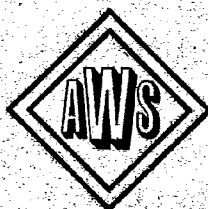


ANSI/AWS A5.7-84
An American National Standard

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



AMERICAN WELDING SOCIETY, INC.

ANSI/AWS A5.7-84
An American National Standard

An American National Standard
Approved by
American National Standards Institute
February 24, 1984

Specification for
Copper and Copper Alloy
Bare Welding Rods
and Electrodes

Superseding
AWS A5.7-77

Prepared by
AWS Committee on Filler Metal

Under the Direction of
AWS Technical Activities Committee

Approved by
AWS Board of Directors, October 20, 1983

AMERICAN WELDING SOCIETY, INC.
550 N.W. LeJeune Road, P.O. Box 351040, Miami, FL 33135

International Standard Book Number: 0-87171-242-3
American Welding Society, 550 N.W. LeJeune Rd., Miami, FL 33126

© 1984, by the American Welding Society
All rights reserved

Note: By publication of this standard, the American Welding Society does not insure anyone utilizing the standard against liability arising from the use of such standard. A publication of a standard by the American Welding Society does not carry with it any right to make, use, or sell any patented items. Each prospective user should make an independent investigation.

This standard is subject to revision at any time by the responsible technical committee. It must be reviewed every five years and if not revised, it must be either reapproved or withdrawn. Comments (recommendations, additions, or deletions) and any pertinent data which may be of use in improving this standard are requested and should be addressed to AWS Headquarters. Such comments will receive careful consideration by the responsible technical committee and you will be informed of the committee's response. Guests are invited to attend all meetings of AWS committees to express their comments verbally. Procedures for appeal of an adverse decision concerning your comments are provided in the Rule of Operation for AWS Technical Committees. A copy of these Rules can be obtained from the American Welding Society, 550 N.W. LeJeune Rd., P.O. Box 351040, Miami, FL 33135.

Printed in the United States of America

Contents

<i>Personnel</i>	v
<i>Scope</i>	1
<i>Part A — General Requirements</i>	1
1. Classification	1
2. Acceptance	1
3. Certification	1
4. Rounding-Off Procedures	1
<i>Part B — Test, Procedures and Requirements</i>	2
5. Summary of Required Tests	2
6. Retests	2
7. Weld Test Assembly	2
8. Chemical Analysis	2
<i>Part C — Manufacture, Identification and Packaging</i>	2
9. Method of Manufacture	2
10. Standard Sizes and Shapes	2
11. Finish and Uniformity	2
12. Standard Package Forms	4
13. Winding Requirements	4
14. Filler Metal Identification	6
15. Packaging	6
16. Package Marking	7
<i>Appendix: Guide to Classification of Copper and Copper Alloy Bare Welding Rods and Electrodes</i>	9
A1. Introduction	9
A2. Method of Classification	9
A3. Ventilation During Welding	9
A4. Description and Intended Use of Welding Rods and Electrodes	10

Personnel

AWS Committee on Filler Metal

<i>R.J. Christoffel, Chairman</i>	General Electric Company
<i>D.C. Helton, 1st Vice Chairman</i>	Allegheny International Alloy Rods Division
<i>J.F. Saenger, Jr., 2nd Vice Chairman</i>	Union Carbide Corporation Linde Division
<i>H.F. Reid, Secretary</i>	American Welding Society, Incorporated
<i>Z. Al-Hillal</i>	Canadian Welding Bureau
<i>B.L. Alia</i>	American Bureau of Shipping
<i>D.F. Betz</i>	Crane Midwest Fittings
<i>J.T. Biskup*</i>	Canadian Institute of Steel Construction
<i>R.S. Brown</i>	Carpenter Technology Corporation
<i>J. Caprarola</i>	Allegheny International Alloy Rods Division
<i>L.J. Christensen*</i>	CBI, Incorporated
<i>P.B. Dickerson</i>	Aluminum Company of America
<i>H.W. Ebert</i>	Exxon Research & Engineering Company
<i>H.N. Farmer, Jr.</i>	Stoody Company
<i>A.W. Francis</i>	Union Carbide Corporation Linde Division
<i>E.H. Franks*</i>	Consultant
<i>J.P. Frandsen</i>	General Electric Company
<i>F.E. Gibbs</i>	Kaiser Aluminum & Chemical Corporation
<i>M.F. Godfrey</i>	Construction Environment, Incorporated
<i>G. Hallstom, Jr.</i>	Consultant
<i>J.R. Hannahs</i>	Midwest Testing Laboratories
<i>R.L. Harris</i>	Robert L. Harris & Associates
<i>T. Hellerstom*</i>	ESAB
<i>R.B. Hitchcock*</i>	Consultant
<i>W.S. Howes*</i>	Advisory and Consultant
<i>J.P. Hunt</i>	Huntington Alloys, Incorporated
<i>J.W. Hunt</i>	General Motors Corporation Buick Motor Division
<i>P.A. Kammer*</i>	Eutectic Corporation
<i>J.J. King</i>	Naval Sea Systems Command
<i>D.J. Kotecki</i>	Teledyne McKay
<i>A.N. Kugler*</i>	Consultant
<i>G.A. Kurisky</i>	Maryland Specialty Wire
<i>R.A. LaFave</i>	Elliott Company, Power Group United Technologies
<i>A.S. Laurenson</i>	ITT Grinnell Corporation
<i>R.K. Lee*</i>	Consultant
<i>G.H. MacShane</i>	Stoody Company
<i>W.F. McLaughlin</i>	Chrysler Corporation
<i>M.T. Merlo</i>	Tri-Mark, Incorporated
<i>A.R. Mertes</i>	Ampco-Pittsburgh Corporation Ampco Metal Division

**Advisory Member*

<i>G.E. Metzger</i>	AFWAL/MLLS
<i>J.W. Mortimer</i>	Consultant
<i>R.L. Peaslee</i>	Wall Colmonoy Corporation
<i>E.W. Pickering</i>	Combustion Engineering
<i>E.E. Pochapsky</i>	U. S. Steel Corporation
<i>J.A. Read*</i>	Canadian Liquid Air, Limited
<i>S.D. Reynolds, Jr.*</i>	USNRC
<i>J.M. Rolnick</i>	Airco Welding Products
<i>D. Rozet</i>	Techalloy Maryland, Incorporated
	Reid-Avery Division
<i>H.S. Sayre*</i>	Consultant
<i>N.G. Schreiner</i>	Consultant
<i>O.W. Seth</i>	CBI, Incorporated
<i>R.J. Shillinsky</i>	C-E Lummus
<i>R.C. Shutt</i>	Lincoln Electric Company
<i>R.W. Straiton*</i>	Bechtel National, Incorporated
<i>H.B. Taylor</i>	Cyclops Corporation
	Steel Division
<i>R.D. Thomas, Jr.</i>	R. D. Thomas & Company
<i>R.T. Webster</i>	Teledyne Wah Chang
<i>A.E. Wiehe</i>	Hobart Brothers Company
<i>W.A. Wiehe</i>	Arcos Corporation
<i>W.L. Wilcox</i>	Scott Paper Company
<i>F.J. Winsor</i>	Consultant
<i>K.G. Wold</i>	Aqua-Chem, Incorporated
<i>T.J. Wonder</i>	Pan Am World Services, Incorporated

AWS Subcommittee on Copper and Copper Alloy Filler Metal

<i>A.R. Mertes, Chairman</i>	Ampco-Pittsburgh Corporation
<i>H.F. Reid, Secretary</i>	American Welding Society, Incorporated
<i>F.S. Babish</i>	Sandvik, Incorporated
<i>C.W. Dralle*</i>	Ampco-Pittsburgh Corporation
<i>R. Henson</i>	J. W. Harris Company
<i>J.P. Hunt</i>	Huntington Alloys, Incorporated
<i>J.A. Read*</i>	Canadian Liquid Air, Limited
<i>S.D. Reynolds, Jr.*</i>	USNRC
<i>J.A. Wallace*</i>	Cerro Metal Products
<i>K.G. Wold</i>	Aqua-Chem, Incorporated

**Advisory Member*

Specification for Copper and Copper Alloy Bare Welding Rods and Electrodes

Issued 1952: Revised 1957, 1966, 1969, 1977, 1984

Scope

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.¹ It includes compositions in which the copper content exceeds that of any other element.

Note: 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.

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

¹ These filler metals may be used with other welding processes for which they are found suitable.

Part A *General Requirements*

1. Classification

The welding materials covered by this specification are classified according to their chemical composition as specified in Table 1. Materials classified under one classification shall not be classified under any other classification of this specification.

2. Acceptance

Acceptance of the material shall be in accordance with the provisions of AWS A5.01, *Filler Metal Procurement Guidelines*.

3. Certification

For all material furnished under this specification, the manufacturer certifies (by affixing the marking required in 1.6) that the material or representative material, has passed the tests required for classification, and that the material meets all other requirements of this specification.

4. Rounding-Off Procedures

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 quanti-

2/SPECIFICATION FOR COPPER AND COPPER ALLOY BARE WELDING RODS AND ELECTRODES

ties in accordance with the rounding-off method given in ASTM E29, *Recommended Practice for Indicating Which Places of Figures are to be Considered Significant in Specified Limiting Values*.²

Part B

Tests, Procedures and Requirements

5. Summary of Required Tests

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

6. Retests

If any test fails to meet its requirement, that specific test must be repeated twice. The results of both tests shall meet the requirement.

For chemical analysis, retest shall be for the specific element(s) which failed to meet the requirement.

7. Weld Test Assembly

No weld assembly is required.

8. Chemical Analysis

8.1 When testing bare electrodes and welding rods, an adequate sample of as-manufactured filler metal, sufficient for retest if necessary, shall be acquired to perform the prescribed chemical analysis. Chemical composition shall conform to the requirements of Table 1.

8.2 Chemical analysis may be made by any suitable method agreed upon between the supplier and purchaser. In case of dispute, the following standard procedures shall be used, as appropriate:

(a) ASTM E62, *Photometric Methods of Chemical Analysis of Copper and Copper-Base Alloys*.

(b) ASTM E75, *Chemical Analysis of Copper-Nickel-Zinc Alloys*.

2. ASTM Standards can be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

Part C

Manufacture, Identification and Packaging

9. Method of Manufacture

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

10. Standard Sizes and Shapes

10.1 Filler metal shall be available in the following forms:

10.1.1 Straight lengths.

10.1.2 Coils with or without support.

10.1.3 Wound on spools.

10.2 Standard sizes shall conform to Table 2.

10.3 Standard lengths shall be 36 in. (900 mm) + 0-1/2 in. (+ 0-12.7 mm).

11. Finish and Uniformity

11.1 All filler metal shall have a smooth finish, free from slivers, depressions, scratches, scale, or other foreign matter that would adversely effect welding characteristics, operation of the welding equipment, or properties of the weld metal.

11.2 Cast and Helix of Filler Metal Wound on Spools

11.2.1 Cast

11.2.1.1 The cast of a spooled filler metal wound on a 12 in. (300 mm) spool shall be such that a specimen of sufficient length [4 to 8 ft (1.2 to 2.4 m)] to form one loop when cut from the spool and laid on a flat surface shall form an unrestrained circle not less than 15 in. (320 mm) nor greater than 40 in. (1,020 mm) in diameter.

11.2.1.2 The cast of a spooled filler metal wound on an 8 in. (200 mm) spool shall be such that a specimen of sufficient length [3 to 6 ft (0.9 to 1.7 m)] to form one loop when cut from the spool and laid on a flat surface shall form an unrestrained circle not less than 11 in. (280 mm) nor greater than 35 in. (885 mm) in diameter.

11.2.1.3 The cast of a spooled filler metal wound on a 4 in. (100 mm) spool shall be such that a specimen of sufficient length [12 to 30 in. (300 to 760 mm)] to form one loop when cut from the spool and laid on a flat surface shall form an unrestrained circle not less than 2.5 in. (54 mm) nor greater than 15 in. (380 mm) in diameter.

Table 1
Chemical composition requirements, percent

Composition, weight percent ^{a,b,c}															
AWS Classification	UNS Number ^d	Common name	Cu		Zn	Sn	Mn	Fe	Si	Ni		Pb	Ti	Total other elements	
			Including Ag							Co					
ERCu	C18980	Copper	98.0 min		-	1.0	0.50	-	0.50	-	-	0.01	0.02	-	0.50
ERCuSi-A	C65600	Silicon bronze (copper-silicon)	Remainder	1.0	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	0.02	-	0.50
ERCuNi ^e	C71580	Copper-nickel	Remainder	-	-	-	1.00	0.40-0.75	0.25	29.0-32.0	0.02	-	0.02	0.20 to 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	-	-	-	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	4.0-5.50	-	8.50	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 in this table.

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

c. Classifications RBCuZn-A, RBCuZn-B, RBCuZn-C, and RBCuZn-D now are included in A5.27-78, *Specification for Copper and Copper Alloy Gas Welding Rods*.

d. ASTM-SAE Unified Numbering System for Metals and Alloys.

e. Sulfur shall be 0.01 percent maximum for the ERCuNi classification.

4/SPECIFICATION FOR COPPER AND COPPER ALLOY BARE WELDING RODS AND ELECTRODES

Table 2
Standard Sizes

Form	Diameter ^{a,b}	
	in.	mm
Straight lengths	1/16	(0.062) 1.6
	5/64	(0.078) 2.0
	3/32	(0.092) 2.4
Coils, with or without support	1/8	(0.125) 3.2
	5/32	(0.156) 4.0
	3/16	(0.187) 4.8
	1/4	(0.250) 6.4
Wound on spools	0.020	0.5
	0.030	0.8
	0.035	0.9
	0.045	1.2
	0.062 (1/16)	1.6
	0.078 (5/64)	2.0
	0.094 (3/32)	2.4

a. Filler metal shall not vary more than ± 0.002 in. (0.05 mm) in diameter.

b. Other sizes, lengths, and forms may be supplied as agreed upon between the purchaser and supplier.

11.2.2 Helix

11.2.2.1 The helix of a spooled filler metal wound on a 12 in. (300 mm) spool shall be such that when the specimen from 11.2.1.1 is laid on a flat surface, the vertical separation between the filler metal and the flat surface shall not exceed 1 in. (25 mm).

11.2.2.2 The helix of the spooled filler metal wound on an 8 in. (200 mm) spool shall be such that when the specimen from 11.2.1.1 is laid on a flat surface, the vertical separation between the filler metal and the flat surface shall not exceed 3/4 in. (19 mm).

11.2.2.3 The helix of a spooled filler metal wound on a 4 in. (100 mm) spool shall be such that when the specimen from 11.2.1.3 is laid on a flat surface, the vertical separation between the filler metal and the flat surface shall not exceed 1/2 in. (13 mm).

11.3 Cast and Helix of Filler Metal in Coils With or Without Support. Cast and helix shall be suitable for feeding in an uninterrupted manner in automatic and semiautomatic equipment.

12. Standard Package Forms

12.1 Filler Metal in Coils Without Support. Dimensions shall be specified by the purchaser.

12.2 Filler Metal in Coils With Support.

12.2.1 Standard dimension of coils with support shall be as specified in Table 3.

12.3 Filler Metal Wound on Spools. Standard spool sizes shall be 4 in. (100 mm), 8 in. (200 mm), and 12 in. (300 mm) with dimensions as shown in Figs. 1 and 2.

12.4 Filler Metal in Straight Lengths. Standard size packages shall be in accordance with 15.4.

12.5 Other package forms shall be agreed upon by the purchaser and supplier.

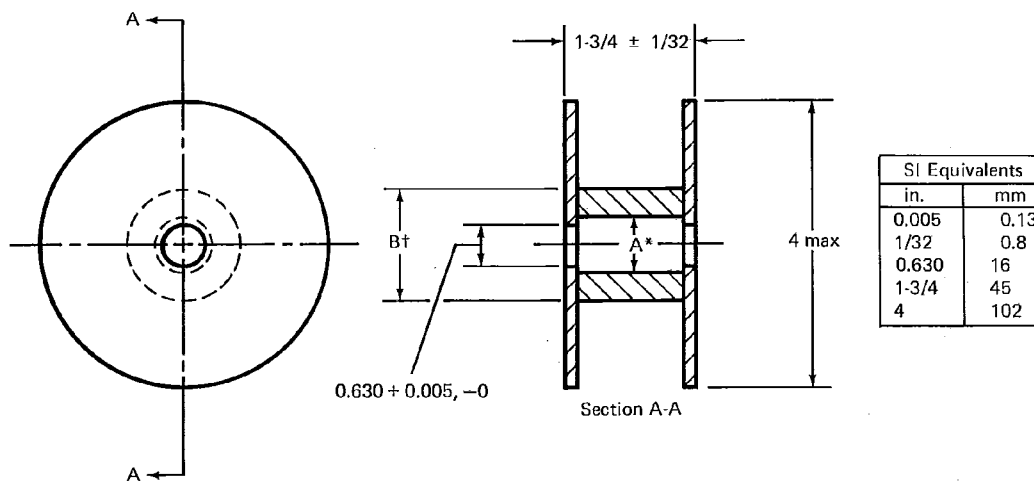
13. Winding Requirements

13.1 Each coil with or without support, or spool, shall contain one continuous length of filler metal made from a single heat or lot of material. When present, butt joints shall be properly made so as not to interface with the uniform, uninterrupted feeding of the filler metal on automatic and semiautomatic equipment.

13.2 Spooled filler metal shall be closely wound in layers, but adjacent turns within a layer need not necessarily touch. The winding shall be such that kinks, waves, sharp bends, overlapping, or wedging are not encountered, leaving the filler metal free to unwind without

Table 3
Standard weight and dimensions for coils with support

Inside diameter of liner		Nominal weight of coil		Max width of wound electrode	
in.	mm	lb	kg	in.	mm
$12 \pm 1/8$	300 ± 3	25	11	$2\text{-}1/2$ or $4\text{-}5/8$	65 or 120
		50	23	$4\text{-}5/8$	120
		60	27	$4\text{-}5/8$	120



All dimensions in inches

*Dimension A, inside diameter of barrel, shall be such that swelling of the barrel or misalignment of the barrel and flanges will not result in the core of the spool being less than the inside diameter of the flanges.

†Dimension B, outside diameter of barrel, shall be such as to permit proper feeding of the electrode.

Fig. 1 — Dimensions of 4 in. (100 mm) spool

6/SPECIFICATION FOR COPPER AND COPPER ALLOY BARE WELDING RODS AND ELECTRODES

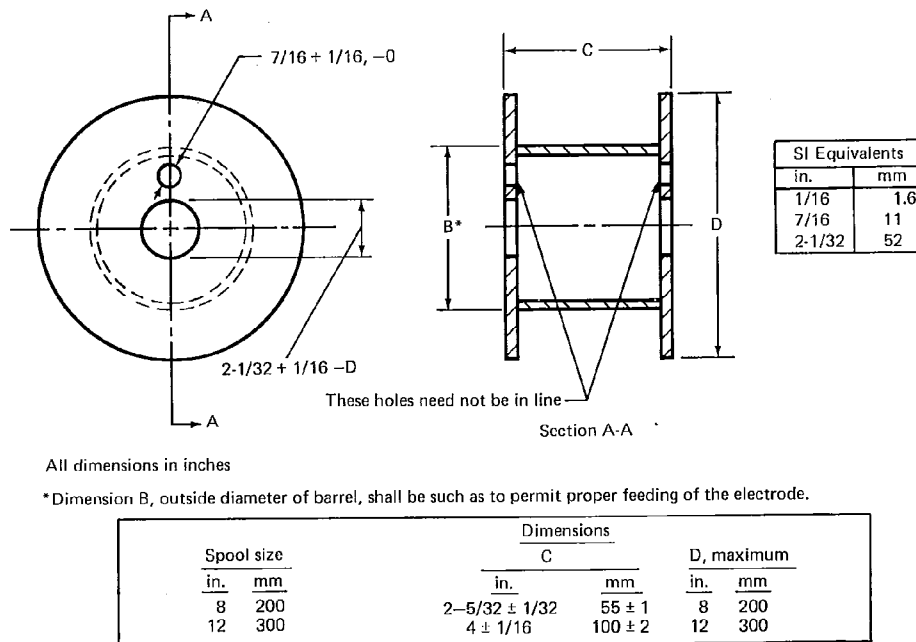


Fig. 2 — Dimensions of 8 and 12 in. (200 and 300 mm) spools

restriction. The outside end of the spooled filler metal shall be identified so that it can be readily located and shall be fastened to the spool to avoid unwinding.

14. Filler Metal Identification

14.1 Product information listed in 14.2.1 thru 14.2.5 and the precautionary information of 16 shall appear on each tag or label.

14.2 Coils Without Support. Within the outer wrapping, coils without support shall be identified by a tag or otherwise at the inside end showing the following information:

14.2.1 AWS specification and classification numbers (year of issue may be excluded).

14.2.2 Supplier name and trade designation.

14.2.3 Standard size and net weight.

14.2.4 Lot, control, or heat number.

14.2.5 Information shall be attached in such a manner that it is not readily removable.

14.3 Coils With Support. Filler metal wound on coils with support shall be identified by the information required in 14.2.1 thru 14.2.5.

14.4 Filler Metal in Straight Lengths.

14.4.1 Identification marking of individual lengths is not required.

14.4.2 Class marking of individual lengths may be as agreed upon between supplier and purchaser.

14.5 Spools Filler metal wound on spools shall be identified by the information required in 14.2.1 thru 14.2.5 placed on one flange of the spool in such a manner that the identification is not readily removable.

15. Packaging

15.1 Filler Metal in Coils Without Support

15.1.1 Nominal weight shall be as specified by the purchaser.

15.1.2 Net weights shall be within 10 percent of the nominal weight.

15.1.3 Coils shall be wrapped and tied securely.

15.2 Filler Metal in Coils With Support

15.2.1 Nominal coil weight shall be in accordance with Table 3.

15.2.2 Net weight shall be within 10 percent of the nominal weight.

15.2.3 Liners shall be of such material and design to provide protection against damage or distortion of the filler metal during normal handling and storage.

15.2.4 Liners shall be sufficiently clean and dry to maintain cleanliness of the filler metal.

15.3 Filler Metal Wound on Spools

15.3.1 Nominal weights shall be:

15.3.1.1 For 12 in. (300 mm) spools - 25 lb (11 kg).

15.3.1.2 For 8 in. (200 mm) spools - 10 lb (4.5 kg).

15.3.1.3 For 4 in. (100 mm) spools - 2 lb (0.9 kg).

15.3.2 Except for 12 in. (300 mm) spools, net weight may vary ± 20 percent from the nominal.

15.3.3 For 12 in. (300 mm) the net weight may vary ± 20 percent from the nominal. In addition, 20 percent of any lot may weight 12.5 to 20 lb (5.7 to 9.1 kg).

15.3.4 Spools shall be of a material and design so as to provide protection against damage or distortion of themselves or the filler metal due to normal handling and use.

15.3.5 Spools shall be sufficiently clean and dry to maintain cleanliness of the filler metal.

15.3.6 Spools shall be constructed to electrically insulate the filler metal from the spool.

15.4 Filler metal in straight lengths. Nominal weights shall be 5, 10, 25, 50 and 60 lbs (2.3, 4.5, 11.2, 27 and 31 kg).

16. Package Marking

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

16.1.1 AWS specification and classification numbers. (Excluding the year of issue)

16.1.2 Supplier's name and trade designation.

16.1.3 Standard size and net weight.

16.1.4 Lot, control, or heat number.

16.2 All packages of welding materials including individual unit packages enclosed within a larger package, shall carry (as a minimum) the following precautionary information prominently displayed in legible type:

WARNING: Protect yourself and others. Read and understand this information. **FUMES AND GASES** can be dangerous to your health. **ARC RAYS** can injure eyes and burn skin. **ELECTRIC SHOCK** can kill.

- Read and understand the manufacturer's instructions and your employer's safety practices.
- Keep your head out of the fumes.
- Use enough ventilation, exhaust at the arc, or both to keep fumes and gases away from your breathing zone, and the general area.
- Wear correct eye, ear and body protection.
- Do not touch live electrical parts.
- See American National Standard Z49.1 *Safety in Welding and Cutting* published by the American Welding Society, 550 N.W. LeJeune Rd., P.O. Box 351040, Miami, Florida 33135; OSHA Safety and Health Standards, 29 CFR 1910, available from U.S. Dept. of Labor, Washington, DC 20210.

DO NOT REMOVE THIS INFORMATION

Appendix: Guide to AWS Classification of Copper and Copper Alloy Bare Welding Rods and Electrodes

This appendix is not a part of AWS A5.7-84, *Specification for Copper and Copper Alloy Bare Welding Rods and Electrodes*, but is included for information only.

A1 Introduction

A1.1 The specification itself is intended to provide both the manufacturer and the purchaser of copper and copper alloy filler metal with a means of production control and a basis of acceptance through mutually acceptable, sound, standard requirements.

A1.2 This guide has been prepared as an aid to prospective users of the copper and copper alloy filler metal covered by this specification in determining which classification of filler metal is best suited for a particular application, with due consideration to the particular requirements for that application.

A2 Method of Classification

A2.1 The specification classifies those copper and copper alloy filler metals used most extensively at the time of issuance of the specification. In A4, the filler metals are arranged in five basic groups. The tensile properties, bend ductility, and soundness of welds produced with the filler metals classified within this specification frequently are determined during procedure qualification. 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 shall give sound welds whose strengths (determined by all-weld-metal tension tests) will meet or exceed the minimums shown in Table A1. Typical hardness properties are also included in Table A1. When supplementary tests for mechanical properties are specified, the procedures should be in accordance with AWS B4.0, *Standard Methods for Mechanical Testing of Welds*.

A2.2 The system for identifying the filler metal classification in this specification follows the standard pattern used in other AWS filler metal specifications. The letters ER at the beginning of a classification indicate that the bare filler metal may be used either as an electrode or as a welding rod.

A2.3 The chemical symbol Cu is used to identify the filler metals as copper-base alloys. The additional chemical symbols, as the Si in ERCuSi, the Sn in ERCuSn, etc., indicate the principal alloying element of each group. Where more than one classification is included in a basic group, the individual classifications in the group are identified by the letters A, B, C, etc., as in ERCuSn-A. Further subdividing is done by using 1, 2, etc., after the last letter, as the 2 in ERCuA1-A2.

A3 Ventilation During Welding

A3.1 Five major factors govern the quantity of fumes to which welders and welding operators can be exposed during welding. These are:

A3.1.1 Dimensions of the space in which welding is done (with special regard to the height of the ceiling).

A3.1.2 Number of welders and welding operators working in that space.

A3.1.3 Rate of evolution of fumes, gases, or dust, according to the materials and processes involved.

A3.1.4 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.

A3.1.5 The ventilation provided to the space in which the welding is done.

A3.2 American National Standard Z49.1, *Safety in Welding and Cutting* (published by the American Welding Society), discusses the ventilation that is required

10/SPECIFICATION FOR COPPER AND COPPER ALLOY BARE WELDING RODS AND ELECTRODES

Table A1
Hardness and tensile strength of copper and copper alloy weld metal

AWS Classification	Brinell Hardness		Minimum tensile strength	
			psi	MPa
ERCu	25 Rockwell F		25 000	172
ERCuSi-A	80 to 100	(500 kg load)	50 000	345
ERCuSn-A	70 to 85	(500 kg load)	35 000	240
ERCuNi	60 to 80	(500 kg load)	50 000	345
ERCuAl-A1	80 to 110	(500 kg load)	55 000	380
ERCuAl-A2	130 to 150	(3000 kg load) ^a	60 000	414
ERCuAl-A3	140 to 180	(3000 kg load) ^a	65 000	450
ERCuNiAl	160 to 200	(3000 kg load) ^a	72 000	480
ERCuMnNiAl	160 to 200	(3000 kg load) ^a	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 process only.

during welding and should be referred to for details. Attention is particularly drawn to the section of that document entitled *Ventilation*.

A4 Description and Intended Use of the Welding Rods and Electrodes

A4.1 General Characteristics

A4.1.1 Gas tungsten arc welding normally employs dcen current.

A4.1.2 Gas metal arc welding normally employs deep current.

A4.1.3 Shielding gas for use with either process normally is argon, helium, or a mixture of the two. Oxygen-bearing gases normally are not recommended.

A4.1.4 Base metal should be free from moisture and all other contaminants, including surface oxides.

A4.2 ERCu (Copper Filler Metal). ERCu 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. ERCu filler metals generally are used for the welding of deoxidized and electrolytic tough pitch copper. Reactions with hydrogen in oxygen-free copper, and the segregation of copper oxide in tough pitch copper may detract from joint efficiency. ERCu welding electrodes and rods may be used to weld these base metals when the highest quality is not required.

A4.2.1 Preheating is desirable on most work; on thick base metal it is essential. Preheat temperatures of 400 to 1000° F (205 to 540° C) are suitable.

A4.2.2 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. (6.4 mm) and thinner in thickness. Preheating in the range of 400 to 1000° F (205 to 540° C) is desirable when welding base metal thicker than 1/4 in. (6.4 mm) if high-quality welds are to be obtained.

A4.3 ERCuSi (Silicon Bronze) Filler Metal

A4.3.1 ERCuSi filler metals are copper-base alloys containing approximately 3 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.

A4.3.2 When gas metal arc welding with ERCuSi 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.

A4.3.3 When gas tungsten arc welding with ERCuSi 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.

A4.4 ERCuSn-A (Phosphor Bronze) Filler Metal

A4.4.1 ERCuSn-A filler metals contain about 5 percent tin and up to 0.35 percent phosphorus added as a deoxidizer. 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. ERCuSn-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.

A4.4.2 When gas tungsten arc welding with ERCuSn filler metals, preheating is desirable. Welding is done in the flat position only.

A4.5 ERCuNi (Copper-Nickel) Filler Metal

A4.5.1 In ERCuNi filler metals, the nickel addition strengthens the weld metal and improves the corrosion resistance, particularly against salt water. The weld metal has good hot and cold ductility. Copper-nickel filler metals are used for welding most copper-nickel alloys.

A4.5.2 When gas tungsten or gas metal arc welding with ERCuNi 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.

A4.6 ERCuAl (Aluminum Bronze) Filler Metal

A4.6.1 ERCuAl-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.

A4.6.2 ERCuAl-A2 filler metal is an iron-bearing aluminum bronze and is generally used for joining aluminum bronzes of similar composition: manganese, silicon bronzes, 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 also is used to provide wear- and corrosion-resistant surfaces.

A4.6.3 ERCuAl-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.

A4.6.4 ERCuNiAl is a nickel-aluminum bronze filler metal used for joining and repairing of cast or wrought nickel-aluminum bronze base metals.

A4.6.5 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.

A4.6.6 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.

A4.6.7 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.

A4.6.8 Welding in the flat position is preferred. Welding in other positions can be done successfully with pulsed arc welding equipment and welder technique.