

AWS A5.7/A5.7M:2007
An American National Standard

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



American Welding Society



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An American National Standard

Approved by the
American National Standards Institute
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Specification for Copper and Copper-Alloy Bare Welding Rods and Electrodes

7th Edition

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

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

Abstract

This specification prescribes the requirements for classifications of copper and copper-alloy electrodes and rods for gas shielded metal arc, gas shielded tungsten arc, and plasma arc welding. Classification is based on chemical composition of the filler metal. Additional requirements are included for manufacture, sizes, lengths and packaging. A guide is appended to the specification as a source of information concerning the classification system employed and intended use of the electrodes.

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.



American Welding Society

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Foreword

This foreword is not part of AWS A5.7/A5.7M:2007, *Specification for Copper and Copper-Alloy Bare Welding Rods and Electrodes*, but is included for informational purposes only.

This documentation is a revision of ANSI/AWS A5.7-84 published in 1984. The AWS Subcommittee on Copper and Copper-Alloy Filler Metals prepared the revision. This specification describes the most common copper and copper-alloy bare rod and electrodes for use with the inert gas shielded arc welding processes. Since the applications for these electrodes and rods are so diverse, i.e., surfacing and joining, discussions on intended uses and suggested welding parameters are included. The reader will find the data describing weld deposit hardness listed in Table A.2 particularly useful when selecting a classification for surfacing applications. This is the sixth revision of AWS A5.7 specification.

This document is the first of the A5.7 specifications which 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. In selecting rational metric units the AWS A1.1, *Metric Practice Guide for the Welding Industry*, and ISO 544: *Welding consumables — Technical delivery conditions for welding filler metals — Type of product, dimensions, tolerances and markings*, are used as guides. 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 new filler metal classification ERCuSn-C, and the requirements for identification of straight length rods have been added in this edition as shown in *Italic* font.

Document Development

ASTM B 259-52T AWS A5.7-52T	<i>Tentative Specifications for Copper and Copper-Alloy Welding Rods</i>
ASTM B 259-57T AWS A5.7-57T	<i>Tentative Specifications for Copper and Copper-Alloy Welding Rods</i>
ASTM B 259-66T AWS A5.7-66T	<i>Tentative Specification for Copper and Copper-Alloy Welding Rods</i>
AWS A5.7-69 ANSI W3.7-73	<i>Specification for Copper and Copper Alloy Welding Rods</i>
AWS A5.7-77	<i>Specification for Copper and Copper Alloy Bare Welding Rods and Electrodes</i>
ANSI/AWS A5.7-84	<i>Specification for Copper and Copper Alloy Bare Welding Rods and Electrodes</i>
ANSI/AWS A5.7-84R	Reaffirmed June 19, 1991
ANSI/AWS A5.7-84R	Reaffirmed December 19, 2000

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, 550 N.W. LeJeune Road, Miami, FL 33126.

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

1. Scope

1.1 This specification prescribes requirements for the classification of copper and copper-alloy bare welding rods and electrodes for plasma arc, gas metal arc, and gas tungsten arc welding. It includes compositions in which the copper content exceeds that of any other element.¹

1.2 Safety and health issues and concerns are beyond the scope of this standard and, therefore, are 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.

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 material properties. The specification with the designation A5.7 uses U.S. Customary Units. The specification A5.7M 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 sizing of filler metal or packaging or both under A5.7 or A5.7M specification.

2. Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this AWS standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreement based on

¹ No attempt has been made to provide for classification of all grades of copper and copper-alloy filler metals; only the more commonly used have been included.

this AWS standard are encouraged to investigate the possibility of applying the most recent editions of the documents shown below. For undated references, the latest edition of the standard referred to applies.

2.2 The following AWS standard² is referenced in the normative clauses of this document:

- (1) AWS A5.01, *Filler Metal Procurement Guidelines*.

2.3 The following ANSI standard³ is referenced in the normative clauses of this document:

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

2.4 The following ASTM International standards⁴ are referenced in the normative clauses of this document:

- (1) ASTM E 29, *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*.
- (2) ASTM E 75, *Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys*.
- (3) ASTM E 478, *Standard Test Methods for Chemical Analysis of Copper Alloys*.

2.5 The following ISO standard⁵ is referenced in the normative clauses of this document:

- ISO 544: *Welding consumables — Technical delivery conditions for welding filler materials — Type of product, dimensions, tolerances and markings*.

² AWS standards are published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

³ This ANSI standard is published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

⁴ ASTM International standards are published by the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

⁵ ISO standards are published by the International Organization for Standardization, 1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland.

3. Classification

3.1 The welding materials covered by the AWS A5.7/A5.7M specification are classified using a system that is independent of U.S. Customary Units and the International System of Units (SI). Classification is according to the chemical composition of the filler metal or rod stock from which it was made, as specified in Table 1.

3.2 Material classified under one classification shall not be classified under any other classification of this specification.

3.3 The materials classified under this specification are intended for plasma arc, gas metal arc, and gas tungsten arc welding, but that does not prohibit their use with other welding processes for which they are found suitable.

4. Acceptance

Acceptance⁶ of the material shall be in accordance with the provisions of AWS A5.01.

5. Certification

By affixing the AWS specification and classification designations to the packaging or the AWS classification to the product, the manufacturer certifies that the product meets the requirements of this specification.⁷

6. Rounding-Off Procedure

For purposes of determining conformance with this specification, 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 value in accordance with the rounding-off method given in ASTM E 29.

7. Summary of Tests

Chemical analysis of the filler metal, or the stock from which it was made, is the only test required for classification of a product under this specification.

⁶See Clause A3 (in Annex A) for further information concerning acceptance, testing of the material shipped, and AWS A5.01.

⁷See Clause A4 (in Annex A) for further information concerning certification and the testing called for to meet this requirement.

8. Retest

If the results of any test fail to meet its requirement, that test shall be repeated twice. The results of both tests shall meet the requirements. Specimens for 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 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 test specimens or in conducting the test, the test shall be considered invalid without regard to whether the test was actually completed, or whether test results met, or failed to meet, the requirement. That test shall be repeated, following prescribed procedures. In this case the requirement for doubling of the number of test specimens does not apply.

9. Chemical Analysis

9.1 A sample of the filler metal or the stock from which it is made shall be prepared for chemical analysis.

9.2 The sample shall be analyzed by accepted analytical methods. The referee method shall be ASTM E 478, and ASTM E 75 for copper-nickel alloys, as appropriate.

9.3 The results of the analysis shall meet the requirements of Table 1 for the classification of filler metal under test.

10. Method of Manufacture

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

11. Standard Sizes and Shapes

Standard sizes for filler metal in the different package forms (straight lengths, coils with support, coils without support, and spools) are shown in Table 2.

Table 1
Chemical Composition Requirements

AWS Classification	UNS Number ^c	Common Name	Composition, weight percent ^{a, b}											Total Other Elements
			Cu Including Ag ^e	Zn	Sn	Mn	Fe	Si	Ni Including Co ^f	P	Al	Pb	Ti	
ERCu	C18980	Copper	98.0 min	—	1.0	0.50	—	0.50	—	0.15	0.01	0.02	—	0.50
ERCuSi-A	C65600	Silicon bronze (copper-silicon)	Remainder	1.0	1.0	1.5	0.50	2.8–4.0	—	—	0.01	0.02	—	0.50
ERCuSn-A	C51800	Phosphor bronze (copper-tin)	Remainder	—	4.0–6.0	—	—	—	—	0.10–0.35	0.01	0.02	—	0.50
ERCuSn-C	C52100		Remainder	0.20	7.0–9.0	—	0.10	—	—	0.10–0.35	0.01	0.02	—	0.50
ERCuNi ^d	C71581	Copper-Nickel	Remainder	—	—	1.0	0.40–0.75	0.25	29.0–32.0	0.02	—	0.02	0.20–0.50	0.50
ERCuAl-A1	C61000	Aluminum bronze	Remainder	0.20	—	0.50	—	0.10	—	—	6.0–8.5	0.02	—	0.50
ERCuAl-A2	C61800		Remainder	0.02	—	—	0.5–1.5	0.10	—	—	8.5–11.0	0.02	—	0.50
ERCuAl-A3	C62400		Remainder	0.10	—	—	2.0–4.5	0.10	—	—	10.0–11.5	0.02	—	0.50
ERCuNiAl	C63280	Nickel-aluminum bronze	Remainder	0.10	—	0.60–3.50	3.0–5.0	0.10	4.0–5.5	—	8.50–9.50	0.02	—	0.50
ERCuMnNiAl	C63380	Manganese-nickel aluminum bronze	Remainder	0.15	—	11.0–14.0	2.0–4.0	0.10	1.5–3.0	—	7.0–8.5	0.02	—	0.50

^a Analysis shall be made for the elements for which specific values are shown in this table. If, however, the presence of other elements is indicated in the course of routine analysis, further analysis shall be made to determine that the total of these other elements is not present in excess of the limits specified for “Total Other Elements” in the last column of this table.

^b Single values shown are maximum, unless otherwise noted.

^c ASTM D5-56/SAE HS-1086, *Metals & Alloys in the Unified Numbering System*.

^d Sulfur shall be 0.01% maximum for the ERCuNi classification.

^e Ag may or may not be present.

^f Co may or may not be present.

Table 2
Standard Sizes

Standard Package Form	Diameter			Tolerance ^b	
	in	in	mm	in	mm
Straight Lengths ^c	1/16	(0.062)	1.6		
	5/64	(0.078)	2.0		
	3/32	(0.094)	2.4		
		(0.097)	2.5		
	1/8	(0.125)	3.2	±0.002	±0.1
	5/32	(0.156)	4.0		
	3/16	(0.187)	4.8 ^d		
		(0.197)	5.0		
	1/4	(0.250)	6.4 ^d		
Coils, with or without Support	1/8	(0.125)	3.2		
	5/32	(0.156)	4.0		
	3/16	(0.187)	4.8 ^d	±0.002	+0.01
		(0.197)	5.0		−0.07
		(0.237)	6.0		
	1/4	(0.250)	6.4 ^d		
Spools	0.020		0.5		
	0.030		0.8		
	0.035		0.9		
			1.0		
	0.045		—	±0.002	+0.01
		(0.047)	1.2		−0.04
	1/16	(0.062)	1.6		
	5/64	(0.078)	2.0		
	3/32	(0.094)	2.4		
		(0.097)	2.5		

^a Dimensions, tolerances, and package forms other than those shown shall be as agreed upon between purchaser and supplier.

^b Out of roundness (the difference between the major and minor diameters) shall not exceed one-half of the tolerance.

^c Length shall be 36 in +0, −1/2 in [900 mm ± 2%].

^d Not included in ISO 544.

12. Finish and Uniformity

12.1 All filler metal shall have a smooth finish that is free from slivers, depressions, scratches, scale, seams, laps, and foreign matter that would adversely affect the welding characteristics, the operation of the welding equipment, or the properties of the weld metal.

12.2 Each continuous length of filler metal shall be from a single heat or lot of material, and welds, when present, shall have been made so as not to interfere with the uniform, uninterrupted feeding of the filler metal on automatic or semiautomatic equipment.

13. Standard Package Forms

13.1 Standard package forms are straight lengths, coils with support, coils without support, and spools. Standard package dimensions and weights for each form are given in Table 3. Dimensions for standard spools are given in Figure 1. Package forms, sizes, and weights other than these shall be as agreed upon between purchaser and supplier.

13.2 The liners in coils with support shall be designed and constructed to prevent distortion of the coil during normal handling and use, and shall be clean and dry enough to maintain the cleanliness of the filler metal.

Table 3
Standard Package Dimensions and Weights^a

Package Form	Net Weight ^b		Width, max.		Diameter			
					Inside		Outside	
	lb	kg	in	mm	in	mm	in	mm
Coils Without Support	As agreed by the purchaser and supplier							
Coils With Support	25	12	2-1/2	65			17-1/2	445
	50	25	4-5/8	120	12 ± 1/8	305 +10, -0	17	430
	60	30	4-5/8	120			17	430
Spools ^c	2 ^d	1 ^d					4	100
	10 ^d	5 ^d					8	200
	25 ^e	12 ^e					12	300
Straight Lengths	5	2.5						
	10	5						
	25	12						
	50	25						

^a Weights, dimensions, and package forms other than these shall be as agreed upon between purchaser and supplier.

^b Net weight may vary ±10% from the nominal weight, except as provided in Notes d and e.

^c Dimensions of the standard spools are specified in Figure 1.

^d ±20%.

^e ±20%, except that 20% of any lot may contain spools that vary in weight from 12-1/2 lb to 20 lb [5 kg to 10 kg].

13.3 Spools shall be designed and constructed to prevent distortion of the spool and the filler metal during normal handling and use, and shall be clean and dry enough to maintain the cleanliness of the filler metal. Spools shall electrically insulate the filler metal from the spindle.

14. Winding Requirements

14.1 The electrode on spools and in coils shall be closely wound so that kinks, waves, sharp bends, overlapping, or wedging are not encountered, leaving the filler metal free to unwind without restriction. The outside end of the filler metal (the end with which welding is to begin) shall be identified so that it can be located readily and shall be fastened to avoid unwinding. The outermost layer of electrode or rod on spools shall be at least 1/8 in [3 mm] from the rim (the O.D.) of the flanges of the spool.

14.2 The cast and helix of the filler metal in coils and spools shall be such that the filler metal will feed in an uninterrupted manner in automatic and semi-automatic equipment.

14.3 The cast and helix of filler metal on 4 in [100 mm] spools shall be such that a specimen long enough to produce a single loop, when cut from the spool and laid unrestrained on a flat surface, will:

(1) form a circle not less than 4 in [100 mm], nor more than 15 in [380 mm] in diameter; and

(2) rise above the flat surface no more than 1/2 in [13 mm] at any location.

14.4 The cast and helix of filler metal on 8 in [200 mm] spools shall be such that a specimen long enough to produce a single loop, when cut from the spool and laid unrestrained on a flat surface, will:

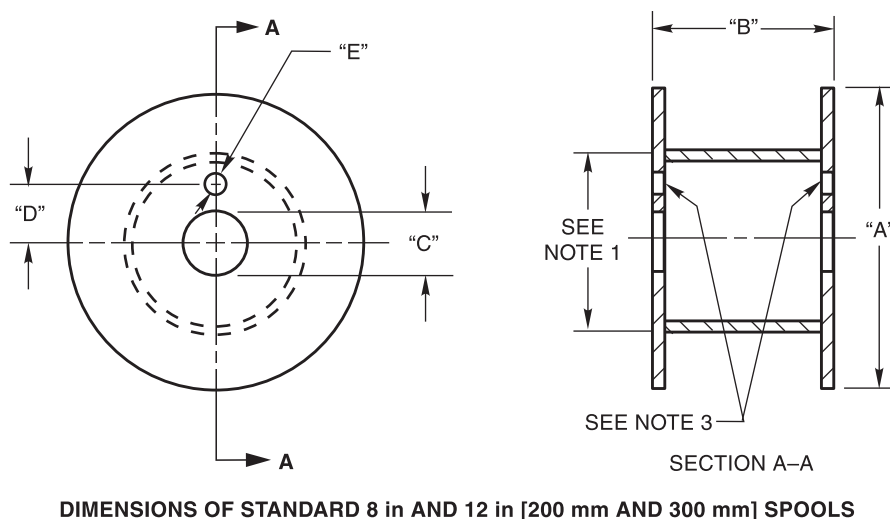
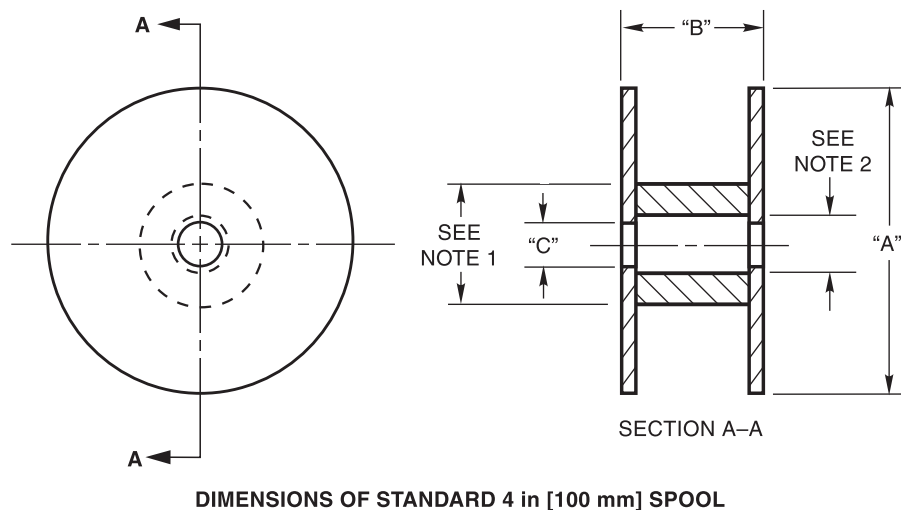
(1) form a circle not less than 10 in [250 mm] nor more than 30 in [760 mm] in diameter, and

(2) rise above the flat surface no more than 3/4 in [19 mm] at any location.

14.5 The cast and helix of filler metal on 12 in [300 mm] spools shall be such that a specimen long enough to produce a single loop, when cut from the spool and laid unrestrained on a flat surface, will:

(1) form a circle not less than 15 in [380 mm] nor more than 50 in [1250 mm] in diameter, and

(2) rise above the flat surface no more than 1 in [25 mm] at any location.



		DIMENSIONS					
		4 in [100 mm] Spools		8 in [200 mm] Spools		12 in [300 mm] Spools	
		in	mm	in	mm	in	mm
A	Diameter, max. (Note 4)	4.0	102	8.0	203	12	305
B	Width	1.75	46	2.16	56	4.0	103
	Tolerance	± 0.03	$+0, -2$	± 0.03	$+0, -3$	± 0.06	$+0, -3$
C	Diameter	0.63	16	2.03	50.5	2.03	50.5
	Tolerance	$+0.01, -0$	$+1, -0$	$+0.06, -0$	$+2.5, -0$	$+0.06, -0$	$+2.5, -0$
D	Distance between axes	—	—	1.75	44.5	1.75	44.5
	Tolerance	—	—	± 0.02	± 0.5	± 0.02	± 0.5
E	Diameter (Note 3)	—	—	0.44	10	0.44	10
	Tolerance	—	—	$+0, -0.06$	$+1, -0$	$+0, -0.06$	$+1, -0$

Notes:

1. Outside diameter of barrel shall be such as to permit proper feeding of the filler metals.
2. Inside diameter of the barrel shall be such that swelling of the barrel or misalignment of the barrel and flanges will not result in the inside of the diameter of the barrel being less than the inside diameter of the flanges.
3. Holes are provided on each flange, but they need not be aligned. No driving holes required for 4 in [100 mm] spools.
4. Metric dimensions and tolerances conform to ISO 544 except that "A" specifies $\pm$ tolerances on the nominal diameter, rather than a plus tolerance only, which is shown here as a maximum.

Figure 1—Dimensions of 4 in, 8 in, and 12 in [100 mm, 200 mm, and 300 mm] Spools

15. Filler Metal Identification

15.1 The product information and precautionary information required in 17.1 and 17.2 for marking each package shall also appear on each coil and spool.

15.2 Coils without support shall have a tag containing this information securely attached to the inside end of the coil.

15.3 Coils with support shall have the information securely affixed in a prominent location on the support.

15.4 Spools shall have the information securely affixed in a prominent location on the outside of at least one flange of the spool.

15.5 *Each bare straight length filler rod shall be durably marked with identification traceable to the unique product type of the manufacturer or supplier. Suitable methods of identification could include stamping, coining, embossing, imprinting, flag-tagging, or color coding. (If color coding is used, the choice of color shall be as agreed upon between supplier and purchaser and the color shall be identified on the packaging.) When the AWS classification designation is used, the “ER” may be omitted; for example, “CuAl-A2” for classification ERCuAl-A2. Additional identification shall be as agreed upon between supplier and purchaser.*

16. Packaging

Filler metal shall be suitably packaged to ensure against damage during shipment and storage under normal conditions.

17. Marking of Packages

17.1 The following product information (as a minimum) shall be legibly marked so as to be visible from the outside of each unit package.

- (1) AWS specification and classification designations (year of issue may be excluded).
- (2) Supplier’s name and trade designation.
- (3) Size and net weight.
- (4) Lot, control, or heat number

17.2 The appropriate precautionary information⁸ as given in ANSI Z49.1, latest edition, (as a minimum) or its equivalent, shall be prominently displayed in legible print on all packages of electrodes, including individual unit packages enclosed within a larger package.

⁸Typical example of “warning labels” are shown in figures in ANSI Z49.1 for some common or specific consumables used with certain processes.

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Annex A (Informative)

Guide to AWS Specification for Copper and Copper-Alloy Bare Welding Rods and Electrodes

This annex is not part of AWS A5.7/A5.7M:2007, *Specification for Copper and Copper-Alloy Bare Welding Rods and Electrodes*, but is included for informational purposes only.

A1. Introduction

The purpose of this guide is to correlate the filler metal classifications with their intended applications so the specification can be used effectively. Appropriate base metal specifications are referred to whenever that can be done and when it would be helpful. Such references are intended only as examples rather than complete listings of the materials for which each filler metal is suitable.

A2. Classification System

A2.1 The system for identifying the filler metal classification in this specification follows the standard pattern used in other AWS filler metal specifications. The prefix letters ER at the beginning of each classification designation stand for electrode and rod, indicating that the filler

metal may be used either way. The chemical symbol Cu is used to identify the electrodes as copper-base alloys. The additional chemical symbol, such as Si for silicon in ERCuSi, Sn for tin in ERCuSn, etc. indicates the principal alloying element of each classification or group of classifications. Where more than one classification is included in a basic group, the individual classifications in the group are identified by using letters (A, B, C, etc.), as in ERCuSn-A and ERCuSn-C. Further subdividing is done by using digits (1, 2, etc.) following the letter, as in ERCuAl-A1, ERCuAl-A2, and ERCuAl-A3.

A2.2 An international system for designating welding filler metals, developed by the International Institute of Welding (IIW), is being adopted in many ISO specifications. Table A.1 shows the designations for bare copper-alloy filler metals in ISO 24373 corresponding to those in this specification.

Table A.1
Comparison of Specifications

Bare Rods and Electrodes A5.7/A5.7M	Covered Electrodes A5.6/A5.6M ^a	ISO 24373 Designations ^b
ERCu	ECu	SCu 1898
ERCuSi-A	ECuSi	SCu 6560
ERCuSn-A	ECuSn-A	SCu 5180
ERCuSn-C	ECuSn-C	SCu 5210
ERCuNi	ECuNi	SCu 7158
ERCuAl-A1		SCu 6100
ERCuAl-A2	ECuAl-A2	SCu 6180
ERCuAl-A3		SCu 6240
ERCuNiAl	ECuNiAl	SCu 6328
ERCuMnNiAl	ECuMnNiAl	SCu 6338

^a AWS A5.6/A5.6M, *Specification for Copper and Copper-Alloy Electrodes for Shielded Metal Arc Welding*.

^b ISO 24373, *Welding consumables — Solid wires and rods for fusion welding of copper and copper alloys — Classification*.

A3. Acceptance

Acceptance of all welding materials classified under this specification is in accordance with AWS A5.01, *Filler Metal Procurement Guidelines*, as the specification states. Any testing a purchaser requires of the supplier, for material shipped in accordance with this specification, needs to be clearly stated in the purchase order, according to the provisions of AWS A5.01. In the absence of any such statement in the purchase order, the supplier may ship the material with whatever testing normally is conducted on material of that classification, as specified in Schedule F, Table 1, of AWS A5.01. 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 conducted. The basis for the "certification" required by the specification is the classification test of "representative material" cited above, and the "Manufacturer's Quality Assurance System" in AWS A5.01.

A5. Ventilation During Welding

A5.1 Five major factors govern the quantity of fumes to which welders and welding operators can be exposed during welding. These are:

- (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 used.

(4) The proximity of the welders or welding operators to the fumes as they issue from the welding zone, and to the gases and dusts in the space in which the welders or welding operators are working.

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

A5.2 ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, discusses the ventilation that is required during welding and should be referred to for details. Attention is drawn particularly to the clause on Health Protection and Ventilation in that document. Further details about ventilation can be found in AWS F3.2, *Ventilation Guide for Welding Fume*.

A6. Welding Considerations

A6.1 The filler metals in this specification can be used with any of a variety of welding processes. Most notable of them are the gas tungsten arc welding (GTAW) and gas metal arc welding (GMAW) processes.

A6.2 Before welding or heating any copper-base alloy, the base metal must be clean. Oil, grease, paint, lubricants, marking pencils, temperature indicating materials, threading compounds and other such materials frequently contain sulfur or lead that may cause cracking (embrittlement) of the base metal or the weld metal if present during welding or heating.

A6.3 For GTAW, direct current-electrode negative (dcen) is used. High purity grades of either argon or helium (or a combination of the two) are used as a shielding gas.

A6.4 For GMAW, direct current-electrode positive (dcep) is employed. Argon shielding gas is most often used, but mixtures of argon and helium are also commonly used when welding high conductivity copper.

A7. Description and Intended Use of Electrodes and Rods

A7.1 General Characteristics

A7.1.1 Gas tungsten arc welding normally employs dcen current.

A7.1.2 Gas metal arc welding normally employs dcep current.

A7.1.3 Shielding gas for use with either process normally is argon, helium, or a mixture of the two, with or without hydrogen. Oxygen-bearing gases normally are not recommended.

A7.1.4 Base metal should be free from moisture and all other contaminants, including surface oxides.

A7.2 ERcCu (Copper) Filler Metal Classification

A7.2.1 ERcCu filler metals are made of deoxidized copper, but also may contain one or more of the following elements: phosphorus, silicon, tin, manganese, and silver. Phosphorus and silicon are added primarily as deoxidizers. The other elements add either to the ease of welding or to the properties of the final weldment. ERcCu filler metals generally are used for the welding of deoxidized and electrolytic tough pitch (ETP) copper. Reactions with hydrogen in oxygen-free copper, and the segregation of copper oxide in tough pitch copper may detract from joint efficiency. ERcCu welding electrodes and rods may be used to weld these base metals when the highest quality is not required.

A7.2.2 Preheating is desirable on most work; on thick base metal it is essential. Preheat temperatures of 400°F to 1000°F [200°C to 500°C] are suitable.

A7.2.3 For thick base metals, gas metal arc welding is preferred. Conventional joint designs consistent with good welding practice are generally satisfactory. An external source of preheating generally is not needed when welding base metal 1/4 in [6 mm] and less in thickness. Preheating in the range of 400°F to 1000°F [200°C to 500°C] is desirable when welding base metal thicker than 1/4 in [6 mm] if high-quality welds are to be obtained.

A7.3 ERcCuSi (Silicon Bronze) Filler Metal Classification

A7.3.1 ERcCuSi filler metals are copper-base alloys containing approximately three percent silicon; they may also contain small percentages of manganese, tin, or zinc. They are used for gas tungsten and gas metal arc welding of copper-silicon and copper-zinc base metals, to themselves and also to steel.

A7.3.2 When gas metal arc welding with ERcCuSi filler metals, it generally is best to keep the weld pool small and the interpass temperature below 150°F [65°C] to minimize hot cracking. The use of narrow weld passes reduces contraction stresses and also permits faster cooling through the hot-short temperature range.

A7.3.3 When gas tungsten arc welding with ERcCuSi filler metals, best results are obtained by keeping the weld pool small. Preheating is not required. Welding can be done in all positions, but the flat position is preferred.

A7.4 ERcCuSn-x (Phosphor Bronze) Filler Metal Classification

A7.4.1 ERcCuSn-A filler metals contain about five percent tin and up to 0.35% phosphorus added as a de-

oxidizer. Tin increases wear resistance of the weld metal and slows the rate of solidification by broadening the temperature differential between the liquidus and solidus. This slower solidification increases the tendency to hot shortness. To minimize this effect, the weld pool should be kept small and welding time as short as possible. ERcCuSn-A filler metals can be used to weld bronze and brass. They also can be used to weld copper if the presence of tin in the weld metal is not objectionable.

A7.4.2 *ERcCuSn-C filler metal contains about 8% tin and up to 0.35% phosphorus. The higher tin increases strength and wear resistance and increases the solidification temperature range during deposition of the weld metal.*

A7.4.3 When gas tungsten arc welding with ERcCuSn filler metals, preheating is desirable. Welding is done in the flat position only.

A7.5 ERcCuNi (Copper-Nickel) Filler Metal Classification

A7.5.1 ERcCuNi electrodes and rods are used for the welding of wrought or cast 70/30, 80/20, and 90/10 copper-nickel alloys to themselves or to each other. These filler metals also are used for welding the clad side of copper-nickel clad steel. Preheating generally is not necessary.

A7.5.2 When gas tungsten or gas metal arc welding with ERcCuNi filler metals, preheating is not required. Welding is done in all positions. The arc should be kept as short as possible to assure adequate shielding gas coverage and thus minimize porosity. This filler metal may also be used for surfacing applications where high resistance to corrosion, erosion, or cavitation is required.

A7.6 ERcCuAl (Aluminum Bronze) Filler Metal Classification

A7.6.1 ERcCuAl-A1 filler metal is an iron-free aluminum bronze. It is recommended for use as a surfacing metal for wear-resistant surfaces having relatively light loads, for resistance to corrosive media such as salt or brackish water, and for resistance to many commonly used acids in varying concentrations and temperatures. This alloy is not recommended for joining.

A7.6.2 ERcCuAl-A2 filler metal is iron-bearing aluminum bronze and is generally used for joining aluminum bronzes of similar composition, manganese bronze, silicon bronze, and some copper-nickel alloys, ferrous metals and dissimilar metals. The most common dissimilar metal combinations are aluminum bronze to steel and copper to steel. This alloy is also used to provide wear- and corrosion-resistant surfaces.

A7.6.3 ERcCuAl-A3 is a higher strength aluminum bronze filler metal used for joining and repair welding of

aluminum bronze castings of similar composition, and for depositing bearing surfaces and wear- and corrosion-resistant surfaces.

A7.6.4 ERCuNiAl is a nickel-aluminum bronze filler metal used for joining and repairing of cast and wrought nickel-aluminum bronze base metals.

A7.6.5 ERCuMnNiAl is a manganese-nickel-aluminum bronze filler metal used for joining or repairing of cast or wrought base metals of similar composition. This filler metal may also be used for surfacing applications where high resistance to corrosion, erosion, or cavitation is required.

A7.6.6 Because of the formation of aluminum oxide in the molten weld pool, aluminum bronze filler metals are not recommended for use with the oxyfuel gas welding process.

A7.6.7 Copper-aluminum weld metals are characterized by relatively high tensile strength, yield strength, and hardness. Depending upon the thickness or composition of the base metal, preheat may or may not be necessary.

A7.6.8 Welding in the flat position is preferred. Welding in other positions can be done successfully with pulsed arc welding equipment and welder technique.

A8. Special Tests

It is recognized that supplementary tests may be required for certain applications. In such cases, tests to determine specific properties (such as corrosion resistance, scaling resistance, or strength at elevated or cryogenic temperatures) may be required. AWS A5.01, *Filler Metal Procurement Guidelines*, contains provisions for ordering such tests. This clause is included for the guidance of those who desire to specify such special tests. Those tests may be conducted as agreed upon between purchaser and supplier.

Tests for tensile strength and hardness are not included in this specification. A chart of strength and hardness is included in Table A.2. When tests for mechanical properties are specified, the procedures should be in accordance with AWS B4.0 or AWS B 4.0M, *Standard Methods for Mechanical Testing of Welds*.

It should be noted that the variables in the procedure (current, voltage, and welding speed), variables in shielding medium (the specific gas mixture or the flux), variables in the composition of the base metal and the filler metal influence the results which may be obtained. When these variables are properly controlled, however, the filler metal should give sound welds whose strengths (determined by all-weld-metal tension tests) should meet or exceed the minimums shown in Table A.2.

Table A.2
Hardness and Tensile Strength of Copper-Alloy Weld Metal

AWS Classification	Hardness					
	Brinell		Vickers		Minimum Tensile Strength	
	HBW	Load, kgf	HV	Load, Kgf	psi	MPa
ERCu	25 ^b		38		25 000	170
ERCuSi-A	80–100	500	94–110	1	50 000	345
ERCuSn-A	70–85	500	76–98	1	35 000	240
ERCuSn-C	85–100	500	98–110	1	55 000	380
ERCuNi	60–80	500	64–94	1	50 000	345
ERCuAl-A1	80–110	500	94–115	10	55 000	380
ERCuAl-A2 ^a	130–150	3000	130–150	10	60 000	415
ERCuAl-A3 ^a	140–180	3000	140–184	10	65 000	450
ERCuNiAl ^a	160–200	3000	163–205	10	72 000	480
ERCuMnNiAl ^a	160–200	3000	163–205	10	75 000	515

Note: Hardness values as listed above are average values for an as-welded deposit made with the filler metal specified. This table is included for information only.

^a Gas tungsten arc welding process only.

^b Rockwell F.

A9. Discontinued Classifications

Some classifications have been discontinued from one revision of this specification to another. This results either from changes in commercial practice or changes in the classification system used in the specification. The classifications that have been discontinued are listed in Table A.3, along with the year in which they were last included in the specification.

A10. General Safety Considerations

A10.1 Safety and health issues and concerns are beyond the scope of this standard and, therefore, are not fully addressed herein. Some safety and health information can be found in annex Clause A5 and below. Safety and health information is available from other sources, including but not limited to Safety and Health Fact Sheets listed in A10.3, ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, and applicable federal and state regulations.

Table A.3
Discontinued Classifications

Discontinued Classification	Last Year Published
RCuAl-A1	1952
RCuSn ^a	1952
RCuSi-B	1957
RCu ^b	1969
RCuSi-A ^b	1969
RCuSn-A ^b	1969
RCuNi ^b	1969
RCuAl-A2 ^b	1969
RBCuZn-A ^c	1969
RCuZn-B ^c	1969
RCuZn-C ^c	1969
RBCuZn-D ^c	1969
RCuAl-B	1969

^a This rod classification was reclassified as RCuSn-A with a wider range listed for phosphorus.

^b These classifications were redesignated as ERxx-x in A5.7-77 to indicate both electrode and rod materials and continue in the current specification.

^c These classifications were transferred to A5.27 where they became RBxx-x rod for braze welding. The A5.27 specification was later withdrawn, and these classifications moved to the current A5.8 specification.

A10.2 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.

A10.3 AWS Safety and Health Fact Sheets Index (SHF)⁹

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

⁹ AWS standards are published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

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Annex B (Informative)

Guidelines for the Preparation of Technical Inquiries

This annex is not part of AWS A5.7/A5.7M:2007, *Specification for Copper and Copper-Alloy Bare Welding Rods and Electrodes*, 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
550 N.W. LeJeune Road
Miami, FL 33126

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.

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	A5.20	A5.17	A5.25	A5.26	A5.8, A5.31
Low-Alloy Steel	A5.2	A5.5	A5.28	A5.29	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			A5.8, 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	<i>Filler Metal Comparison Charts</i>
IFS	<i>International Index of Welding Filler Metal Classifications</i>
UGFM	<i>User's Guide to Filler Metals</i>
A4.2M (ISO 8249:2000 MOD)	<i>Standard Procedures for Calibrating Magnetic Instruments to Measure the Delta Ferrite Content Austenitic and Duplex Ferritic-Austenitic Stainless Steel Weld Metal</i>
A4.3	<i>Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding</i>
A4.4M	<i>Standard Procedures for Determination of Moisture Content of Welding Fluxes and Welding Electrode Flux Coverings</i>
A5.01	<i>Filler Metal Procurement Guidelines</i>
A5.02/A5.02M	<i>Specification for Filler Metal Standard Sizes, Packaging, and Physical Attributes</i>
A5.1/A5.1M	<i>Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding</i>
A5.2/A5.2M	<i>Specification for Carbon and Low-Alloy Steel Rods for Oxyfuel Gas Welding</i>
A5.3/A5.3M	<i>Specification for Aluminum and Aluminum-Alloy Electrodes for Shielded Metal Arc Welding</i>
A5.4/A5.4M	<i>Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding</i>
A5.5/A5.5M	<i>Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding</i>
A5.6	<i>Specification for Covered Copper and Copper-Alloy Arc Welding Electrodes</i>
A5.7/A5.7M	<i>Specification for Copper and Copper-Alloy Bare Welding Rods and Electrodes</i>
A5.8/A5.8M	<i>Specification for Filler Metals for Brazing and Braze Welding</i>
A5.9/A5.9M	<i>Specification for Bare Stainless Steel Welding Electrodes and Rods</i>
A5.10/A5.10M	<i>Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods</i>
A5.11/A5.11M	<i>Specification for Nickel and Nickel-Alloy Welding Electrodes for Shielded Metal Arc Welding</i>
A5.12/A5.12M	<i>Specification for Tungsten and Tungsten-Alloy Electrodes for Arc Welding and Cutting</i>
A5.13	<i>Specification for Surfacing Electrodes for Shielded Metal Arc Welding</i>
A5.14/A5.14M	<i>Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods</i>
A5.15	<i>Specification for Welding Electrodes and Rods for Cast Iron</i>
A5.16/A5.16M	<i>Specification for Titanium and Titanium Alloy Welding Electrodes and Rods</i>
A5.17/A5.17M	<i>Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding</i>
A5.18/A5.18M	<i>Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding</i>
A5.19	<i>Specification for Magnesium Alloy Welding Electrodes and Rods</i>
A5.20/A5.20M	<i>Specification for Carbon Steel Electrodes for Flux Cored Arc Welding</i>
A5.21	<i>Specification for Bare Electrodes and Rods for Surfacing</i>
A5.22	<i>Specification for Stainless Steel Electrodes for Flux Cored Arc Welding and Stainless Steel Flux Cored Rods for Gas Tungsten Arc Welding</i>
A5.23/A5.23M	<i>Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding</i>
A5.24/A5.24M	<i>Specification for Zirconium and Zirconium Alloy Welding Electrodes and Rods</i>
A5.25/A5.25M	<i>Specification for Carbon and Low-Alloy Steel Electrodes and Fluxes for Electroslag Welding</i>
A5.26/A5.26M	<i>Specification for Carbon and Low-Alloy Steel Electrodes for Electrogas Welding</i>
A5.28/A5.28M	<i>Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding</i>
A5.29/A5.29M	<i>Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding</i>
A5.30/A5.30M	<i>Specification for Consumable Inserts</i>
A5.31	<i>Specification for Fluxes for Brazing and Braze Welding</i>
A5.32/A5.32M	<i>Specification for Welding Shielding Gases</i>
A5.34/A5.34M	<i>Specification for Nickel-Alloy Electrodes for Flux Cored Arc Welding</i>

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