

AWS A5.10/A5.10M:2023
(ISO 18273:2015 MOD)
An American National Standard

Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods



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**AWS A5.10/A5.10M:2023
(ISO 18273:2015 MOD)
An American National Standard**

**Approved by the
American National Standards Institute
May 19, 2023**

Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods

13th Edition

Revises AWS A5.10/A5.10M:2021 (ISO 18273:2015 MOD)

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 requirements for the classification of bare wrought and cast aluminum-alloy electrodes and rods for use with the gas metal arc, gas tungsten arc, oxyfuel gas, and plasma arc welding processes.

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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J. S. Lee	<i>Consultant</i>
V. Van Der Mee	<i>Consultant</i>
D. A. Wright	<i>Wright Welding Technologies</i>

Foreword

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

This is the fourth edition of this specification with modified adoption of ISO 18273, *Welding Consumables – Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys – Classification*. Classification in accordance with this document requires prescribed weld testing which is not a requirement of ISO 18273. Therefore, classification to ISO 18273, without additional testing specified herein, does not provide classification to this document. Annex C provides more information on the differences in the two documents.

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. For selecting rational metric units, AWS A1.1, *Metric Practice Guide for the Welding Industry*, is used where suitable. Tables and figures make use of both U.S. Customary and SI units, which, with the application of the specified tolerances, provide for interchangeability of products in both U.S. Customary and SI Units.

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.

Substantive changes include a change to the rounding rules, and changes in radiography found in subclause 11.4 and Figures 4A, 4B, and 5. These substantive changes are shown in *italic* font.

This specification developed as follows:

ASTM B285-54T AWS A5.10-54T	<i>Tentative Specification for Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes</i>
ASTM B285-57T AWS A5.10-57T	<i>Tentative Specification for Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes</i>
AWS A5.10-61T ASTM B285-61T	<i>Tentative Specification for Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes</i>
AWS A5.10-69 ANSI W5.10-1973	<i>Specification for Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes</i>
ANSI/AWS A5.10-80	<i>Specification for Aluminum and Aluminum-Alloy Bare Electrodes and Rods</i>
ANSI/AWS A5.10-88	<i>Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods</i>
ANSI/AWS A5.10-92	<i>Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods</i>
AWS A5.10/A5.10M:1999	<i>Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods</i>
AWS A5.10/A5.10M:1999 (R2007)	<i>Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods</i>

AWS A5.10/A5.10M:2012
(ISO 18273:2004 MOD)

*Welding Consumables—Wire Electrodes, Wires and Rods for Welding
of Aluminum and Aluminum-Alloys – Classification*

AWS A5.10/A5.10M:2017
(ISO 18273:2004 MOD)

*Welding Consumables—Wire Electrodes, Wires and Rods for Welding of
Aluminum and Aluminum-Alloys – Classification*

AWS A5.10/A5.10M:2021
(ISO 18273:2015 MOD)

*Specification for Bare Aluminum and Aluminum-Alloy
Welding Electrodes and Rods*

Comments and suggestions for the improvement of this standard are welcome. They should be sent to the Secretary, AWS A5 Committee on Filler Metals and Allied Materials, American Welding Society, 8669 NW 36th St., # 130, Miami, FL 33166.

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

Table of Contents

	Page No.
<i>Personnel</i>	v
<i>Foreword</i>	vii
<i>List of Tables</i>	x
<i>List of Figures</i>	x
1. Scope	1
2. Normative References	1
3. Classifications	2
4. Acceptance	2
5. Certification	2
6. Rounding Procedure	3
7. Summary of Tests	3
8. Retest	3
9. Weld Test Assemblies	4
10. Chemical Analysis	4
11. Radiographic Test	5
12. Tension Test	5
13. Bead-on-Plate Test	6
14. Method of Manufacture	6
15. Standard Sizes	6
16. Finish and Uniformity	6
17. Standard Package Forms	6
18. Winding Requirements	6
19. Filler Metal Identification	6
20. Packaging	7
21. Marking of Packages	7
Annex A (Informative)—Guide to Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods	23
Annex B (Informative)—Requesting an Official Interpretation on an AWS Standard	37
Annex C (Informative)—List of Deviations from ISO 18273:2015	39
AWS Filler Metal Specifications by Material and Welding Process	41
AWS Filler Metal Specifications and Related Documents	43

List of Tables

Table	Page No.
1. Symbols and Chemical Composition Requirements for Electrodes and Rods	8
2. Required Tests	11
3. Base Metal for Soundness, Usability, and Mechanical Testing	13
4. Welding Parameters for Groove Weld Mechanical Testing	14
5. Mechanical Testing Requirements	14
6. Typical Sizes of Flattened Rods	15
A.1. Weld Metal Properties—(To Be Used in Conjunction with Table A.2)	31
A.2. Aluminum Filler Metal Selection Chart	32
A.3. Discontinued Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods	35

List of Figures

Figure	Page No.
1. A5.10/A5.10M Classification System	16
2. Groove Weld Test Assembly for Radiographic Test	17
3. Groove Weld Test Assembly for Weld Metal Tension Properties	18
4A. Radiographic Acceptance Standards for 3/16 in [5 mm] and 1/4 in [6 mm] Thick Test Assemblies—Overhead Welding Position	19
4B. Radiographic Acceptance Standards for 3/8 in [10 mm] Thick Test Assemblies—Overhead Welding Position	20
5. Radiographic Acceptance Standard for Test Assemblies—Flat Welding Position	21

Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods

1. Scope

1.1 This specification prescribes requirements for classification of solid electrodes and rods for fusion welding of aluminum and aluminum alloys. The classification of the solid electrodes and rods is based on their chemical composition, operability testing and mechanical testing, when required.

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 weld metal properties. The specification A5.10 uses U.S. Customary Units. The specification with the designation A5.10M uses SI units. The latter are shown within brackets [] or in appropriate columns in tables and figures. Standard dimensions based on either system may be used for the sizing of electrodes or packaging or both under specification A5.10 or A5.10M.

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 A11.

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 or revisions of the publications may not apply since the relevant requirements may have changed.

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 A5.01M/A5.01, *Welding 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) documents:

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

ASTM International (ASTM) documents:

ASTM B108, *Standard Specification for Aluminum-Alloy Permanent Mold Castings*

ASTM B209, *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate*

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

ASTM E34, *Standard Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys*

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

ASTM E2033, *Standard Practice for Computed Radiology (Photostimulable Luminescence Method)*

ASTM E2698, *Standard Practice for Radiological Examination Using Digital Detector Arrays*

International Organization for Standardization (ISO) documents.

ISO 80000-1:2022, *Quantities and units — Part 1: General*.

3. Classifications

3.1 The classification designation system is as shown in Figure 1, and the symbols and chemical compositions are as shown in Table 1.

3.1.1 Any filler metal tested and classified as an electrode shall also be considered classified as a welding rod. Filler metal tested and classified only as a welding rod shall not be considered classified as an electrode.

3.1.2 The electrodes and rods classified under this specification are intended for gas metal arc, gas tungsten arc, oxyfuel gas, and plasma arc welding, but that is not to prohibit their use with any other process for which they are found suitable.

3.2 Electrodes and rods classified under one classification shall not be classified under any other classification in this specification.

4. Acceptance

Acceptance of the welding electrodes and rods shall be in accordance with the provisions of AWS A5.01M/A5.01. See Clause A3 in Annex A for further information concerning acceptance, testing of the material shipped, and AWS A5.01M/A5.01.

5. Certification

By affixing the AWS specification and classification designations to the packaging or the classification designation to the product, the manufacturer certifies that the product meets the requirements of this specification. See Clause A4 in Annex A for further information concerning certification and the testing called for to meet this requirement.

6. Rounding Procedure

The Aluminum Association International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys (commonly known as Teal Sheets) has a rule (Footnote 1 in its table of Chemical Composition Limits) for setting chemical composition as follows:

Composition in weight percent maximum unless shown as a range or a minimum. Standard limits for alloying elements and impurities are expressed to the following places:

Less than 0.001 percent..... 0.000X

0.001 but less than 0.01 percent..... 0.00X

0.01 but less than 0.10 percent

Unalloyed aluminum made by a refining process 0.0XX

Alloys and unalloyed aluminum not made by a refining process 0.0X

0.10 through 0.55 percent 0.XX

(It is customary to express limits of 0.30 percent through 0.55 percent as 0.X0 or 0.X5).

Over 0.55 percent 0.X, X.X, etc.

(except that combined Si + Fe limits for 1xxx designations must be expressed as 0.XX or 1.XX).

The following rounding rules apply to all other areas of this specification:

For the purpose of determining compliance with the requirements of this standard, the actual test values obtained shall be subjected to the rounding rules of ASTM E29 or Rule A in Clause B.3 of ISO 80000-1 (the results are the same). If the measured values are obtained by equipment calibrated in units other than those of the specified limit, the measured values shall be converted to the units of the specified limit before rounding. If an average value is to be compared to the specified limit, rounding shall be done only after calculating the average. An observed or calculated value shall be rounded to the nearest 1000 psi (1 ksi) for tensile and yield strength for A5.10 [to the nearest 5 MPa for tensile and yield strength for A5.10M] and to the nearest unit in the last right-hand place of figures used in expressing the limiting values for other quantities. The rounded results shall fulfill the requirements for the classification under test.

7. Summary of Tests

The tests required for each classification are specified in Table 2. The purpose of these tests is to determine the chemical composition of the filler metal, the soundness of the weld metal produced by gas metal arc welding electrodes, the deposition characteristics of welding rods, and the strength of the weld metal, when required. The base metal for the weld test assemblies, the welding and testing procedures to be employed, and the results required are given in Clauses 9 through 13.

8. Retest

If the result of any test fails to meet the requirement, that test shall be repeated twice. The results of both retests shall meet the requirement. Specimens for the retest may be taken from the original weld test assembly or test sample or from a new weld test assembly or from a new test sample. For chemical analysis, retest need be only for those specific elements that failed to meet the test requirement. If the results of one or both retests fail to meet the requirement, the material under test shall be considered as not meeting the requirements of this specification for that classification.

In the event that, during preparation or after completion of any test, it is clearly determined that prescribed or proper procedures were not followed in preparing the weld test sample or test specimen(s), or in conducting the test, the test shall be considered invalid, without regard to whether the test was actually completed, or whether the test results met or failed to meet the requirement. That test shall be repeated, following proper prescribed procedures. In this case, the requirement for doubling the number of test specimens does not apply.

9. Weld Test Assemblies

9.1 One or two weld test assemblies are required:

- (a) The groove weld test assembly for the usability of electrodes and the soundness of the weld metal (see 9.3 and Figure 2).
- (b) The groove weld test assembly for mechanical properties (see 9.4 and Figure 3).
- (c) The bead-on-plate weld test assembly for the usability of rods (see 9.5).

9.2 Usability tests shall be made using electrodes and welding rods of each diameter. A filler metal that satisfactorily meets the requirements of the radiographic soundness test, when tested as an electrode, shall also be classified as a welding rod without being subjected to the bead-on-plate test required for a welding rod. A filler metal that satisfactorily meets the bead-on-plate test requirements may be classified as a rod. In order to be classified as an electrode, the filler metal shall also be tested as an electrode, and meet the testing requirements.

9.3 Groove Weld for Soundness and Usability of Electrodes

9.3.1 A test assembly shall be prepared and welded as specified in Figure 2 and Clause 9.3.2 through 9.3.4 using base metal of the appropriate type specified in Table 3. The welding position shall be as specified in Figure 2 for each electrode diameter. Testing of the assembly shall be as specified in Clause 11, Radiographic Test.

9.3.2 Welding of the test assembly shall be conducted using the gas metal arc welding process with techniques and procedures specified by the manufacturer for the factors not covered herein.

9.3.3 Dimensions of the groove weld joint and the position of welding shall be as specified in Figure 2 for the electrode diameter being tested. The backing material shall be of the same type as the test plate base metal.

9.3.4 The test assembly shall be at a temperature of not less than 60 °F [16 °C] when commencing the initial or subsequent weld passes. The preheat and interpass temperatures shall not exceed 250 °F [120 °C].

9.4 Groove Weld Test for Mechanical Properties

9.4.1 When required in Table 2, a groove weld test assembly shall be prepared and welded as specified in Figure 3 and Table 4.

9.4.2 The electrode diameter shall be 0.047 in or 0.062 in [1.2 mm or 1.6 mm], or the nearest size manufactured. The welding parameters shall be as specified in Table 4. Base plate and backing strip materials shall be used as specified in Table 3. Alternately, 1xxx or 6xxx series base plate and backing strip materials may be used for all classifications. The test assembly shall be at a temperature of not less than 60 °F [16 °C] when commencing the initial or subsequent weld passes. The preheat and interpass temperatures shall not exceed 250 °F [120 °C].

9.4.3 Welding shall be in the flat position. The assembly may be pre-set or restrained during welding to prevent excess warpage. Testing of the assemblies shall be as required in Clause 12, Tension Test.

9.5 Bead-on-Plate Weld Test for Usability of Welding Rods

9.5.1 The test assembly shall consist of sheet, plate, or extrusion approximately 12 in [300 mm] in length upon which a weld shall be made as specified in 9.5.2, using base metal of the appropriate type specified in Table 3. Examination of the assembly shall be as specified in Clause 13, Bead-on-Plate Test.

9.5.2 The assembly shall be welded in the flat position with the gas tungsten arc welding process employing alternating current and argon gas shielding. The test plate thickness and the welding current shall be compatible with the rod size being tested.

9.5.3 The completed bead-on-plate welds shall be examined with the unaided eye (corrected to normal vision) and shall meet the requirements specified in Clause 13, Bead-on-Plate Test.

10. Chemical Analysis

10.1 A sample of the filler metal, or the stock from which it is made, shall be prepared for chemical analysis by any method that will not affect the chemical composition.

10.2 The sample shall be analyzed by accepted analytical methods. The referee method shall be ASTM E34.

10.3 The results of the analysis shall meet the requirements of Table 1 for the classification of electrode or rod under test.

11. Radiographic Test

11.1 The groove weld described in 9.3 and shown in Figure 2 shall be radiographed to evaluate the soundness of the weld metal. In preparation for radiography, the backing shall be removed and both surfaces of the weld shall be machined or ground smooth and flush with the original surfaces of the base metal or with a uniform reinforcement not exceeding 3/32 in [2.5 mm]. It is permitted on both sides of the test assembly to remove base metal to a depth of 1/16 in [1.5 mm] nominal below the original base metal surface in order to facilitate backing and/or buildup removal. The thickness of the weld metal shall not be reduced by more than 1/16 in [1.5 mm] so that the thickness of the prepared radiographic test specimen equals at least the thickness of the base metal minus 1/16 in [1.5 mm]. Both surfaces of the test assembly, in the area of the weld, shall be smooth enough to avoid difficulty in interpreting the radiograph.

11.2 The weld shall be radiographed in accordance with one of the following. The quality level of inspection shall be 2-2T.

(1) Film Radiology: ASTM E1032.

(2) Computed Radiology (CR): ASTM E2033 and the requirements of ASTM E1032 except where CR differs from film. The term film, as used within ASTM E1032, applicable to performing radiography in accordance with ASTM E2033, refers to phosphor imaging plate.

(3) Digital Radiology (DR): ASTM E2698 and the requirements of ASTM E1032 except where DR differs from film. The term film, as used within ASTM E1032, applicable to performing radiography in accordance with ASTM E2698, refers to digital detector array (DDA).

11.3 The soundness of the weld metal and the usability of the electrode meet the requirements of this specification if the radiograph shows no cracks, no incomplete fusion, and no rounded indications in excess of those permitted by the radiographic standards in Figure 4 for test assemblies welded in the overhead position for electrode sizes up to and including 1/16 in [1.6 mm], and in Figure 5 for test assemblies welded in the flat position for electrode sizes larger than 1/16 in [1.6 mm]. In evaluating the radiograph, the center 6 in [150 mm] of the test specimen shall be considered, and all extra weld shall be disregarded.

A rounded indication is an indication on the radiograph whose length is no more than three times its width. Rounded indications may be circular, elliptical, conical, or irregular in shape and they may have tails. The size of the rounded indication is the largest dimension of the indication including any tail that may be present. Indications whose largest dimension does not exceed 1/64 in [0.4 mm] shall be disregarded. Test assemblies with indications larger than the large indications permitted in the radiographic standards in Figure 4 and Figure 5 do not meet the requirements of this specification.

11.4 *The alternative method of evaluation of radiographic conformance involves calculation of the total area of the rounded indications as they appear on the radiograph. This total area shall not exceed 1.5% of the thickness of the test assembly multiplied by the length of the weld used in evaluation for overhead weld assemblies, or 1% of the thickness of the test assembly multiplied by the length of the weld used in evaluation for flat weld assemblies. The values given in Note 3 to each Figure (4A, 4B, and 5) have been calculated for 6 in [150 mm] of weld. The maximum size permitted still applies.*

11.5 An electrode that produces a groove weld which satisfactorily meets these radiographic requirements may also be classified as a welding rod under this specification without conducting the test specified in 9.5.

12. Tension Test

12.1 One all-weld-metal tension test specimen, as specified in the Tension Test Clause of AWS B4.0, shall be machined from the welded test assembly described in 9.4 and shown in Figure 3. The tensile specimen shall have a nominal diameter of 0.500 in [12.5 mm], and a nominal gage length to diameter ratio of 4:1. The specimen shall be tested in the

manner described in the Tension Test Clause of AWS B4.0. The results of the all-weld-metal tension test shall meet the requirements specified in Table 5 for that classification.

12.2 An electrode that produces a groove weld which satisfactorily meets the tension test requirements of Table 5 and the other requirements for classification as an electrode may also be classified as a welding rod under this specification.

13. Bead-on-Plate Test

13.1 Welding rod tested in accordance with 9.5 shall produce weld metal that flows freely and uniformly without sputtering or other irregularities. The resultant weld metal shall be smooth and uniform with no visible evidence of cracks or porosity.

13.2 If a filler metal satisfactorily meets the weld bead-on-plate test requirements when tested as a welding rod, it also shall be tested as an electrode if it is to be classified as an electrode.

14. Method of Manufacture

The electrodes and rods classified according to this specification may be manufactured by any method that will produce material that meets the requirements of this specification.

15. Standard Sizes

15.1 Standard sizes for round filler metal in the different package forms of straight lengths, coils without support, and spools are as shown in AWS A5.02/A5.02M. Diameters of cast rods in straight lengths are approximate with no specified tolerance.

15.2 Typical sizes for flattened shapes of straight length welding rod are shown in Table 6. The cross-sectional area of such shapes shall be equivalent to that of corresponding round rods of the same nominal diameter as listed in AWS A5.02/A5.02M.

16. Finish and Uniformity

Finish and uniformity shall be as specified as in AWS A5.02/A5.02M.

17. Standard Package Forms

Standard package dimensions and weights and other requirements for each form shall be as specified in AWS A5.02/A5.02M.

18. Winding Requirements

18.1 Winding requirements shall be as specified in AWS A5.02/A5.02M.

18.2 The cast and helix of the filler metal shall be as specified in AWS A5.02/A5.02M.

19. Filler Metal Identification

Filler metal identification, product information, and precautionary information shall be as specified in AWS A5.02/A5.02M.