used independently of the other, without combining values in any way. In selecting rational metric units, AWS A1.1, *Metric Practice Guide for the Welding Industry* is used where suitable.

This specification is the latest revision of the first filler metal specification issued over 80 years ago. The initial 1940 document and the three revisions within the next five years were prepared by a joint committee of the American Society for Testing and Materials (ASTM) and the American Welding Society. However, they were issued with only an ASTM specification designation. The 1948 revision was the first specification issued with the AWS designation appearing on the document. The 1969 revision was the first time that the document was issued without the ASTM designation.

Document Development:

ASTM A 233-40T	*Tentative Specifications for Iron and Steel Arc-Welding Electrodes*
ASTM A 233-42T	*Tentative Specifications for Iron and Steel Arc-Welding Electrodes*
ASTM A 233-43T	*Tentative Specifications for Iron and Steel Arc-Welding Electrodes*
ASTM A 233-45T	*Tentative Specifications for Iron and Steel Arc-Welding Electrodes*
ASTM A 233-48T AWS A5.1-48T	*Tentative Specifications for Mild Steel Arc Welding Electrodes*
ASTM A 233-55T AWS A5.1-55T	*Tentative Specifications for Mild Steel Arc Welding Electrodes*
ASTM A 233-58T AWS A5.1-58T	*Tentative Specification for Mild Steel Arc Welding Electrodes*
AWS A5.1-64T ASTM A 233-64T	*Tentative Specification for Mild Steel Covered Arc Welding Electrodes*
AWS A5.1-69 ANSI W3.1-1973	*Specification for Mild Steel Covered Arc Welding Electrodes*
ANSI/AWS A5.1-78	*Specification for Carbon Steel Covered Arc-Welding Electrodes*
ANSI/AWS A5.1-81	*Specification for Carbon Steel Covered Arc-Welding Electrodes*
ANSI/AWS A5.1-91	*Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding*
AWS A5.1/A5.1M:2004	*Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding*
AWS A5.1/A5.1M:2012	*Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding*

Substantive changes in this document are shown in italic font and include:

(1) Computed Radiology (CR) and Digital Radiology (DR) have been added as options for radiographic inspection.

(2) Fillet weld requirements have been adapted to facilitate measurement with fillet weld gauges.

(3) E60-G and E70-G classifications have been added.

(4) Grade 3 Radiographic Acceptance Standards were added for E7024 and E7024-1 classifications.

(5) Table A.2 was deleted.

The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, no position is taken with respect to the validity of any such claim(s) or of any patent rights in connection therewith. If a patent holder has filed a statement of willingness to grant a license under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license, then details may be obtained from the standards developer.

Comments and suggestions for the improvement of this specification are welcome. They should be sent to the Secretary, Committee on Filler Metals and Allied Materials, American Welding Society, 8669 NW 36 St, # 130, Miami, FL 33166.

All errata to a standard shall be published in the *Welding Journal* and posted on the AWS website.

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Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding

1. Scope

1.1 This specification prescribes requirements for the classification of carbon steel electrodes for shielded metal arc welding of carbon steels.

1.2 This specification makes use of both U.S. Customary Units and the International System of Units (SI). The measurements are not exact equivalents; therefore, each system must be used independently of the other without combining in any way when referring to material properties. The specification designated A5.1 uses U.S. Customary Units. The specification designated A5.1M uses SI Units. The latter units are shown within brackets [ ] or in appropriate columns in tables and figures. Standard dimensions based on either system may be used for sizing of filler metal or packaging or both under either the A5.1 or the A5.1M specification.

1.3 Safety and health issues and concerns are beyond the scope of this standard; some safety and health information is provided, but such issues are not fully addressed herein. Some safety and health information can be found in Annex A, Clauses A5 and A10.

Safety and health information is available from the following sources:

American Welding Society:

(1) ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*

(2) AWS Safety and Health Fact Sheets

(3) Other safety and health information on the AWS website

Material or Equipment Manufacturers:

(1) Safety Data Sheets supplied by materials manufacturers

(2) Operating Manuals supplied by equipment manufacturers

Applicable Regulatory Agencies.

Work performed in accordance with this standard may involve the use of materials that have been deemed hazardous and may involve operations or equipment that may cause injury or death. This standard does not purport to address all safety and health risks that may be encountered. The user of this standard should establish an appropriate safety program to address such risks as well as to meet applicable regulatory requirements. ANSI Z49.1 should be considered when developing the safety program.

2. Normative References

The documents listed below are referenced within this publication and are mandatory to the extent specified herein. For undated references, the latest edition of the referenced standard shall apply. For dated references, subsequent amendments to or revisions of any of these publications do not apply.

American Welding Society (AWS) documents:

AWS A3.0M/A3.0, Standard Welding Terms and Definitions, Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying

AWS A4.3 ADD1, *Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding*

AWS A4.4M, *Standard Procedure for Determination of Moisture Content of Welding Fluxes and Welding Electrode Flux Coatings*

AWS A4.5M/A4.5, Standard Methods for Classification Testing of Positional Capacity and Root Penetration of Welding Consumables in a Fillet Weld

AWS A5.01M/A5.01, *Welding and Brazing Consumables—Procurement of Filler Metals and Fluxes*

AWS A5.02/A5.02M, Specification for Filler Metal Standard Sizes, Packaging, and Physical Attributes

AWS B4.0, *Standard Methods for Mechanical Testing of Welds*

American National Standards Institute (ANSI) document:

ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*

ASTM International (ASTM) document*s*:

ASTM A29/A29M, Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought

ASTM A36/A36M, Standard Specification for Carbon Structural Steel

ASTM A131/A131M, Standard Specification for Structural Steel for Ships

ASTM A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

ASTM A285/A285M, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength

ASTM E29, *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*

ASTM E350, *Standard Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron*

ASTM E1032, *Standard Test Method for Radiographic Examination of Weldments*

ASTM E2033, Standard Practice for Radiographic Examination Using Computed Radiography (Photostimulable Luminescence Method)

ASTM E2698, Standard Practice for Radiographic Examination Using Digital Detector Arrays

International Organization for Standardization (ISO) document:

ISO 80000-1, Quantities and units — Part 1: General.

3. Classification

3.1 The welding electrodes covered by the A5.1 and A5.1M specifications utilize a classification system (shown in Figure 1) based upon U.S. Customary Units and the International System of Units (SI), respectively, and are classified according to:

(1) Type of current (Table 1)

(2) Type of covering (Table 1)

(3) Welding position (Table 1)

(4) Mechanical properties of the weld metal in the as-welded condition (Tables 4 and 5)

3.2 Electrodes classified under one classification shall not be classified under any other classification in this specification, except as herein noted. *Electrodes classified as E60-G [E43-G] or E70-G [E49-G] may also be classified as any other classification provided that the electrode meets all of the requirements of both classifications.* E7018M [E4918M] electrodes may also be classified as E7018 [E4918] provided that the electrode meets all of the requirements of both classifications.