AWS A5.10/A5.10M:2012
(ISO 18273:2004 MOD)
An American National Standard

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

American Welding Society®

Approved American National Standard
ANSI

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(ISO 18273:2004 MOD)
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Approved by the
American National Standards Institute
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Welding Consumables—Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys—Classification

10th Edition

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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 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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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 It must be reviewed every five years, and if not revised, it must be either reaffirmed or withdrawn.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 required 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 Doral Blvd., Suite 130, Doral, FL 33166.

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Foreword

This foreword is not part of 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*, but is included for informational purposes only.

This standard is the U.S. national adoption of ISO 18273:2004, *Welding consumables — Wire electrodes, wires and rods for welding of aluminum and aluminum-alloys — Classification*. Classification in accordance with ISO 18273:2004 does not provide classification in accordance with this document.

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. 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 the U.S. Customary and SI Units.

ISO uses comma (,) for decimal, but AWS uses period (.) for decimal. Decimal commas have been changed to decimal periods.

Additions and modifications to ISO 18273:2004 are shown in italic font.

Changes in this edition include addition of "ER1070, R1070, ER1080A, R1080A, ER1200, R1200, ER1450, R1450, ER3103, R3103, ER4018, R4018, ER4043A, R4043A, ER4046, R4046, ER4047A, R4047A, ER5087, R5087, ER5183A, R5183A, ER5187, R5187, ER5249, R5249, ER5356A, R5356A, ER5556A, R5556A, ER5556B, R5556B, ER5556C, R5556C, ER5654A, R5654A, ER5754, and R5754, as a result of ISO 18273 adoption. Beryllium has been reduced to 0.0003% maximum for most classifications as shown in Table 1.

Other new classifications ER4943 and R4943 have been added. These two classifications are subject to a pending patent application.

NOTE: 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 non-discriminatory terms and conditions to applicants desiring to obtain such a license, then details may be obtained from the standards developer.

This specification developed as below:

ASTM B285-54T AWS A5.10-54T	*Tentative Specification for Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes*
ASTM B285-57T AWS A5.10-57T	*Tentative Specification for Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes*
AWS A5.10-61T ASTM B285-61T	*Tentative Specification for Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes*
AWS A5.10-69 ANSI W5.10-1973	*Specification for Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes*

ANSI/AWS A5.10-80	*Specification for Aluminum and Aluminum-Alloy Bare Electrodes and Rods*
ANSI/AWS A5.10-88	*Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods*
ANSI/AWS A5.10-92	*Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods*
AWS A5.10/A5.10M:1999	*Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods*
AWS A5.10/A5.10M:1999 (R2007)	*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 Metal and Allied Materials, American Welding Society, 8669 Doral Blvd., Suite 130, Doral, FL 33166.

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1 Scope

1.1 This standard specifies requirements for classification of solid wires and rods for fusion welding of aluminum and aluminum alloys. The classification of the solid wires and rods is based on their chemical composition.

1.2 *Safety and health issues and concerns are beyond the scope of this standard and are therefore not fully addressed herein. Some safety and health information can be found in informative annex Clauses A6 and A12. Safety and health information is available from other sources, including, but not limited to, ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes, and applicable federal and state regulations.*

1.3 *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.*

2 Normative references

This standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

2.1 *The following AWS standards*[1] *are referenced in the mandatory clauses of this document:*

AWS A1.1, Metric Practice Guide for the Welding Industry

AWS A3.0M/A3.0, Standard Welding Terms and Definitions

AWS A5.01M/A5.01 (ISO 14344 MOD), Procurement Guidelines for Consumables—Welding and Allied Processes—Flux and Gas Shielded Electrical Welding Processes

AWS A5.02/A5.02M:2007, Filler Metal Standard Sizes, Packaging, and Physical Attributes

2.2 *The following ANSI standard is referenced in the mandatory clauses of this document:*

ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes[2]

[1] *AWS standards are published by the American Welding Society, 8669 Doral Blvd., Suite 130, Doral, FL 33166.*
[2] *This ANSI standard is published by the American Welding Society, 8669 Doral Blvd., Suite 130, Doral, FL 33166.*

2.3 *The following ASTM standards*[3] *are referenced in the mandatory clauses of this document:*

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

ASTM E34, Standard Methods for Chemical Analysis of Aluminum and Aluminum Alloys

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

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

ASTM E1032, Standard Test Methods for Radiographic Examination of Weldments

2.4 *The following ISO standards*[4] *are referenced in the mandatory clause of this document:*

ISO 544, *Welding Consumables — Technical Delivery Conditions for Filler Materials and Fluxes — Type of Product, Dimensions, Tolerances and Markings*.

ISO 80000-1, Quantities and units.

3 Classifications

3.1 *AWS Classifications (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 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.*

3.1.3 *Filler metal containing more than 0.0003% by weight of beryllium shall not be classified as electrode and should not be used as an electrode.*

4 *Acceptance*

Acceptance[5] *of the material shall be in accordance with the provisions of AWS A5.01M/A5.01 (ISO 14344 MOD).*

5 *Certification*

By affixing the AWS specification and classification designations to the packaging, or the classification to the product, the manufacturer certifies that the product meets the requirements of this specification.[6]

6 *Rounding-off procedure*

For purposes of determining compliance with the requirements of this standard, the actual test values obtained shall be subjected to the rounding-off rules of ASTM E29 or ISO 80000-1, Part 1: General (the results are the same). If the measured values are obtained by equipment calibrated in units other than

[3] *ASTM standards are published by ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.*
[4] *ISO standards are published by the International Organization of Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland.*
[5] *See A3, Acceptance (in Annex A) for further information concerning acceptance, testing of the material shipped, and AWS A5.01M/A5.01 (ISO 14344 MOD).*
[6] *See A4, Certification (in Annex A) for further information concerning certification and the testing called for to meet this requirement.*

Table 1 — Symbol for the Chemical Composition of Solid Wires and Rods

Alloy Symbol			Chemical Composition in Weight Percent[a, b]													
AWS Classification	ISO 18273 Numerical	ISO 18273 Chemical	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ga, V	Ti	Zr	$Al_{min.}$	Be	Other Each	Other Total
ALUMINIUM-LOW ALLOYED																
ER1070, R1070	Al 1070	Al99,7	0.20	0.25	0.04	0.03	0.03	—	0.04	V 0.05	0.03	—	99.70	0.0003	0.03	—
ER1080A, R1080A	Al 1080A	Al99,8(A)	0.15	0.15	0.03	0.02	0.02	—	0.06	Ga 0.03	0.02	—	99.80	0.0003	0.02	—
ER1100, R1100	Al 1100	Al99,0Cu	Si + Fe 0.95		0.05–0.20	0.05	—	—	0.10	—	—	—	99.00	0.0003	0.05	0.15
ER1188 R1188	Al 1188	Al 99,88	0.06	0.06	0.005	0.01	0.01	—	0.03	Ga 0.03 V 0.05	0.01	—	99.88	0.0003	0.01	—
ER1200, R1200	Al 1200	Al99,0	Si + Fe 1.00		0.05	0.05	—	—	0.10	—	0.05	—	99.00	0.0003	0.05	0.15
ER1450, R1450	Al 1450	Al99,5Ti	0.25	0.40	0.05	0.05	0.05	—	0.07	—	0.10–0.20	—	99.50	0.0003	0.03	—
ALUMINIUM-COPPER																
R-206.0[c]	—	—	0.10	0.15	4.2–5.0	0.20–0.50	0.15–0.35	—	0.10	—	0.15–0.30	—	Rem	—	0.05	0.15
ER2319, R2319	Al 2319	AlCu6MnZrTi	0.20	0.30	5.8–6.8	0.20–0.40	0.02	–	0.10	V 0.05–0.15	0.10–0.20	0.10–0.25	Rem	0.0003	0.05	0.15
ALUMINIUM-MANGANESE																
ER3103, R3103	Al 3103	AlMn 1	0.50	0.7	0.10	0.9–1.5	0.30	0.10	0.20	—	Ti + Zr 0.10		Rem	0.0003	0.05	0.15
ALUMINIUM-SILICON																
R-C355.0	—	—	4.5–5.5	0.20	1.0–1.5	0.10	0.40–0.6	—	0.10	—	0.20	—	Rem	—	0.05	0.15
R-A356.0	—	—	6.5–7.5	0.20	0.20	0.10	0.25–0.45	—	0.10	—	0.20	—	Rem	—	0.05	0.15
R-357.0	—	—	6.5–7.5	0.15	0.05	0.03	0.45–0.6	—	0.05	—	0.20	—	Rem	—	0.05	0.15
R-A357.0	—	—	6.5–7.5	0.20	0.20	0.10	0.40–0.7	—	0.10	—	0.04–0.20	—	Rem	0.04–0.07	0.05	0.15
ER4009, R4009	Al 4009	AlSi5Cu1Mg	4.5–5.5	0.20	1.0–1.5	0.10	0.45–0.6	—	0.10	—	0.20	—	Rem	0.0003	0.05	0.15
ER4010, R4010	Al 4010	AlSi7Mg	6.5–7.5	0.20	0.20	0.10	0.30–0.45	—	0.10	—	0.20	—	Rem	0.0003	0.05	0.15
R4011	Al 4011	AlSi7Mg0,5Ti	6.5–7.5	0.20	0.20	0.10	0.45–0.7	—	0.10	—	0.04–0.20	—	Rem	0.04–0.07	0.05	0.15
ER4018, R4018	Al 4018	AlSi7Mg	6.5–7.5	0.20	0.05	0.10	0.50–0.8	—	0.10	—	0.20	—	Rem	0.0003	0.05	0.15
ER4043, R4043	Al 4043	AlSi5	4.5–6.0	0.8	0.30	0.05	0.05	—	0.10	—	0.20	—	Rem	0.0003	0.05	0.15
ER4043A, R4043A	Al 4043A	AlSi5(A)	4.5–6.0	0.6	0.30	0.15	0.20	—	0.10	—	0.15	—	Rem	0.0003	0.05	0.15
ER4046, R4046	Al 4046	AlSi10Mg	9.0–11.0	0.50	0.03	0.40	0.20–0.50	—	0.10	—	0.15	—	Rem	0.0003	0.05	0.15
ER4047, R4047	Al 4047	AlSi12	11.0–13.0	0.8	0.30	0.15	0.10	—	0.20	—	—	—	Rem	0.0003	0.05	0.15
ER4047A, R4047A	Al 4047A	AlSi12(A)	11.0–13.0	0.6	0.30	0.15	0.10	—	0.20	—	0.15	—	Rem	0.0003	0.05	0.15
ER4145, R4145	Al 4145	AlSi10Cu4	9.3–10.7	0.8	3.3–4.7	0.15	0.15	0.15	0.20	—	—	—	Rem	0.0003	0.05	0.15

(Continued)

Table 1 (Continued) — Symbol for the Chemical Composition of Solid Wires and Rods

Alloy Symbol			Chemical Composition in Weight Percent[a, b]													
AWS Classification	ISO 18273 Numerical	ISO 18273 Chemical	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ga, V	Ti	Zr	$Al_{min.}$	Be	Other Each	Other Total
ALUMINIUM-SILICON (Continued)																
ER4643, R4643	Al 4643	AlSi4Mg	3.6–4.6	0.8	0.10	0.05	0.10–0.30	—	0.10	—	0.15	—	Rem	0.0003	0.05	0.15
ER4943,[d] R4943[d]	—	—	*5.0–6.0*	*0.40*	*0.10*	*0.05*	*0.10–0.50*	—	*0.10*	—	*0.15*	—	*Rem*	*0.0003*	*0.05*	*0.15*
ALUMINIUM-MAGNESIUM																
ER5087, R5087	Al 5087	AlMg4,5MnZr	0.25	0.40	0.05	0.7–1.1	4.5–5.2	0.05–0.25	0.25	—	0.15	0.10–0.20	Rem	0.0003	0.05	0.15
ER5183, R5183	Al 5183	AlMg4,5Mn0,7(A)	0.40	0.40	0.10	0.50–1.0	4.3–5.2	0.05–0.25	0.25	—	0.15	—	Rem	0.0003	0.05	0.15
ER5183A, R5183A	Al 5183A	AlMg4,5Mn0,7(A)	0.40	0.40	0.10	0.50–1.0	4.3–5.2	0.05–0.25	0.25	—	0.15	—	Rem	0.0005	0.05	0.15
ER5187, R5187	Al 5187	AlMg4,5MnZr	0.25	0.40	0.05	0.7–1.1	4.5–5.2	0.05–0.25	0.25	—	0.15	0.10–0.20	Rem	0.0005	0.05	0.15
ER5249, R5249	Al 5249	AlMg2Mn0,8Zr	0.25	0.40	0.05	0.50–1.1	1.6–2.5	0.30	0.20	—	0.15	0.10–0.20	Rem	0.0003	0.05	0.15
ER5356, R5356	Al 5356	AlMg5Cr(A)	0.25	0.40	0.10	0.05–0.20	4.5–5.5	0.05–0.20	0.10	—	0.06–0.20	—	Rem	0.0003	0.05	0.15
ER5356A R5356A	Al 5356A	AlMg5Cr(A)	0.25	0.40	0.10	0.05–0.20	4.5–5.5	0.05–0.20	0.10	—	0.06–0.20	—	Rem	0.0005	0.05	0.15
ER5554, R5554	Al 5554	AlMg2,7Mn	0.25	0.40	0.10	0.50–1.0	2.4–3.0	0.05–0.20	0.25	—	0.05–0.20	—	Rem	0.0003	0.05	0.15
ER5556, R5556	Al 5556	AlMg5Mn1Ti	0.25	0.40	0.10	0.50–1.0	4.7–5.5	0.05–0.20	0.25	—	0.05–0.20	—	Rem	0.0003	0.05	0.15
ER5556A, R5556A	Al 5556A	AlMg5Mn	0.25	0.40	0.10	0.6–1.0	5.0–5.5	0.05–0.20	0.20	—	0.05–0.20	—	Rem	0.0003	0.05	0.15
ER5556B, R5556B	Al 5556B	AlMg5Mn	0.25	0.40	0.10	0.6–1.0	5.0–5.5	0.05–0.20	0.20	—	0.05–0.20	—	Rem	0.0005	0.05	0.15
ER5556C, R5556C	Al 5556C	AlMg5Mn1Ti	0.25	0.40	0.10	0.50–1.0	4.7–5.5	0.05–0.20	0.25	—	0.05–0.20	—	Rem	0.0005	0.05	0.15
ER5654, R5654	Al 5654	AlMg3,5Ti	Si + Fe 0.45		0.05	0.01	3.1–3.9	0.15–0.35	0.20	—	0.05–0.15	—	Rem	0.0003	0.05	0.15
ER5654A, R5654A	Al 5654A	AlMg3,5Ti	Si + Fe 0.45		0.05	0.01	3.1–3.9	0.15–0.35	0.20	—	0.05–0.15	—	Rem	0.0005	0.05	0.15
ER5754, R5754	Al 5754[e]	AlMg3	0.40	0.40	0.10	0.50	2.6–3.6	0.30	0.20	—	0.15	—	Rem	0.0003	0.05	0.15

[a] Single values shown in the table are maximum values, except for Al.
[b] The results shall be rounded to the same number of significant figures as in the specified value using the rules in accordance with *ISO 80000-1* or ASTM E29.
[c] For R-206.0, Ni = 0.05 max. and Sn = 0.05 max.
[d] These classifications have patent application pending.
[e] Alloy Al 5754 also limits the sum (Mn + Cr): 0.10 to 0.6.

those of the specified limit, the measured values shall be converted to the units of the specified limit before rounding off. If an average value is to be compared to the specified limit, rounding off shall be done only after calculating the average. An observed or calculated value shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the limiting values. The rounded-off 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, soundness of the weld metal produced by gas metal arc welding electrodes, and the deposition characteristics of welding rods. 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 12.

8 Retest

If 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 test sample or from a new test sample. For chemical analysis, retest need be only for those specific elements that failed to meet their 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 tests, 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 of two weld test assemblies is required:*

a) *The groove weld test assembly for the usability of electrodes and the soundness of the weld metal (see Figure 1).*

b) *The bead-on-plate weld test assembly for the usability of rods (see 9.4).*

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 weld test requirements, when tested as a welding rod, shall also be tested as an electrode and meet the requirements of the radiographic soundness test in order to be classified as an electrode.*

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 1 and 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 1 for the different 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.*

Table 2 — Required Tests

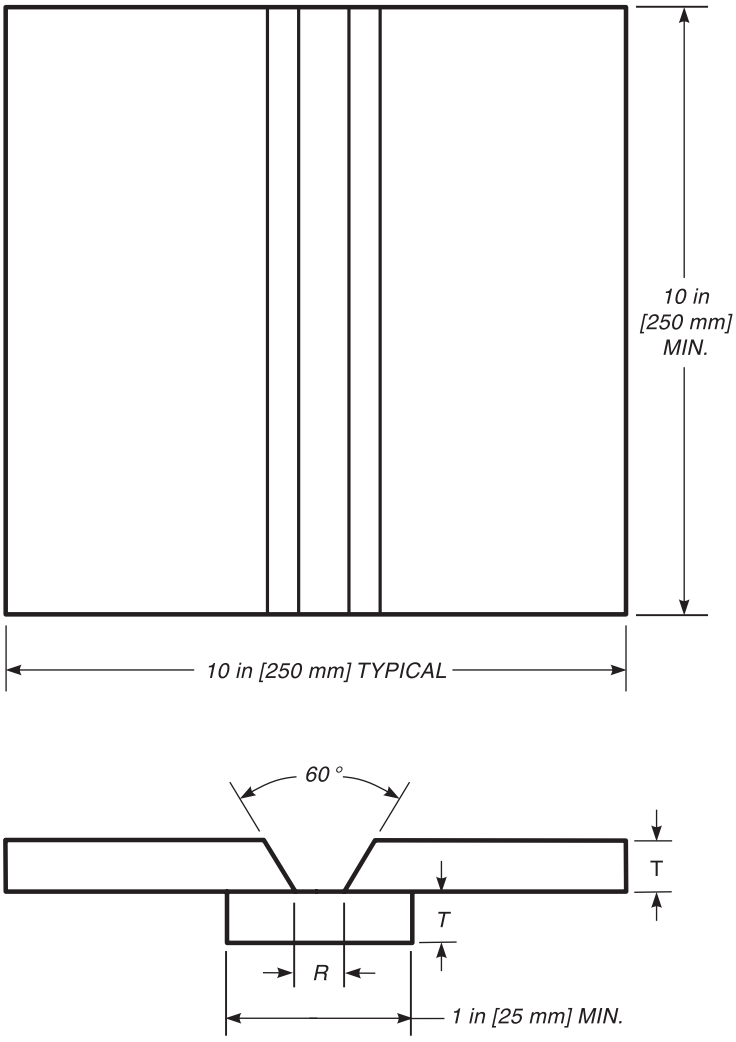
AWS Classification	*Chemical Analysis*	*Radiographic Test[a] (Electrode)*	*Bead-on-Plate Test (Rod)*
ER1070	*X*	*X*	—
R1070	*X*	—	*X*
ER1080A	*X*	*X*	—
R1080A	*X*	—	*X*
ER1100	*X*	*X*	—
R1100	*X*	—	*X*
ER1188	*X*	*X*	—
R1188	*X*	—	*X*
ER1200	*X*	*X*	—
R1200	*X*	—	*X*
ER1450	*X*	*X*	—
R1450	*X*	—	*X*
ER2319	*X*	*X*	—
R2319	*X*	—	*X*
ER3103	*X*	*X*	—
R3103	*X*	—	*X*
ER4009	*X*	*X*	—
R4009	*X*	—	*X*
ER4010	*X*	*X*	—
R4010	*X*	—	*X*
R4011	*X*	—	*X*
ER4018	*X*	*X*	—
R4018	*X*	—	*X*
ER4043	*X*	*X*	—
R4043	*X*	—	*X*
ER4043A	*X*	*X*	—
R4043A	*X*	—	*X*
ER4046	*X*	*X*	—
R4046	*X*	—	*X*
ER4047	*X*	*X*	—
R4047	*X*	—	*X*
ER4145	*X*	*X*	—
R4145	*X*	—	*X*
ER4643	*X*	*X*	—
ER4943	*X*	*X*	—
R4943	*X*	—	*X*
ER5087	*X*	*X*	—
R5087	*X*	—	*X*
ER5183	*X*	*X*	—
R5183	*X*	—	*X*

(Continued)

Table 2 (Continued) — Required Tests

AWS Classification	*Chemical Analysis*	*Radiographic Test[a] (Electrode)*	*Bead-on-Plate Test (Rod)*
ER5183A	*X*	*X*	—
R5183A	*X*	—	*X*
ER5187	*X*	*X*	—
R5187	*X*	—	*X*
ER5249	*X*	*X*	—
R5249	*X*	—	*X*
ER5356	*X*	*X*	—
R5356	*X*	—	*X*
ER5356A	*X*	*X*	—
R5356A	*X*	—	*X*
ER5554	*X*	*X*	—
R5554	*X*	—	*X*
ER5556	*X*	*X*	—
R5556	*X*	—	*X*
ER5556A	*X*	*X*	—
R5556A	*X*	—	*X*
ER5556B	*X*	*X*	—
R5556B	*X*	—	*X*
ER5556C	*X*	*X*	—
R5556C	*X*	—	*X*
ER5654	*X*	*X*	—
R5654	*X*	—	*X*
ER5654A	*X*	*X*	—
R5654A	*X*	—	*X*
ER5754	*X*	*X*	—
R5754	*X*	—	*X*
R-206.0	*X*	—	*X*
R-C355.0	*X*	—	*X*
R-A356.0	*X*	—	*X*
R-357.0	*X*	—	*X*
R-A357.0	*X*	—	*X*

[a] *Filler metal meeting the radiographic requirement, when tested as an electrode, is not required to be tested as a rod, as specified in 9.2.*



Electrode Diameter		Plate Thickness, T[a]		Nominal Root Opening, R		Welding Position
in	mm	in	mm	in	mm	
0.030 0.035	0.8 0.9	3/16 or 1/4	5 or 6.5	1/4	6.5	Overhead
 3/64	1.0 1.2	1/4 1/4	6.5 6.5	1/4 1/4	6.5 6.5	Overhead
1/16	1.6 2.0	3/8 3/8	10 10	3/8 3/8	10 10	Overhead
3/32	2.4 2.5	3/8 3/8	10 10	3/8 3/8	10 10	Flat
1/8	3.2	3/8	10	1/2	13	Flat

[a] A variation of ±5% in the specified plate thickness is acceptable.

Notes:
1. Assembly shall be welded employing the gas metal arc welding process.
2. Assembly may be machined or extruded as a single piece if the minimum dimensions shown are maintained for the specific electrode diameter being tested.

Figure 1 — Groove Weld Test Assembly for Radiographic Test

Table 3 — Base Metal for Test Assemblies

Electrode and Rod (AWS Classification)	*Base Metal [a] (Aluminum Association Designations)[b]*
ER1070, R1070, ER1080A, R1080A ER1100, R1100, ER1188, R1188 ER1200, R1200, ER14t50, R1450	*1060, 1100, 1350, 3003, 6005, or 6061*
ER2319, R2319, ER4145, R4145	*2014, 2219,3003, 6005, or 6061*
ER4009, R4009, ER4010, R4010 R4011, ER4018, R4018, ER4043, R4043, ER4043A, R4043A ER4046, R4046, ER4047, R4047, ER4047A, R4047A, ER4643, R4643 ER4943, R4943 ER3103, R3103	*3003, 6005, or 6061*
ER5087, R5087, ER5183, R5183 ER5183A, R5183A, ER5187, R5187, ER5249, R5249, ER5356, R5356, ER5356A, R5356A ER5554, R5554, ER5556 R5556, ER5556A, R5556A ER5556B, R5556B, ER5556C, R5556C, ER5654, R5654, ER5654A, R5654A ER5754 R5754	*3004, 5052, 5083, 5086, 5154, 5454, 5456, 6005, or 6061*
R-206.0	*206.0, 2014, 2219, 3003, 6005, or 6061*
R-C355.0	*355.0, C355.0, 3003, 6005, or 6061*
R-A356.0, R357.0, R-A357.0	*356.0, A356.0, 357.0, A357.0, 3003, 6005, or 6061*

[a] *All wrought base alloys 1060, 1100, 2014, 2219, 3003, 3004, 5052, 5083, 5086, 5154, 5454, 6005, and 6061 are included in ASTM B209. Cast base alloys 355.0, C355.0, 356.0, A356.0, 357.0, and A357.0 are included in ASTM B108.*

[b] *The Aluminum Association, Inc., 1525 Wilson Blvd., Suite 600, Arlington, VA 22209.*

9.3.3 *Dimensions of the groove weld joint and the position of welding shall be as specified in Figure 1 for the electrode diameter being tested. The backing material shall be of the same type of base metal 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 150°F [66°C].*

9.4 *Bead-on-plate weld test for usability of welding rods*

9.4.1 *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 9.4.2, using base metal of the appropriate type specified in Table 3. Examination of the assembly shall be as specified in Clause 12, Bead-on-plate test.*

9.4.2 *Welding of the assembly shall be done 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 being tested.*

9.4.3 *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 12, 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.*

10.2 *The sample shall be analyzed by accepted analytical methods.*[7] *The referee method shall be ASTM E34, Standard Methods for Chemical Analysis of Aluminum and Aluminum Alloys.*

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 1, shall be completed and then radiographed to evaluate the soundness of the weld metal and to determine the usability of the electrode. 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 ASTM E1032. The quality level of inspection shall be 2-2T.*

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 2 for test assemblies welded in the overhead position for electrode sizes up to and including 1/16 in [1.6 mm] and Figure 3 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 do not meet the requirements of this specification.

11.4 *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 9.4.*

12 *Bead-on-plate test*

12.1 *Welding rod tested in accordance with 9.4 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.*

12.2 *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.*

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[7] *See Clause A10 (in Annex A) for further information concerning accepted analysis methods.*

ASSORTED ROUNDED INDICATIONS

SIZE PERMITTED IS 0.050 in [1.3 mm] MAXIMUM
NUMBER PERMITTED IN ANY 6 in [150 mm] OF WELD IS 29 WITH THE FOLLOWING RESTRICTIONS:
LARGE: UP TO 0.050 in [1.3 mm]—6 PERMITTED
MEDIUM: UP TO 0.031 in [0.8 mm]—5 PERMITTED
SMALL: UP TO 0.020 in [0.5 mm]—18 PERMITTED

MEDIUM ROUNDED INDICATIONS

SIZE PERMITTED IS 0.030 in [0.8 mm] MAXIMUM
NUMBER PERMITTED IN ANY 6 in [150 mm] OF WELD IS 39

SMALL ROUNDED INDICATIONS

SIZE PERMITTED IS 0.020 in [0.5 mm] MAXIMUM
NUMBER PERMITTED IN ANY 6 in [150 mm] OF WELD IS 72

Notes:
1. *In using these standards, the chart that is most representative of the size of the rounded indications present in the test specimen radiograph shall be used for determining conformance to these radiographic standards.*
2. *Indications which do not exceed 1/64 in [0.4 mm] diameter or length, or both, shall be disregarded.*
3. *Total area of porosity in a 6 in [150 mm] length of weld is 0.0225 sq in [14.52 sq mm] based on 1.5% T per in [25 mm] where T is the base metal thickness.*

Figure 2A — Radiographic Acceptance Standards for 3/16 in [5 mm] and 1/4 in [6.4 mm] Thick Test Assemblies — Overhead Welding Position

13 *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.

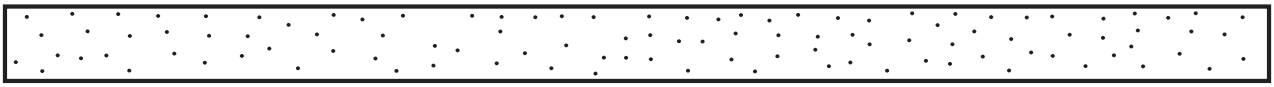
14 *Standard sizes*

14.1 *Standard sizes for round filler metal in the different package forms of straight lengths, coils without support, and spools are as shown in Table 4. Diameters of cast rods in straight lengths are approximate with no specified tolerance.*

14.2 *Typical sizes for flattened shapes of straight length welding rod are shown in Table 5. The cross-sectional area of such shapes shall be equivalent to that of corresponding round rods of the same nominal diameter as listed in Table 5.*

ASSORTED ROUNDED INDICATIONS

SIZE PERMITTED IS 0.075 in [1.9 mm] MAXIMUM
NUMBER PERMITTED IN ANY 6 in [150 mm] OF WELD IS 26 WITH THE FOLLOWING RESTRICTIONS:
LARGE: UP TO 0.075 in [1.9 mm]—4 PERMITTED
MEDIUM: UP TO 0.049 in [1.3 mm]—5 PERMITTED
SMALL: UP TO 0.020 in [0.5 mm]—17 PERMITTED



SMALL ROUNDED INDICATIONS

SIZE PERMITTED IS 0.020 in [0.5 mm] MAXIMUM
NUMBER PERMITTED IN ANY 6 in [150 mm] OF WELD IS 108

Notes:
1. *In using these standards, the chart that is most representative of the size of the rounded indications present in the test specimen radiograph shall be used for determining conformance to these radiographic standards.*
2. *Indications which do not exceed 1/64 in [0.4 mm] diameter or length, or both, shall be disregarded.*
3. *Total area of porosity in a 6 in [150 mm] length of weld is 0.0337 sq in [21.7 sq mm] based on 1.5% T per in [25 mm] where T s the base metal thickness.*
4. *These radiographic acceptance standards are identical to those previously incorporated in MIL-E-16053L (Amendment 2, 20 October 1980) and as Class 3 NAVSEA 0900-LP-003-9000 (see Annex A5).*

Figure 2B — Radiographic Acceptance Standards for 3/8 in [10 mm] Thick Test Assemblies — Overhead Welding Position

15 *Finish and uniformity*

Finish and uniformity shall be as specified in 4.2.1 and 4.2.2 of AWS A5.02/A5.02M.

16 *Standard package forms*

Standard package dimensions and weights and other requirements for each form shall be as specified in 4.3 of AWS A5.02/A5.02M.

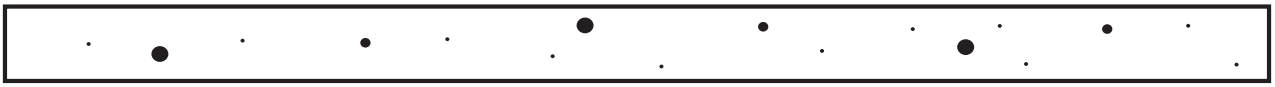
17 *Winding requirements*

17.1 *Winding requirement shall be as specified in 4.4.1 of AWS A5.02/A5.02M.*

17.2 *The cast and helix of the filler metal shall be as specified in 4.4.2 of AWS A5.02/A5.02M.*

18 *Filler metal identification*

Filler metal identification, product information, and the precautionary information shall be as specified in 4.5.1 through 4.5.6 of AWS A5.02/A5.02M.

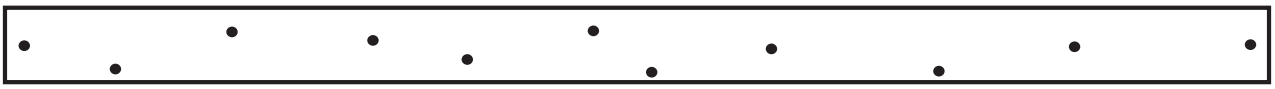


ASSORTED ROUNDED INDICATIONS

SIZE PERMITTED IS 0.075 in [1.9 mm] MAXIMUM
NUMBER PERMITTED IN ANY 6 in [150 mm] OF WELD IS 17 WITH THE FOLLOWING RESTRICTIONS:
LARGE: UP TO 0.075 in [1.9 mm]—3 PERMITTED
MEDIUM: UP TO 0.049 in [1.3 mm]—3 PERMITTED
SMALL: UP TO 0.020 in [0.5 mm]—11 PERMITTED

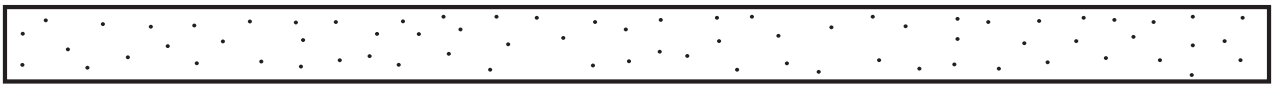
LARGE ROUNDED INDICATIONS

SIZE PERMITTED IS 0.075 in [1.9 mm] MAXIMUM
NUMBER PERMITTED IN ANY 6 in [150 mm] OF WELD IS 5



MEDIUM ROUNDED INDICATIONS

SIZE PERMITTED IS 0.049 in [1.3 mm] MAXIMUM
NUMBER PERMITTED IN ANY 6 in [150 mm] OF WELD IS 11



SMALL ROUNDED INDICATIONS

SIZE PERMITTED IS 0.020 in [0.5 mm] MAXIMUM
NUMBER PERMITTED IN ANY 6 in [150 mm] OF WELD IS 72

Notes:
1. *In using these standards, the chart that is most representative of the size of the rounded indications present in the test specimen radiograph shall be used for determining conformance to these radiographic standards.*
2. *Indications which do not exceed 1/64 in [0.4 mm] diameter or length, or both, shall be disregarded.*
3. *Total area of porosity in a 6 in [150 mm] length of weld is 0.0225 sq in [14.52 sq mm] based upon 1.0% T per in [25 mm] where T is the base metal thickness.*
4. *This radiographic acceptance standard is identical to that previously incorporated in MIL-E-16053L (Amendment 2, 20 October 1980) and as Class 1 NAVSEA 0900-LP-003-9000 (see Annex A5).*

Figure 3 — Radiographic Acceptance Standard for Test Assemblies — Flat Position Welding

Table 4 — Standard Sizes[a]

Standard Package Forms	Diameter			Tolerances	
	in[b]		mm	in	mm
Straight lengths and coils without support (Notes c, d)	1/16	(0.062)	1.6	+0.001, –0.002	+0.03, –0.05
		(0.079)	2.0		
	3/32	(0.094)	2.4[e]		
		(0.098)	2.5		
	1/8	(0.125)	3.2		
	5/32	(0.156)	4.0		
	3/16	(0.188)	4.8[e]		
		(0.197)	5.0		
	1/4	(0.250)	6.4[e]		
4 in [100 mm] and 8 in [200 mm] Spools	0.030		0.8	+0.001, –0.002	+0.03, –0.05
	0.035		0.9		
		(0.039)	1.0		
	3/64	(0.047)	1.2		
	1/16	(0.062)	1.6		
12 in [300 mm] Spools	0.030		0.8	+0.001, –0.002	+0.03, –0.05
	0.035		0.9		
		(0.039)	1.0		
	3/64	(0.047)	1.2		
	1/16	(0.062)	1.6		
		(0.079)	2.0		
	3/32	(0.094)	2.4[e]		
		(0.098)	2.5		
	1/8	(0.125)	3.2		
13-1/2 in [340 mm] Spools	1/16	(0.062)	1.6	+0.001, –0.002	+0.03, –0.05
		(0.079)	2.0		
	3/32	(0.094)	2.4[e]		
		(0.098)	2.5		
	1/8	(0.125)	3.2		

[a] Dimensions, tolerances, and package forms (for round filler metal) other than those shown shall be as agreed by purchaser and supplier.
[b] Decimal inches are exact conversions with appropriate rounding.
[c] There is no specified tolerance for cast rod in straight lengths.
[d] Length of wrought rods shall be 36 in, +0, –1/2 in [900 mm ± 2%]. Length of cast rods shall be 18 in ± 1/2 in [450 mm ± 2%].
[e] Metric sizes not shown in ISO 544.

Table 5 — Typical Sizes of Flattened Rods

Equivalent Round Diameter		Thickness		Width	
in	mm	in	mm	in	mm
1/16	1.6	0.047	1.2	0.072	1.8
	2.0		1.5		2.1
3/32	2.4	0.070	1.8	0.105	2.7
	2.5		1.9		2.6
1/8	3.2	0.095	2.4	0.142	3.6
5/32	4.0	0.115	2.9	0.175	4.4
3/16	4.8	0.140	3.6	0.210	5.0
	5.0		3.8		5.2
1/4	6.4	0.187	4.8	0.280	7.1

Note: Standard length shall be 36 in, +0, –1/2 in [900 mm ± 2%].

19 *Packaging*

19.1 *Filler metal in all product forms, excepting welding rods in straight lengths, shall be packaged in accordance with 4.3 of AWS A5.02/A5.02M and Table 6 of this standard.*

19.2 *Packaging of straight lengths of bare welding rods shall be as agreed upon between the purchaser and supplier.*

20 *Marking of packages*

The product information (as a minimum) shall be legibly marked so as to be visible from the outside of each unit package as specified in AWS A5.02/A5.02M.

21 Symbols and requirements

21.1 Symbols for the product form

The symbol for the solid wire and rod shall be *ER or R for AWS classifications*.

NOTE One product form may be used for more than one welding process.

21.2 Symbol for the chemical composition

The numerical symbol in Table 1 indicates the chemical composition of a solid wire and rod, determined under conditions given in Clause 10.

22 Mechanical properties of the weld metal

Mechanical properties of the weld metal are not part of the classification.

Table 6 — Standard Packages, Dimensions, and Weights[a]

Package Form[b]			***Nominal Net Weight***	
			lb	***kg***
Straight lengths			*5* *10* *25* *50*	*2.5* *5* *10* *25*
Coils without support[c]			*25* *50*	*10* *25*
Spools	*in*	*mm*		
	4	*100*	*1*	*0.5*
	8	*200*	*5*	*2.5*
	12	*300*	*10–26*	*5–12*
	13-1/2	*340*	*30*	*15*

[a] *Filler metal diameters for all forms and lengths are given in Table 4.*
[b] *No more than one classification or size shall be included in each package.*
[c] *Dimensions of coils shall be as agreed between purchaser and supplier.*

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National Annexes

Annex A (Informative)

Guide to Welding Consumables—Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys—Classifcation

This annex is not part of AWS A5.10/A5.10M:2012 (ISO 18273:2004 MOD), Welding Consumables—Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys—Classifications*, but is included for informational purposes only.*

A1. *Introduction*

This guide is designed to correlate the filler metal classifications with their intended applications so the specification can be used more effectively. Reference to appropriate base metal alloys is made whenever that can be done and when it would be helpful. Such references are intended as examples rather than complete listings of the materials for which each filler metal is suitable.

A2. *Classification System*

A2.1 *Both welding electrodes and rods are classified upon the basis of the chemical composition of the aluminum filler metal and a usability test. The AWS classifications used in this specification are based as follows:*

A2.2 *The Aluminum Association alloy designation nomenclature is used for the numerical portion to identify the alloy and thus its registered chemical composition.*

A2.3 *A letter prefix designates usability of the filler metal. The letter system for identifying the filler metal classifications in this specification follows the standard pattern used in other AWS filler metal specifications. The prefix "E" indicates the filler metal is suitable for use as an electrode and the prefix "R" indicates suitability as welding rod. Since some of these filler metals are used as electrodes in gas metal arc welding, and as welding rods in oxyfuel gas, gas tungsten arc, and plasma arc welding, both letters, "ER," are used to indicate suitability as an electrode or a rod. In all cases, a product which meets the test requirements for an electrode in this specification, also meets the requirements for a welding rod. A product that meets the test requirements for a welding rod, must also pass the test for an electrode before being classified as an electrode.*

A2.4 Description of ISO Alloy Symbols (Table 1)

A2.4.1 *The ISO alloy symbols in Table 1 are divided into two parts:*

(1) the first part indicates the product form being solid wires or rods, see A2.4.2;

(2) the second part gives a numerical symbol indicating the chemical composition of the solid wire or rod, see Table 1.

A2.4.2 ISO Symbols for the Product Form

The ISO symbol for the solid wire and rod shall be S.

NOTE: One product form may be used for more than one welding process.

A2.4.3 ISO Designation

The ISO designation of solid wires and rods shall follow the principle given in the example below.

EXAMPLE 1 A solid wire (S) for gas shielded metal arc welding has a chemical composition within the limits for the alloy symbol Al 4043 (AlSi5) of Table 1, is designated:

Solid wire ISO 18273 – S Al 4043

or alternatively

Solid wire ISO 18273 – S Al 4043 (AlSi5)

EXAMPLE 2 A solid rod (S) for tungsten arc welding is designated

Solid rod ISO 18273 – S Al 4043

or alternatively

Solid rod ISO 18273 – S Al 4043 (AlSi5)

where:

ISO 18273 is the standard number;

S is the product form (see A2.4.2);

Al 4043 is the chemical composition of welding consumable (see Table 1);

AlSi5 is the optional chemical composition symbol of welding consumable (see Table 1).

A2.5 *Minor changes in procedures used in the manufacture of aluminum filler metals can affect their surface quality and significantly affect the resultant weld soundness. Usability testing of the electrode is desirable on a periodic basis to assure that the product classified in this specification continues to meet the soundness requirement. The supplier should perform the usability tests of this specification on an annual basis, as a minimum, to assure that the specified soundness and operating characteristics criteria are maintained. AWS A5.01M/A5.01 (ISO 14344 MOD) should be used by a purchaser for definition of lot and frequency of testing references when purchasing aluminum filler metals.*

A2.6 ***Request for Filler Metal Classification***

(1) *When an existing electrode or rod cannot be classified as given in this specification, the manufacturer may request that a classification be established for that welding electrode. The manufacturer may do this by following the procedure given here.*

(2) *A request to establish a new electrode or rod classification must be a written request, and must provide sufficient detail to permit the AWS A5 Committee on Filler Metals and Allied Materials or the subcommittee to determine whether the new classification or the modification of an existing classification is more appropriate, and whether either is necessary to satisfy the need. The request needs to state the variables and their limits, for such a classification or modification. The request should contain some indication of the time by which completion of the new classification or modification is needed. In particular, the request needs to include:*

(a) *All classification requirements as given for existing classifications, such as, chemical composition ranges and usability test requirements.*

(b) *Any testing conditions for conducting the tests used to demonstrate that the product meets the classification requirements. (It would be sufficient, for example, to state that welding conditions are the same as for other classifications.)*

(c) *Information on Descriptions and Intended Use, which parallels that for existing classifications, for that clause of the annex.*

(d) *Actual test data for all tests required for classification according to the requirements of the specification for a minimum of two production heats/lots must be provided.*

(e) *A request for a new classification without the above information will be considered incomplete. The Secretary will return the request to the requestor for further information.*

(3) *The request should be sent to the Secretary of the AWS A5 Committee on Filler Metals and Allied Materials at AWS Headquarters. Upon receipt of the request, the Secretary will:*

(a) *Assign an identifying number to the request. This number will include the date the request was received.*

(b) *Confirm receipt of the request and give the identification number to the person who made the request.*

(c) *Send a copy of the request to the Chair of the AWS A5 Committee on Filler Metals and Allied Materials, and the Chair of the particular Subcommittee involved.*

(d) *File the original request.*

(e) *Add the request to the log of outstanding requests.*

(4) *All necessary action on each request will be completed as soon as possible. If more than 12 months lapse, the Secretary shall inform the requestor of the status of the request, with copies to the Chairs of the Committee and of the Subcommittee. Requests still outstanding after 18 months shall be considered not to have been answered in a "timely manner" and the Secretary shall report these to the Chair of the AWS A5 Committee on Filler Metals and Allied Materials, for action.*

(5) *The Secretary shall include a copy of the log of all requests pending and those completed during the preceding year with the agenda for each AWS A5 Committee on Filler Metals and Allied Materials meeting. Any other publication of requests that have been completed will be at the option of the American Welding Society, as deemed appropriate.*

A3. *Acceptance*

Acceptance of all welding materials classified under this specification is in accordance with A5.01M/A5.01 (ISO 14344 MOD), as the specification states. Any testing a purchaser requires of the supplier, for material shipped in accordance with this specification, shall be clearly stated in the purchase order, according to the provisions of *A5.01M/A5.01 (ISO 14344 MOD)*. In the absence of any such statement in the purchase order, the supplier may ship the material with whatever testing the supplier normally conducts on material of that classification, as specified in Schedule F, Table 1, of *A5.01M/A5.01 (ISO 14344 MOD*). Testing in accordance with any other Schedule in that Table must be specifically required by the purchase order. In such cases, acceptance of the material shipped will be in accordance with those requirements.

A4. *Certification*

The act of placing the AWS specification and classification designations on the packaging enclosing the product or the classification on the product itself, constitutes the supplier's (manufacturer's) certification that the product meets all of the requirements of the specification. The only testing requirement implicit in this certification is that the manufacturer has actually conducted the tests required by the specification on material that is representative of that being shipped and that the material met the requirements of the specification. Representative material, in this case, is any production run of that classification using the same formulation. "Certification" is not to be construed to mean that tests of any kind were necessarily conducted on samples of the specific material shipped. Tests on such material may or may not have been made. The basis for the certification required by the specification is the classification test of representative material cited above and the "Manufacturer's Quality Assurance Program" in AWS A5.01M/A5.01 (ISO 14344 MOD).

A5. *Application of Military and Federal Specifications*

At the time of cancellation (June 7, 1982) of Military Specification MIL-E-16053L, Amendment 2 (October 20, 1980), Electrodes, Welding, Bare, Aluminum Alloys, the technical requirements were identical to those of AWS A5.10-80. They both covered the same aluminum alloys, compositions, welding tests, and radiographic standards. The MIL-E-16053L cancellation notice canceled the Qualified Products List QPL-16053 as well as the specification and stated, "Future acquisition of replacement electrodes should be made under AWS A5.10-80, Aluminum and Aluminum Alloy Bare Welding Rods and Electrodes."

Federal Specification QQ-R-566B, Rods and Electrodes, Welding, Aluminum, and Aluminum Alloys, was technically the same as AWS A5.10 when it was issued July 5, 1973, and was in the process of being updated at the time of the

MIL-E-16053L cancellation. On November 29, 1982, Federal Specification QQ-R-566B was also cancelled with the recommendation, "The ANSI/AWS Standard A5.10, latest issue in effect, concerning Aluminum Alloy Bare Welding Rods and Electrodes should be used." Straight length, coiled, and spooled rod for Oxyfuel gas and gas tungsten arc welding were included in QQ-R-566B, as well as the spooled electrode for gas metal arc welding. Thus the total coverage was the same as ANSI/AWS A5.10.

AWS A5.10/A5.10M (ISO 18273 MOD) is a classification document, which defines tests and acceptance criteria to determine that the product meets the requirements for classification. These tests need to be repeated only if a significant change is made in the manufacturing process. These tests become a part of the specific procurement only when used in combination with AWS A5.01M/A5.01 (ISO 14344 MOD) which identifies lot classifications, level of testing and the frequency of tests. To order the specific tests previously required by MIL-E-16053L and QQ-R-566B specifications, the following Lot Classification and Level of Testing defined in AWS A5.01M/A5.01 (ISO 14344 MOD) document apply:

Lot Definition	***AWS A5.01M/A5.01 (ISO 14344 MOD) Lot Classification***
A lot consists of bare solid electrodes or rods, not exceeding 100 000 lb [45 000 kg] of one classification, size, form, and temper identified by controlled chemical composition	*Class S2*
Tests	***Level of Testing Schedule***
a. Conformance to chemical composition limits	*Sch. H, I, or J*
b. Welding tests upon the lot shipped	*Sch. I or J*
c. Visual Examination, diameters and finish	*A5.10 Requirement*
d. Filler wire tension test	*Identify as part of Sch. K*

The minimum tensile requirement for the test shall be as agreed upon between the supplier and purchaser.

Purchase Order Information

In addition to stating the AWS classification, AWS Specification A5.10/A5.10M (ISO 18273 MOD), diameter, form, and quantity, the purchase order should state that the material is to conform to AWS A5.01M/A5.01 (ISO 14344 MOD), Lot Class S2, Schedule K. Schedule K must be stated to be, "Schedule J plus tension tests of the filler wire for each lot of 2000 lb [900 kg] supplied." When referencing level of testing Schedules I or J, certification of performance to the chemical composition limits and acceptable welding test results will be supplied. Quantitative results of the tension test can be requested on the purchase order.

A6. *Ventilation During Welding*

A6.1 *Five major factors govern the quantity of fumes in the atmosphere to which welders and welding operators are exposed during welding:*

(1) *Dimensions of the space in which welding is done (with special regard to the height of the ceiling)*

(2) *Number of welders and welding operators working in that space*

(3) *Rate of evolution of fumes, gases, or dust, according to the materials and processes involved*

(4) *The proximity of the welder or welding operator to the fumes as they issue from the welding zone, and to the gases and dusts in the space in which the welder or welding operator is working*

(5) *The ventilation provided to the space in which the welding is done.*

A6.2 *ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes, published by the American Welding Society, discusses the ventilation that is required during welding and should be referred to for details. Attention is drawn particularly to the sections of that document covering Ventilation and Confined Spaces. See also AWS F3.2, Ventilation Guide for Weld Fume, for more detailed description of ventilation options.*

A7. *Welding Considerations*

The electrodes and rods described in this specification are primarily for use with the inert gas arc welding processes. However, they may be used with other welding processes such as electron beam or oxyfuel gas welding.

A7.1 *The gas metal arc process permits the successful welding of aluminum alloys that are crack-sensitive when welded by oxyfuel gas or other manual welding processes. The reasons for this might be described briefly as follows:*

Distortion is reduced to a minimum because the increase in temperature of the parts being welded is confined to a narrow zone. Because the aluminum alloys have high thermal conductivity, the reduction of distortion is greater than would be the case with ferrous base metals. Cracking of welds in the aluminum alloys is reduced if the cooling rate is high. The gas metal arc process permits the welding of alloys that have a wide melting range, which heretofore have been difficult to weld without cracking.

A7.2 *The high melting and solidification rate of the weld metal from the gas metal arc process can result in entrapped hydrogen gas in the welds. Control of this factor should be understood to obtain good results. Hydrogen gas in the welds can be caused by contaminating influences, such as grease, hydrocarbon cleaning agents, or moisture on the electrode or on the base metal. Moist air leaking into the inert gas lines may also cause this condition. The introduction of hydrogen gas in the weld metal from any of these causes can result in porosity, because the solidification rate is high and the gas may not have time to escape before the molten metal solidifies.*

A7.3 *Welds can be made in all positions with the gas metal arc process. Edge preparation similar to that used for gas tungsten arc welding is satisfactory. Either pure argon or argon/helium mixtures may be used as shielding. Semiautomatic welding, in which the welding gun is moved by a welder, may be difficult to control on metal thicknesses below 0.08 in [2 mm]. The use of a pulsed power supply permits the welding of base metal as thin as 0.03 in [0.8 mm]. No upper limit on metal thickness has been established for the gas metal arc welding process. Welds in plate up to 8 in [200 mm] in thickness have been made. Automatic gas metal arc welding is suitable for all thicknesses welded, and particularly for 1/8 in [3.2 mm] or less in thickness.*

A7.4 *Gas metal arc welding is typically performed with direct current (electrode positive). An electrode feeding mechanism, in which electrode speed can be adjusted is needed. U-groove radiused top and bottom electrode feed rolls are preferred in both manual and mechanized equipment. Stabilization of the arc with high-frequency current is not required.*

A7.5 *Gas tungsten arc welds can be made in all positions. Welding travel speed is reduced compared to GMA welding, however, this is beneficial in several aspects. The process is more maneuverable for manually welding small tubes or piping than GMAW; entrapment of gases is minimized to permit production of sound welds; short repair welds can be made more easily; and the reduced concentration of heat allows welding aluminum base metal thicknesses as thin as 0.02 in [0.5 mm] or less. Corner and edge joints in sheet gauges can be made more satisfactorily than with GMAW due to the better control of the filler metal additions.*

A7.6 *Gas tungsten arc welds are most commonly made with alternating-current power and pure argon (AWS A5.32 (ISO 14175) – I1) gas shielding. Helium (AWS A5.32 (ISO 14175) – I2) additions to the extent of 25% of the mixture with argon are used to increase the rate of initial melting and the amount of melting in thick base metal. Pure tungsten (AWS A5.12M/A5. 12 Class EWP or zirconia-tungsten (AWS A5.12M/A5.12 Class EWZr-1) electrodes are preferred for AC-GTAW. The positive electrode polarity of the AC power provides an arc cleaning action to remove the surface oxide; however, thick aluminum oxides caused by weathering, thermal treatments, or anodic treatments need to be reduced by chemical or mechanical means prior to welding to obtain uniform results and proper fusion. As stated in A7.2, sources of hydrogen, such as moisture on the base or filler metals or in the gas shielding and residual hydrocarbons on the base or filler metals, must be removed to avoid porosity in the welds.*

A7.7 *Direct current power can also be used to GTA weld aluminum. DCEP power can be used to weld sheet gauges; however, a 1/4 in [6.40 mm] diameter tungsten electrode is required to carry the 125 amperes needed to weld 1/8 in [3.2 mm] thickness, so this polarity is seldom used. DCEN power is used with helium (AWS A5.32 (ISO 14175) – I2) gas shielding and a thoriated tungsten electrode for welding aluminum-base alloys. This negative electrode polarity provides a deep, narrow melting pattern, which is advantageous for repair of thick weldments or castings and for increased welding speeds in all thicknesses. Higher as-welded strength is obtained with DCEN-GTA welds in the heat treatable aluminum alloys due to the reduced heat input compared to ACGTAW. Since no arc cleaning action occurs in the DCEN arc, special attention must be given to minimizing the oxide thickness immediately before welding, such as mechanical scraping or arc cleaning all base metal surfaces within the fusion zone.*

A8. *Description and Intended Use*

A8.1 *The selection of the proper classification of filler metal depends primarily on the aluminum base alloy used in the parts to be welded; and secondly on the welding process, the geometry of the joints, the resistance to corrosion required in service, and on the finish or appearance desired on the welded part. For example, welded vessels for holding hydrogen peroxide require special aluminum alloys, quite frequently a high-purity alloy, in order to have good resistance to corrosion or to prevent contamination of the product contained. In this case, the proper choice of filler metal is an alloy that has at least as high a purity as the base metal. Another example is the foundry welding of castings, where an alloy meeting the composition limits of the castings is, in most cases, the best choice; for example, as in the repair and fabrication of cast alloys including 206.0, C355.0, A356.0, 357.0, and A357.0.*

A8.2 *Experience has shown that certain classifications of filler metal are suitable for welding specific base metals and combinations of base metals. These are listed in Table A.1. If it is desired to weld other combinations than those listed, they should be evaluated as to suitability for the purpose intended. The alloy combinations listed will be suitable for most environments; some are preferable from one or more standpoints. In the absence of specific information, consultation with the material supplier is recommended. Additional information may be found in the aluminum chapter of Welding Handbook, Volume 3, Eighth Edition.*

A8.3 *Filler metal in the form of straight lengths and coils without support is used as welding rod with a number of welding processes. These include oxyfuel gas welding, plasma arc welding, and gas tungsten arc welding. The filler metal is usually fed by hand, although mechanized welding in these processes may involve either manual feeding of the welding rod or use of a feeding mechanism.*

A8.4 *Spooled filler metal is used most commonly as electrode for the gas metal arc welding process. It also is used as filler rod when mechanized feeding systems are employed for gas tungsten arc, plasma-arc welding and other processes. Finite lengths of filler metal can be removed from the spools for use as a high-quality, handfed filler rod with manual gas tungsten arc, plasma-arc or oxyfuel gas welding processes.*

A8.5 *The cleanliness and minimal surface oxidation of the filler metal are important with all welding processes. Oil, or other organic materials, as well as a heavy oxide film on the rod, will interfere with coalescence of the weld and also are sources of porosity. Because of this, it is necessary to clean the welding rod and electrode before packaging.*

A8.6 *Proper storage of welding rods and electrodes is essential to avoid contamination which may affect their performance. Packages of filler metal should not be left outdoors or in unheated buildings because the greater variations in temperature and humidity increase the possibility of condensation creating hydrated surface oxides. Experience has demonstrated that undesirable storage conditions may adversely affect filler metal performance. Investigation of the effect of storage time on electrode performance indicates that packaged electrodes, stored under good conditions (dry places in heated buildings), are satisfactory after extended storage.*

A8.7 *Contamination of filler metal from handling or storage may occur. In most cases, the contaminating influences will dictate the cleaning method. The practice of giving the welding rod, if it has been exposed to the shop atmosphere for long periods of time, a rub with stainless steel wool just before welding is quite widely followed.*

A9. *Special Tests*

This specification classifies those aluminum and aluminum alloy filler metals used most extensively at the time of issuance of the specification. It is recognized that supplementary tests may be necessary to determine the suitability of these welding electrodes and rods for applications involving properties not considered in this specification. In such cases, additional tests to determine such specific properties as corrosion resistance, mechanical properties at high and low temperature, wear resistance, and suitability for welding combinations of dissimilar metals may need to be conducted.

Table A.1
Guide to the Choice of Filler Metal for General Purpose Welding

Base Metal	201.0 206.0 224.0	319.0, 333.0, 354.0, 355.0, C355.0	356.0, A356.0 357.0, A357.0 413.0, 443.0, A444.0	511.0, 512.0, 513.0, 514.0, 535.0	7004, 7005, 7039, 710.0, 712.0	6009 6010 6070	6005, 6061, 6063, 6101, 6151, 6201, 6351, 6951	5456	5454
1060, 1070, 1080, 1350	ER4145	ER4145	ER4043[a, b]	ER5356[c, d]	ER5356[c, d]	ER4043[a, b]	ER4043[b]	ER5356[d]	ER4043[b, d]
1100, 3003, Al[c] 3003	ER4145	ER4145	ER4043[a, b]	ER5356[c, d]	ER5356[c, d]	ER4043[a, b]	ER4043[b]	ER5356[d]	ER4043[b, d]
2014, 2036	ER4145[e]	ER4145[e]	ER4145	—	—	ER4145	ER4145	—	—
2219	ER2319[a]	ER4145[e]	ER4145[b, c]	ER4043	ER4043	ER4043[a, b]	ER4043[a, b]	—	ER4043[b]
3004, Al[c] 3004	—	ER4043[b]	ER4043[b]	ER5356[f]	ER5356[f]	ER4043[b]	ER4043[b, f]	ER5356[d]	ER5356[f]
5005, 5050	—	ER4043[b]	ER4043[b]	ER5356[f]	ER5356[f]	ER4043[b]	ER4043[b, f]	ER5356[d]	ER5356[f]
5052, 5652[i]	—	ER4043[b]	ER4043[f]	ER5356[f]	ER5356[f]	ER4043[b]	ER5356[c, f]	ER5356[f]	ER5356[f]
5083	—	—	ER5356[c, d]	ER5356[d]	ER5183[d]	—	ER5356[d]	ER5183[d]	ER5356[d]
5086	—	—	ER5356[c, d]	ER5356[d]	ER5356[d]	—	ER5356[d]	ER5356[d]	ER5356[d]
5154, 5254[i]	—	—	ER4043[f]	ER5356[f]	ER5356[f]	—	ER5356[f]	ER5356[f]	ER5356[f]
5454	—	ER4043[b]	ER4043[f]	ER5356[f]	ER5356[f]	ER4043[b]	ER5356[c, f]	ER5356[f]	ER5554[c, f]
5456	—	—	ER5356[c, d]	ER5356[d]	ER5556[d]	—	ER5356[d]	ER5556[d]	
6005, 6061, 6063 6101, 6151, 6201 6351, 6951	ER4145	ER4145[b, c]	ER4043[b, f, g]	ER5356[f]	ER5356[c, f]	ER4043[a, b, g]	ER4043[b, f, g]		
6009, 6010, 6070	ER4145	ER4145[b, c]	ER4043[a, b, g]	ER4043	ER4043	ER4043[a, b, g]			
7004, 7005, 7039 710.0, 712.0	—	ER4043[b]	ER4043[b, f]	ER5356[f]	ER5356[d]				
511.0, 512.0, 513.0 514.0, 535.0	—	—	ER4043[f]	ER5356[f]					
356.0, A356.0, 357.0 A357.0, 413.0 443.0, A444.0	ER4145	ER4145[b, c]	ER4043[b, h]						
319.0, 333.0 354.0, 355.0 C355.0	ER4145[c]	ER4145[b, c, h]							
201.0, 206.0, 224.0	ER2319[a, h]								

(Continued on next page)

Table A.1 (Continued)
Guide to the Choice of Filler Metal for General Purpose Welding

Base Metal	5154 5254[i]	5086	5083	5052 5652[i]	5005 5050	3004 Alc. 3004	2219	2014 2036	1100 3003 Alc. 3003	1060 1070 1080 1350
1060, 1070, 1080, 1350	ER5356[c, d]	ER5356[d]	ER5356[d]	ER4043[b, d]	ER1100[b, c]	ER4043[b, d]	ER4145[b, c]	ER4145	ER1100[b, c]	ER1188[b, c, h, j]
1100, 3003, Al[c] 3003	ER5356[c, d]	ER5356[d]	ER5356[d]	ER4043[b, d]	ER1100[b, c]	ER4043[b, d]	ER4145[b, c]	ER4145	ER1100[b, c]	
2014, 2036	—	—	—	—	ER4145	ER4145	ER4145[e]	ER4145[e]		
2219	ER4043	—	—	ER4043[b]	ER4043[a, b]	ER4043[a, b]	ER2319[a]			
3004, Al[c] 3004	ER5356[f]	ER5356[d]	ER5356[d]	ER5356[c, f]	ER5356[c, f]	ER5356[c, f]				
5005, 5050	ER5356[f]	ER5356[d]	ER5356[d]	ER5356[c, d]	ER5356[c, f]					
5052, 5652[i]	ER5356[f]	ER5356[d]	ER5356[d]	ER5654[c, f, i]						
5083	ER5356[d]	ER5356[d]	ER5183[d]							
5086	ER5356[d]	ER5356[d]								
5154, 5254[i]	ER5356[f, i]									

Note: ISO Classifications different from AWS Classifications have not been added to this table.

[a] *ER4145 may be used for some applications.*
[b] *ER4047 may be used for some applications.*
[c] *ER4043 may be used for some applications.*
[d] *ER5183, ER5356, or ER5556 may be used.*
[e] *ER2319 may be used for some applications. It can supply high strength when the weldment is postweld solution heat-treated and aged.*
[f] *ER5183, ER5356, ER5554, ER5556, and ER5654 may be used. In some cases, they provide: (1) improved color match after anodizing treatment, (2) highest weld ductility, and (3) higher weld strength. ER5554 is suitable for sustained elevated temperature service.*
[g] *ER4643 and ER4943 will provide higher strength than ER4043 in 1/2 in [12 mm] and thicker groove welds in 6XXX base alloys when postweld solution heat-treated and aged. They will also provide higher strength fillet welds than ER4043 in the as welded, postweld aged, or postweld heat-treated and aged conditions.*
[h] *Filler metal with the same analysis as the base metal is sometimes used. The following wrought filler metals possess the same chemical composition limits as cast filler alloys: ER4009 and R4009 as R-C355.0; ER4010 and R4010 as R-A356.0; and R4011 as R-A357.0.*
[i] *Base metal alloys 5254 and 5652 are used for hydrogen peroxide service. ER5654 filler metal is used for welding both alloys for service temperatures below 150°F [66°C].*
[j] *ER1100 may be used for some applications.*

Notes:
1. *ER4047, ER4643, or ER4943 may be used in some applications when alloy ER4043 is specified.*
2. *Service conditions such as immersion in fresh or salt water, exposure to specific chemicals, or a sustained high temperature (over 150°F [66°C]) may limit the choice of filler metals. Filler metals ER5183, ER5356, and ER5556 are not recommended for sustained elevated temperature service.*
3. *Recommendations in this table apply to gas shielded arc welding processes. For oxyfuel gas welding, only ER1188, ER1100, ER4043, ER4047, and ER4145 filler metals are ordinarily used.*
4. *Where no filler metal is listed, the base metal combination is not recommended for welding.*

A10. *Chemical Analysis*

The most widely used method for chemical analysis is ASTM E227, Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloy by the Point-to-Plane Technique*, but other established analytical methods are acceptable. The ASTM E227 method analyzes a bulk sample and all elements simultaneously. The ASTM E34 standard method prescribes individual test methods for which each element is tested. The ASTM E34 tests methods are used as a referee method if a dispute arises concerning a specific element analysis.*

A11. *Discontinued and Replaced Alloys*

Compositions of aluminum alloy welding electrodes and rods have been discontinued and/or replaced as new editions of A5.10/A5.10M have been issued (see Table A.2).

Table A.2
Discontinued Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods

Discontinued		Replacement	
AWS A5.10		AWS A5.10	
Classification	Issue	Classification	Issue
ER1060	1961	—	—
ER1260	1980	ER1188	1988
ER2014	1961	—	—
ER3004	1961	—	—
ER5039	1980	—	—
ER5052	1967	—	—
ER5154	1969	ER5654	1969
ER5254	1969	ER5654	1969
ER5652	1969	ER5654	1969
R242.0	1988	—	—
R295.0	1988	—	—
R355.0	1988	R-C355.0	1988
		ER4009 & R4009	1992
R356.0	1988	R-A356.0	1988
		ER4010 & R4010	1992
R-990A	1957	ER1100	1992
E-990A	1957	ER1100	1992
R-996A	1957	ER1060	1957
E-996A	1957	ER1060	1957
R-C4A	1980	R295.0	1980
R-CN42A	1980	R242.0	1980
R-C541A	1957	ER2014	1957
E-C541A	1957	ER2014	1957
R-G1A	1961	—	—
E-G1A	1961	—	—
R-GM50A	1957	ER5356	1957
E-GM50A	1957	ER5356	1957
R-GR20A	1957	ER5052	1957
E-GR20A	1957	ER5052	1957
R-GR40A	1957	ER5154	1957
E-GR40A	1957	ER5154	1957
R-MG11A	1957	ER3004	1957
E-MG11A	1957	ER3004	1957
R-SG70A	1980	R356.0	1980

A12. *General Safety Considerations*

A12.1 *Safety issues and concerns are addressed in this standards, although health issues and concerns are beyond the scope of this standard. Some safety and health information can be found in Annex Clause A6. Safety and health information is available from other sources, including, but not limited to Safety and Health Fact Sheets listed in A12.3, ANSI Z49.1, and applicable federal and state regulations.*

A12.2 ***Safety and Health Fact Sheets.*** *The Safety and Health Fact Sheets listed below are published by the American Welding Society (AWS). They may be downloaded and printed directly from the AWS website at http://www.aws.org. The Safety and Health Fact Sheets are revised and additional sheets added periodically.*

A12.3 AWS Safety and Health Fact Sheets Index (SHF)[8]

No.	Title
1	*Fumes and Gases*
2	*Radiation*
3	*Noise*
4	*Chromium and Nickel in Welding Fume*
5	*Electrical Hazards*
6	*Fire and Explosion Prevention*
7	*Burn Protection*
8	*Mechanical Hazards*
9	*Tripping and Falling*
10	*Falling Objects*
11	*Confined Spaces*
12	*Contact Lens Wear*
13	*Ergonomics in the Welding Environment*
14	*Graphic Symbols for Precautionary Labels*
15	*Style Guidelines for Safety and Health Documents*
16	*Pacemakers and Welding*
17	*Electric and Magnetic Fields (EMF)*
18	*Lockout/Tagout*
19	*Laser Welding and Cutting Safety*
20	*Thermal Spraying Safety*
21	*Resistance Spot Welding*
22	*Cadmium Exposure from Welding & Allied Processes*
23	*California Proposition 65*
24	*Fluxes for Arc Welding and Brazing: Safe Handling and Use*
25	*Metal Fume Fever*
26	*Arc Viewing Distance*
27	*Thoriated Tungsten Electrodes*
28	*Oxyfuel Safety: Check Valves and Flashback Arrestors*
29	*Grounding of Portable and Vehicle Mounted Welding Generators*
30	*Cylinders: Safe Storage, Handling, and Use*
31	*Eye and Face Protection for Welding and Cutting Operations*
33	*Personal Protective Equipment (PPE) for Welding & Cutting*
34	*Coated Steels: Welding and Cutting Safety Concerns*
36	*Ventilation for Welding & Cutting*
37	*Selecting Gloves for Welding & Cutting*

[8] *AWS standards are published by the American Welding Society, 8669 Doral Blvd., Suite 130, Doral, FL 33166.*

Annex B (Informative)

Guidelines for the Preparation of Technical Inquiries

This annex is not part of AWS A5.10/A5.10M: 2012 (ISO 18273:2004 MOD), Welding Consumables—Wire Electrodes, Wire and Rods for Welding of Aluminum and Aluminum-Alloys—Classification, but is included for informational purposes only.

B1. Introduction

The American Welding Society (AWS) Board of Directors has adopted a policy whereby all official interpretations of AWS standards are handled in a formal manner. Under this policy, all interpretations are made by the committee that is responsible for the standard. Official communication concerning an interpretation is directed through the AWS staff member who works with that committee. The policy requires that all requests for an interpretation be submitted in writing. Such requests will be handled as expeditiously as possible, but due to the complexity of the work and the procedures that must be followed, some interpretations may require considerable time.

B2. Procedure

All inquiries shall be directed to:

Managing Director
Technical Services Division
American Welding Society
8669 Doral Blvd., Suite 130
Doral, FL 33166

All inquiries shall contain the name, address, and affiliation of the inquirer, and they shall provide enough information for the committee to understand the point of concern in the inquiry. When the point is not clearly defined, the inquiry will be returned for clarification. For efficient handling, all inquiries should be typewritten and in the format specified below.

B2.1 Scope. *Each inquiry shall address one single provision of the standard unless the point of the inquiry involves two or more interrelated provisions. The provision(s) shall be identified in the scope of the inquiry along with the edition of the standard that contains the provision(s) the inquirer is addressing.*

B2.2 Purpose of the Inquiry. *The purpose of the inquiry shall be stated in this portion of the inquiry. The purpose can be to obtain an interpretation of a standard's requirement or to request the revision of a particular provision in the standard.*

B2.3 Content of the Inquiry. *The inquiry should be concise, yet complete, to enable the committee to understand the point of the inquiry. Sketches should be used whenever appropriate, and all paragraphs, figures, and tables (or annex) that bear on the inquiry shall be cited. If the point of the inquiry is to obtain a revision of the standard, the inquiry shall provide technical justification for that revision.*

B2.4 Proposed Reply. *The inquirer should, as a proposed reply, state an interpretation of the provision that is the point of the inquiry or provide the wording for a proposed revision, if this is what the inquirer seeks.*

B3. Interpretation of Provisions of the Standard

Interpretations of provisions of the standard are made by the relevant AWS technical committee. The secretary of the committee refers all inquiries to the chair of the particular subcommittee that has jurisdiction over the portion of the standard addressed by the inquiry. The subcommittee reviews the inquiry and the proposed reply to determine what the response to the inquiry should be. Following the subcommittee's development of the response, the inquiry and the response are presented to the entire committee for review and approval. Upon approval by the committee, the interpretation is an official interpretation of the Society, and the secretary transmits the response to the inquirer and to the Welding Journal *for publication.*

B4. Publication of Interpretations

All official interpretations will appear in the Welding Journal and will be posted on the AWS web site.

B5. Telephone Inquiries

Telephone inquiries to AWS Headquarters concerning AWS standards should be limited to questions of a general nature or to matters directly related to the use of the standard. The AWS Board Policy Manual requires that all AWS staff members respond to a telephone request for an official interpretation of any AWS standard with the information that such an interpretation can be obtained only through a written request. Headquarters staff cannot provide consulting services. However, the staff can refer a caller to any of those consultants whose names are on file at AWS Headquarters.

B6. AWS Technical Committees

The activities of AWS technical committees regarding interpretations are limited strictly to the interpretation of provisions of standards prepared by the committees or to consideration of revisions to existing provisions on the basis of new data or technology. Neither AWS staff nor the committees are in a position to offer interpretive or consulting services on (1) specific engineering problems, (2) requirements of standards applied to fabrications outside the scope of the document, or (3) points not specifically covered by the standard. In such cases, the inquirer should seek assistance from a competent engineer experienced in the particular field of interest.

Annex C (Informative)

List of Deviations from ISO 18273:2004

This annex is not part of AWS A5.10/A5.10M: 2012 (ISO 18273:2004 MOD), Welding Consumables—Wire Electrodes, Wire and Rods for Welding of Aluminum and Aluminum-Alloys—Classification, but is included for informational purposes only.

Deleted "European" globally

Added names and addresses of the publishers whose documents are referred in this specification

ISO uses comma (,) for decimal, but AWS uses period (.) for decimal. Decimal commas have been changed to decimal periods.

Numbered all clauses

Added "Safety and health issues and concerns are beyond the scope of this standard and are therefore not fully addressed herein. Some safety and health information can be found in the informative annex Clauses A5 and A10. Safety and health information is available from other sources, including, but not limited to, ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes, and applicable federal and state regulations" in Clause 1.

Added "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 with the designation A510M uses SI Units. The specification A5.10 uses U.S. Customary 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 A5.10M or A5.10" in Clause 1.

Added subclauses 2.1, 2.2, and 2.3

***2.4** The following ISO standards is referenced in the mandatory clause of this document:"*

Changed "ISO 31-0:1992, principles" to "ISO 80000-1, Quantities and units*"*

Replaced "ISO 14344, Welding and allied processes — Flux and gas shielded electrical welding processes — Procurement guidelines for consumables*" with "AWS A5.01M/A5.01 (ISO 14344 MOD)" globally.*

Added "in Table 1" in 3b

Added Clauses 3.1, 3.2, 3.3, and 3.4

*Replaced "**8 Technical delivery conditions***

Technical delivery conditions shall meet the requirements in EN ISO 544 and ISO 14344" with clause titled as "Acceptance."

Added Clauses 4, 5, 6, 7, and 9

*Replaced "**10. Chemical Analysis***

Chemical analysis shall be performed on samples of the product or the stock from which it is made. Any analytical technique may be used, but in case of dispute reference shall be made to established published methods" with the text shown now.

Added Clauses 11, 12, 13, 14, 15, 16, 17, 18, 19, and 20

Renumbered other clauses as needed

Deleted Note 1 "Consumables not listed in the Table can be symbolized by Al Z. Chemical symbol established by the manufacturer may be added in brackets" from Table 1.

AWS Filler Metal Specifications by Material and Welding Process

	OFW	*SMAW*	*GTAW GMAW PAW*	*FCAW*	*SAW*	*ESW*	*EGW*	*Brazing*
Carbon Steel	*A5.2*	*A5.1*	*A5.18, A5.36*	*A5.36*	*A5.17*	*A5.25*	*A5.26*	*A5.8, A5.31*
Low-Alloy Steel	*A5.2*	*A5.5*	*A5.28, A5.36*	*A5.36*	*A5.23*	*A5.25*	*A5.26*	*A5.8, A5.31*
Stainless Steel		*A5.4*	*A5.9, A5.22*	*A5.22*	*A5.9*	*A5.9*	*A5.9*	*A5.8, A5.31*
Cast Iron	*A5.15*	*A5.15*	*A5.15*	*A5.15*				*A5.8, A5.31*
Nickel Alloys		*A5.11*	*A5.14*	*A5.34*	*A5.14*	*A5.14*		*A5.8, A5.31*
Aluminum Alloys		*A5.3*	*A5.10*					*A5.8, A5.31*
Copper Alloys		*A5.6*	*A5.7*					*A5.8, A5.31*
Titanium Alloys			*A5.16*					*A5.8, A5.31*
Zirconium Alloys			*A5.24*					*A5.8, A5.31*
Magnesium Alloys			*A5.19*					*A5.8, A5.31*
Tungsten Electrodes			*A5.12*					
Brazing Alloys and Fluxes								*A5.8, A5.31*
Surfacing Alloys	*A5.21*	*A5.13*	*A5.21*	*A5.21*	*A5.21*			
Consumable Inserts			*A5.30*					
Shielding Gases			*A5.32*	*A5.32*			*A5.32*	

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AWS Filler Metal Specifications and Related Documents

Designation	*Title*
FMC	Filler Metal Comparison Charts
IFS	International Index of Welding Filler Metal Classifications
UGFM	User's Guide to Filler Metals
A4.2M (ISO 8249 MOD)	Standard Procedures for Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic and Duplex Ferritic-Austenitic Stainless Steel Weld Metal
A4.3	Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding
A4.4M	Standard Procedures for Determination of Moisture Content of Welding Fluxes and Welding Electrode Flux Coverings
A4.5M/A4.5 (ISO 15792-3 MOD)	Standard Methods for Classification Testing of Positional Capacity and Root Penetration of Welding Consumables in a Fillet Weld
A5.01M/A5.01 (ISO 14344 MOD)	Procurement Guidelines for Consumables—Welding and Allied Processes—Flux and Gas Shielded Electrical Welding Processes
A5.02/A5.02M	Specification for Filler Metal Standard Sizes, Packaging, and Physical Attributes
A5.1/A5.1M	Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
A5.2/A5.2M	Specification for Carbon and Low-Alloy Steel Rods for Oxyfuel Gas Welding
A5.3/A5.3M	Specification for Aluminum and Aluminum-Alloy Electrodes for Shielded Metal Arc Welding
A5.4/A5.4M	Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding
A5.5/A5.5M	Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding
A5.6/A5.6M	Specification for Copper and Copper-Alloy Electrodes for Shielded Metal Arc Welding
A5.7/A5.7M	Specification for Copper and Copper-Alloy Bare Welding Rods and Electrodes
A5.8/A5.8M	Specification for Filler Metals for Brazing and Braze Welding
A5.9/A5.9M	Specification for Bare Stainless Steel Welding Electrodes and Rods
A5.10/A5.10M (ISO 18273 MOD)	Welding Consumables—Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys—Classification
A5.11/A5.11M	Specification for Nickel and Nickel-Alloy Welding Electrodes for Shielded Metal Arc Welding
A5.12M/A5.12 (ISO 6848 MOD)	Specification for Tungsten and Oxide Dispersed Tungsten Electrodes for Arc Welding and Cutting
A5.13/A5.13M	Specification for Surfacing Electrodes for Shielded Metal Arc Welding
A5.14/A5.14M	Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods
A5.15	Specification for Welding Electrodes and Rods for Cast Iron
A5.16/A5.16M	Specification for Titanium and Titanium-Alloy Welding Electrodes and Rods
A5.17/A5.17M	Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding
A5.18/A5.18M	Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding
A5.19	Specification for Magnesium Alloy Welding Electrodes and Rods
A5.21/A5.21M	Specification for Bare Electrodes and Rods for Surfacing
A5.22/A5.22M	Specification for Stainless Steel Flux Cored and Metal Cored Welding Electrodes and Rods
A5.23/A5.23M	Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding
A5.24/A5.24M	Specification for Zirconium and Zirconium-Alloy Welding Electrodes and Rods
A5.25/A5.25M	Specification for Carbon and Low-Alloy Steel Electrodes and Fluxes for Electroslag Welding
A5.26/A5.26M	Specification for Carbon and Low-Alloy Steel Electrodes for Electrogas Welding
A5.28/A5.28M	Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding
A5.30/A5.30M	Specification for Consumable Inserts
A5.31M/A31	Specification for Fluxes for Brazing and Braze Welding
A5.32M/A5.32 (ISO 14175 MOD)	Welding Consumables—Gases and Gas Mixtures for Fusion Welding and Allied Processes
A5.34/A5.34M	Specification for Nickel-Alloy Electrodes for Flux Cored Arc Welding
A5.36/A5.36M	Specification for Carbon and Low-Alloy Steel Flux Cored Electrodes for Flux Cored Arc Welding and Metal Cored Electrodes for Gas Metal Arc Welding

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