

AWS A5.14/A5.14M:2009
An American National Standard

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



American Welding Society



**AWS A5.14/A5.14M:2009
An American National Standard**

**Approved by the
American National Standards Institute
October 28, 2008**

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

9th Edition

Supersedes AWS A5.14/A5.14M:2005

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

The chemical compositions of 50 nickel and nickel-alloy welding electrodes and rods are specified, including three compositions not previously classified. Major topics include general requirements, testing, packaging, and application guidelines.

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

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

International Standard Book Number: 978-0-87171-667-5

American Welding Society

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

© 2008 by American Welding Society

All rights reserved

Printed in the United States of America

Photocopy Rights. No portion of this standard may be reproduced, stored in a retrieval system, or transmitted in any form, including mechanical, photocopying, recording, or otherwise, without the prior written permission of the copyright owner.

Authorization to photocopy items for internal, personal, or educational classroom use only or the internal, personal, or educational classroom use only of specific clients is granted by the American Welding Society provided that the appropriate fee is paid to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, tel: (978) 750-8400; Internet: <www.copyright.com>.

Statement on the Use of American Welding Society Standards

All standards (codes, specifications, recommended practices, methods, classifications, and guides) of the American Welding Society (AWS) are voluntary consensus standards that have been developed in accordance with the rules of the American National Standards Institute (ANSI). When AWS American National Standards are either incorporated in, or made part of, documents that are included in federal or state laws and regulations, or the regulations of other governmental bodies, their provisions carry the full legal authority of the statute. In such cases, any changes in those AWS standards must be approved by the governmental body having statutory jurisdiction before they can become a part of those laws and regulations. In all cases, these standards carry the full legal authority of the contract or other document that invokes the AWS standards. Where this contractual relationship exists, changes in or deviations from requirements of an AWS standard must be by agreement between the contracting parties.

AWS American National Standards are developed through a consensus standards development process that brings together volunteers representing varied viewpoints and interests to achieve consensus. While the AWS administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in its standards.

AWS disclaims liability for any injury to persons or to property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this standard. AWS also makes no guarantee or warranty as to the accuracy or completeness of any information published herein.

In issuing and making this standard available, AWS is neither undertaking to render professional or other services for or on behalf of any person or entity, nor is AWS undertaking to perform any duty owed by any person or entity to someone else. Anyone using these documents should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. It is assumed that the use of this standard and its provisions are entrusted to appropriately qualified and competent personnel.

This standard may be superseded by the issuance of new editions. Users should ensure that they have the latest edition.

Publication of this standard does not authorize infringement of any patent or trade name. Users of this standard accept any and all liabilities for infringement of any patent or trade name items. AWS disclaims liability for the infringement of any patent or product trade name resulting from the use of this standard.

Finally, the AWS does not monitor, police, or enforce compliance with this standard, nor does it have the power to do so.

On occasion, text, tables, or figures are printed incorrectly, constituting errata. Such errata, when discovered, are posted on the AWS web page (www.aws.org).

Official interpretations of any of the technical requirements of this standard may only be obtained by sending a request, in writing, to the appropriate technical committee. Such requests should be addressed to the American Welding Society, Attention: Managing Director, Technical Services Division, 550 N.W. LeJeune Road, Miami, FL 33126 (see Annex B). With regard to technical inquiries made concerning AWS standards, oral opinions on AWS standards may be rendered. These opinions are offered solely as a convenience to users of this standard, and they do not constitute professional advice. Such opinions represent only the personal opinions of the particular individuals giving them. These individuals do not speak on behalf of AWS, nor do these oral opinions constitute official or unofficial opinions or interpretations of AWS. In addition, oral opinions are informal and should not be used as a substitute for an official interpretation.

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

This page is intentionally blank.

AMERICAN WELDING SOCIETY

Personnel

AWS A5 Committee on Filler Metals and Allied Materials

J. S. Lee, Chair	<i>Chevron</i>
H. D. Wehr, 1st Vice Chair	<i>Arcos Industries, LLC</i>
J. J. DeLoach, Jr., 2nd Vice Chair	<i>Naval Surface Warfare Center</i>
R. Gupta, Secretary	<i>American Welding Society</i>
T. Anderson	<i>ESAB Welding & Cutting Products</i>
J. M. Blackburn	<i>Naval Sea Systems Command</i>
R. Brown	<i>RSB Alloy Applications, LLC</i>
J. C. Bundy	<i>Hobart Brothers Company</i>
D. D. Crockett	<i>The Lincoln Electric Company</i>
D. A. DelSignore	<i>Consultant</i>
J. DeVito	<i>ESAB Welding & Cutting Products</i>
H. W. Ebert	<i>Consultant</i>
D. M. Fedor	<i>The Lincoln Electric Company</i>
J. G. Feldstein	<i>Foster Wheeler North America</i>
S. E. Ferree	<i>ESAB Welding & Cutting Products</i>
D. A. Fink	<i>The Lincoln Electric Company</i>
G. L. Franke	<i>Naval Surface Warfare Center</i>
R. D. Fuchs	<i>Böhler Welding Group USA, Incorporated</i>
J. A. Henning	<i>Nuclear Management Company</i>
R. M. Henson	<i>J. W. Harris Company, Incorporated</i>
S. D. Kiser	<i>Special Metals</i>
P. J. Konkol	<i>Concurrent Technologies Corporation</i>
D. J. Kotecki	<i>Damian Kotecki Welding Consultants</i>
L. Kvidahl	<i>Northrop Grumman Ship Systems</i>
A. Y. Lau	<i>Canadian Welding Bureau</i>
A. S. Laurenson	<i>Consultant</i>
W. A. Marttila	<i>Chrysler LLC</i>
T. Melfi	<i>The Lincoln Electric Company</i>
R. Menon	<i>Stoody Company</i>
M. T. Merlo	<i>HyperTech Research, Incorporated</i>
D. R. Miller	<i>ABS Americas Materials Department</i>
B. Mosier	<i>Polymet Corporation</i>
A. K. Mukherjee	<i>Siemens Power Generation, Incorporated</i>
C. L. Null	<i>Consultant</i>
R. L. Peaslee	<i>Wall Colmonoy Corporation</i>
K.C. Pruden	<i>Hydril Company</i>
S. D. Reynolds, Jr.	<i>Consultant</i>
P. K. Salvesen	<i>Det Norske Veritas (DNV)</i>
K. Sampath	<i>Consultant</i>
W. S. Severance	<i>ESAB Welding & Cutting Products</i>
M. J. Sullivan	<i>NASSCO—National Steel & Shipbuilding</i>
R. Sutherlin	<i>ATI Wah Chang</i>
R.A. Swain	<i>Euroweld, Limited</i>
K. P. Thornberry	<i>Care Medical, Incorporated</i>
M. D. Tumuluru	<i>U.S. Steel Corporation</i>

Advisors to the AWS A5 Committee on Filler Metal and Allied Material

R. L. Bateman	<i>Electromanufacturas, S. A.</i>
R. A. Daemen	<i>Consultant</i>
C. E. Fuerstenau	<i>Lucas-Milhaupt, Incorporated</i>
J. P. Hunt	<i>Consultant</i>
S. Imaoka	<i>Kobe Steel Limited</i>
M. P. Parekh	<i>Consultant</i>
M. A. Quintana	<i>The Lincoln Electric Company</i>
E. R. Stevens	<i>Stevens Welding Consulting</i>
E. S. Surian	<i>National University of Lomas de Zamora</i>

AWS A5E Subcommittee on Nickel and Nickel Alloy Filler Metals

R. D. Fuchs, Chair	<i>Böhler Thyssen Welding USA, Incorporated</i>
J. S. Lee, Vice Chair	<i>Chevron</i>
R. Gupta, Secretary	<i>American Welding Society</i>
R. B. Brown	<i>RSB Alloy Applications LLC</i>
G. J. Bruck	<i>Siemens Power Generation, Incorporated</i>
J. J. DeLoach, Jr.	<i>Naval Surface Warfare Center</i>
S. R. Jana	<i>Select Arc Incorporated</i>
D. D. Kiilunen	<i>Cor-Met Incorporated</i>
S. D. Kiser	<i>Special Metals</i>
G. A. Kurisky	<i>Consultant</i>
F. B. Lake	<i>ESAB Welding & Cutting Products</i>
W. E. Layo	<i>Midalloy</i>
R. Menon	<i>Stoody Company</i>
S. J. Merrick	<i>Techalloy Welding Products</i>
R. A. Swain	<i>Euroweld, Limited</i>
J. F. Turner	<i>Electrode Engineering, Incorporated</i>
H. D. Wehr	<i>Arcos Industries LLC</i>

Advisors to the AWS A5E Subcommittee on Nickel and Nickel Alloy Filler Metals

F. S. Babish	<i>Sandvik Steel Company</i>
R. E. Cantrell	<i>Constellation Energy Group</i>
D. A. DelSignore	<i>Consultant</i>
P. Ditzel	<i>Parker Hannifin Corporation</i>
K. K. Gupta	<i>Westinghouse Electric Corporation</i>
V. W. Hartmann	<i>Westinghouse Electric Corporation</i>
J. P. Hunt	<i>Special Metals</i>
S. Imaoka	<i>Kobe Steel Limited</i>
V. van der Mee	<i>Lincoln Electric Europe bv</i>

Foreword

This foreword is not part of AWS A5.14/A5.14M:2009, *Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods*, but is included for informational purposes only.

This document is the third of the A5.14 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 values in any way. In selecting rational metric units the AWS A1.1, *Metric Practice Guide for the Welding Industry*, and International Standard ISO 544, *Welding Consumables — Technical delivery conditions for welding filler materials — Type of product, dimensions, tolerances and markings*, are used where suitable. Tables and figures make use of both U.S. Customary and SI Units, which with the application of the specified tolerances provides for interchangeability of products in both the U.S. Customary and SI Units. This document also relates its classifications to ISO 18274, *Welding consumables — Wire and strip electrodes, wires and rods for arc welding of nickel and nickel alloys — Classifications*.

The first specification for bare nickel and nickel-alloy welding electrodes and rods was prepared by a joint committee of the American Society for Testing and Materials and the American Welding Society and was issued in 1956. Eight years later, the first revision was prepared by the joint committee. This is the sixth revision prepared exclusively by the AWS A5 Committee on Filler Metals and Allied Materials.

Substantive changes are shown in italic font in the body of this specification which include new classifications ERNiCr-7, ERNiCrFe-13, and ERNiCrMo-22. The amount of Ti for ERNiCrMo-21 has been changed to 0.4% maximum in this revision. The Rounding-off Procedure has been revised.

Document Development

ASTM B304-56T AWS A5.14-56T	<i>Tentative Specification for Nickel and Nickel-Base Alloy Bare Welding Filler Metals</i>
AWS A5.14-64T ASTM B304-64T	<i>Tentative Specification for Nickel and Nickel Alloy Bare Welding Rods and Electrodes</i>
AWS A5.14-69T ANSI W3.14-1973	<i>Specification for Nickel and Nickel-Alloy Bare Welding Rods and Electrodes</i>
ANSI/AWS A5.14-76	<i>Specification for Nickel and Nickel Alloy Bare Welding Rods and Electrodes</i>
ANSI/AWS A5.14-83	<i>Specification for Nickel and Nickel Alloy Bare Welding Rods and Electrodes</i>
ANSI/AWS A5.14-89	<i>Specification for Nickel and Nickel Alloy Bare Welding Electrodes and Rods</i>
ANSI/AWS A5.14/A5.14M-97	<i>Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods</i>
AWS A5.14/A5.14M:2005	<i>Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods</i>

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.

This page is intentionally blank.

Table of Contents

	Page No.
<i>Personnel</i>	v
<i>Foreword</i>	vii
<i>List of Tables</i>	x
<i>List of Figures</i>	x
1. Scope	1
2. Normative References	1
3. Classification	2
4. Acceptance	2
5. Certification	2
6. Rounding-Off Procedure	2
7. Summary of Tests	2
8. Retest	2
9. Chemical Analysis	8
10. Method of Manufacture	8
11. Standard Sizes	8
12. Finish and Uniformity	8
13. Standard Package Forms	8
14. Winding Requirements	10
15. Filler Metal Identification	10
16. Packaging	10
17. Marking of Packages	10
Annex A (Informative)—Guide to AWS Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods	13
Annex B (Informative)—Guidelines for the Preparation of Technical Inquiries	23
<i>AWS Filler Metal Specifications by Material and Welding Process</i>	25
<i>AWS Filler Metal Specifications and Related Documents</i>	27

List of Tables

Table		Page No.
1	Chemical Composition Requirements for Nickel and Nickel-Alloy Electrodes and Rods	3
2	Standard Sizes of Electrodes and Rods.....	8
3	Standard Sizes of Strip Electrodes	8
4	Standard Package Dimensions and Weights	9
A.1	Comparison of Classifications	14
A.2	Typical Weld Metal Tensile Strengths	21
A.3	Discontinued Classifications.....	22

List of Figures

Figure		Page No.
1	Dimensions of Standard Spools.....	11

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

1. Scope

1.1 This specification prescribes requirements for the classification of bare nickel and nickel-alloy welding electrodes, strip electrodes, and welding rods. It includes those compositions where the nickel content exceeds that of any other element.

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 nonmandatory 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 A5.14 uses U.S. Customary Units. The specification A5.14M 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 A5.14 or A5.14M specifications.

2. Normative References

2.1 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 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 standards¹ are referenced in the mandatory sections of this document:

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

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

2.3 The following ANSI standard² is referenced in the mandatory sections of this document:

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

2.4 The following ASTM standards³ are referenced in the mandatory sections of this document:

(1) ASTM E 29, *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*

(2) ASTM E 76, *Standard Methods for Chemical Analysis of Nickel-Copper Alloys*

(3) ASTM E 354, *Test Methods for Chemical Analysis of High-temperature, Electrical, Magnetic and Other Similar Iron, Nickel, and Cobalt Alloys*

(4) ASTM E 1019, *Methods for Determination of Carbon, Sulfur, Nitrogen, Oxygen, and Hydrogen in Steels and in Iron, Nickel and Cobalt Alloys*

(5) ASTM E 1473, *Test Methods for Chemical Analysis of Nickel, Cobalt, and High Temperature Alloys*

¹ AWS standards are published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

² This ANSI standard is published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

³ ASTM standards are published by the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

2.5 The following ISO standards⁴ are referenced in the mandatory sections of this document:

(1) *ISO 31-0, Quantities and units — Part 0: General principles*

(2) *ISO 544, Welding consumables — Technical delivery conditions for welding filler materials — Type of product, dimensions, tolerances and markings*

(3) *ISO 18274, Welding consumables — Wire and strip electrodes, wires and rods for arc welding of nickel and nickel alloys — Classifications.*

The following MIL standard⁵ is referenced in the mandatory sections of this document:

MIL-E-21562E Military Specification—Electrodes and Rods—Welding, Bare, Nickel Alloy

3. Classification

3.1 The welding filler metals covered by this A5.14/A5.14M:2009 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, as specified in Table 1.

3.2 A filler metal classified under one classification shall not be classified under any other classification in this specification.

3.3 The filler metals classified under this specification are intended for use with the plasma arc, gas metal arc, gas tungsten arc, and submerged arc welding processes, but this is not to prohibit their use with any other process for which they are found suitable.

4. Acceptance

Acceptance⁶ of the filler metal shall be in accordance with the provisions of AWS A5.01M/A5.01.

⁴ISO standards are published by the International Organization of Standardization, 1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland.

⁵This MIL-E-21562E document is published by the Document Automation and Production Service, 700 Robbins Avenue, Bldg 4D, Philadelphia, PA 19111-5094.

⁶See Annex A, Clause A3, Acceptance, for further information concerning acceptance and testing of the material shipped, and AWS A5.01M/A5.01.

5. Certification

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

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 E 29 or ISO 31-0, Annex B, Rule A (the results are the same). If the measured values are obtained by equipment calibrated in units other than those of the specified limit, the measured values shall be converted to the units of the specified limit before rounding 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 1000 psi for tensile and yield strength for (U.S. Customary Unit standard) (to the nearest 10 MPa for tensile and yield strength for [S.I. unit standard]) and to the nearest unit in the last right-hand place of figures used in expressing the limiting values for other quantities. The rounded-off results shall fulfil the requirements for the classification under test.

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.

8. Retest

If the results of any test fail to meet the requirement of that test, that test shall be repeated twice. The results of both retests shall meet the requirement. Material for retest may be taken from the original test sample or from a new sample. Retest need be only for those specific elements that failed to meet the test requirement.

If the results of one or both retests fail to meet the requirement, the material under test shall be considered as not meeting the requirements of this specification for that classification.

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

Table 1
Chemical Composition Requirements for Nickel and Nickel-Alloy Electrodes and Rods

AWS Classification ^m	UNS Number ^c	Weight Percent ^{a,b}															Other Elements, Total	
		C	Mn	Fe	P	S	Si	Cu	Ni ^d	Co	Al	Ti	Cr	Nb(Cb) Plus Ta	Mo	V		W
ERNi-1 ^k	N02061	0.15	1.0	1.0	0.03	0.015	0.75	0.25	93.0 min.	—	1.5	2.0 to 3.5	—	—	—	—	—	0.50
ERNiCu-7 ^k	N04060	0.15	4.0	2.5	0.02	0.015	1.25	Rem	62.0 to 69.0	—	1.25	1.5 to 3.0	—	—	—	—	—	0.50
ERNiCu-8 ^k	N05504	0.25	1.5	2.0	0.03	0.015	1.00	Rem	63.0 to 70.0	—	2.0 to 4.0	0.25 to 1.00	—	—	—	—	—	0.50
ERNiCr-3 ^{k,l}	N06082	0.10	2.5 to 3.5	3.0	0.03	0.015	0.50	0.50	67.0 min.	(e)	—	0.75	18.0 to 22.0	2.0 to 3.0 ^f	—	—	—	0.50
ERNiCr-4	N06072	0.01 to 0.10	0.20	0.50	0.02	0.015	0.20	0.50	Rem	—	—	0.3 to 1.0	42.0 to 46.0	—	—	—	—	0.50
ERNiCr-6 ^k	N06076	0.08 to 0.15	1.00	2.00	0.03	0.015	0.30	0.50	75.0 min.	—	0.40	0.15 to 0.50	19.0 to 21.0	—	—	—	—	0.50
ERNiCr-7 ^r	N06073	0.03	0.50	1.0	0.02	0.015	0.30	0.30	Rem	1.0	0.75 to 1.20	0.25 to 0.75	36.0 to 39.0	0.25 to 1.00	0.50	—	—	0.50
ERNiCrFe-5 ^k	N06062	0.08	1.0	6.0 to 10.0	0.03	0.015	0.35	0.50	70.0 min.	(e)	—	—	14.0 to 17.0	1.5 to 3.0 ^f	—	—	—	0.50
ERNiCrFe-6 ^k	N07092	0.08	2.0 to 2.7	8.0	0.03	0.015	0.35	0.50	67.0 min.	—	—	2.5 to 3.5	14.0 to 17.0	—	—	—	—	0.50
ERNiCrFe-7 ^j	N06052	0.04	1.0	7.0 to 11.0	0.02	0.015	0.50	0.30	Rem	—	1.10	1.0	28.0 to 31.5	0.10	0.50	—	—	0.50
ERNiCrFe-7A ^{j,p}	N06054	0.04	1.0	7.0 to 11.0	0.02	0.015	0.50	0.30	Rem	0.12	1.10	1.0	28.0 to 31.5	0.5 to 1.0	0.50	—	—	0.50

(Continued)

Table 1 (Continued)
Chemical Composition Requirements for Nickel and Nickel-Alloy Electrodes and Rods

AWS Classification ^m	UNS Number ^c	Weight Percent ^{a,b}																Other Elements, Total
		C	Mn	Fe	P	S	Si	Cu	Ni ^d	Co	Al	Ti	Cr	Nb(Cb) Plus Ta	Mo	V	W	
ERNiCrFe-8 ^k	N07069	0.08	1.0	5.0 to 9.0	0.03	0.015	0.50	0.50	70.0 min.	—	0.4 to 1.0	2.00 to 2.75	14.0 to 17.0	0.70 to 1.20	—	—	—	0.50
ERNiCrFe-11	N06601	0.10	1.0	Rem	0.03	0.015	0.50	1.0	58.0 to 63.0	—	1.0 to 1.7	—	21.0 to 25.0	—	—	—	—	0.50
ERNiCrFe-12	N06025	0.15 to 0.25	0.50	8.0 to 11.0	0.020	0.010	0.5	0.1	Rem	1.0	1.8 to 2.4	0.10 to 0.20	24.0 to 26.0	—	—	—	—	0.50
<i>ERNiCrFe-13^r</i>	<i>N06055</i>	<i>0.03</i>	<i>1.0</i>	<i>Rem</i>	<i>0.02</i>	<i>0.015</i>	<i>0.50</i>	<i>0.30</i>	<i>52.0 to 62.0</i>	<i>0.10</i>	<i>0.50</i>	<i>0.50</i>	<i>28.5 to 31.0</i>	<i>2.1 to 4.0</i>	<i>3.0 to 5.0</i>	—	—	<i>0.50</i>
ERNiCrFeSi-1	N06045	0.05 to 0.12	1.0	21.0 to 25.0	0.020	0.010	2.5 to 3.0	0.3	Rem	1.0	0.30	—	26.0 to 29.0	—	—	—	—	0.50
ERNiCrFeAl-1	N06693	0.15	1.0	2.5 to 6.0	0.03	0.01	0.5	0.5	Rem	—	2.5 to 4.0	1.0	27.0 to 31.0	0.5 to 2.5	—	—	—	0.50
ERNiFeCr-1 ^k	N08065	0.05	1.0	22.0 min.	0.03	0.03	0.50	1.5 to 3.0	38.0 to 46.0	—	0.20	0.6 to 1.2	19.5 to 23.5	—	2.5 to 3.5	—	—	0.50
ERNiFeCr-2 ^g	N07718	0.08	0.35	Rem	0.015	0.015	0.35	0.30	50.0 to 55.0	—	0.20 to 0.80	0.65 to 1.15	17.0 to 21.0	4.75 to 5.50	2.80 to 3.30	—	—	0.50
ERNiMo-1	N10001	0.08	1.0	4.0 to 7.0	0.025	0.03	1.0	0.50	Rem	2.5	—	—	1.0	—	26.0 to 30.0	0.20 to 0.40	1.0	0.50
ERNiMo-2	N10003	0.04 to 0.08	1.0	5.0	0.015	0.02	1.0	0.50	Rem	0.20	—	—	6.0 to 8.0	—	15.0 to 18.0	0.50	0.50	0.50
ERNiMo-3	N10004	0.12	1.0	4.0 to 7.0	0.04	0.03	1.0	0.50	Rem	2.5	—	—	4.0 to 6.0	—	23.0 to 26.0	0.60	1.0	0.50

(Continued)

AWS A5.14/A5.14M:2009

4

Table 1 (Continued)
Chemical Composition Requirements for Nickel and Nickel-Alloy Electrodes and Rods

AWS Classification ^m	UNS Number ^c	Weight Percent ^{a,b}																Other Elements, Total
		C	Mn	Fe	P	S	Si	Cu	Ni ^d	Co	Al	Ti	Cr	Nb(Cb) Plus Ta	Mo	V	W	
ERNiMo-7	N10665	0.02	1.0	2.0	0.04	0.03	0.10	0.50	Rem	1.0	—	—	1.0	—	26.0 to 30.0	—	1.0	0.50
ERNiMo-8	N10008	0.10	1.0	10.0	0.015	0.015	0.50	0.50	60.0 min.	—	—	—	0.5 to 3.5	—	18.0 to 21.0	—	2.0 to 4.0	0.50
ERNiMo-9	N10009	0.10	1.0	5.0	0.015	0.015	0.50	0.3 to 1.3	65.0 min.	—	1.0	—	—	—	19.0 to 22.0	—	2.0 to 4.0	0.50
ERNiMo-10 ⁿ	N10675	0.01	3.0	1.0 to 3.0	0.03	0.01	0.10	0.20	65.0 min.	3.0	0.50	0.20	1.0 to 3.0	0.20	27.0 to 32.0	0.20	3.0	0.50
ERNiMo-11	N10629	0.010	1.0	2.0 to 5.0	0.020	0.010	0.10	0.5	Rem	1.0	0.1 to 0.5	0.30	0.5 to 1.5	0.50	26.0 to 30.0	—	—	0.50
ERNiMo-12 ^g	N10242	0.03	0.80	2.0	0.030	0.015	0.80	0.50	Rem	1.0	0.50	—	7.0 to 9.0	—	24.0 to 26.0	—	—	—
ERNiCrMo-1	N06007	0.05	1.0 to 2.0	18.0 to 21.0	0.04	0.03	1.0	1.5 to 2.5	Rem	2.5	—	—	21.0 to 23.5	1.75 to 2.50	5.5 to 7.5	—	1.0	0.50
ERNiCrMo-2	N06002	0.05 to 0.15	1.0	17.0 to 20.0	0.04	0.03	1.0	0.50	Rem	0.5 to 2.5	—	—	20.5 to 23.0	—	8.0 to 10.0	—	0.2 to 1.0	0.50
ERNiCrMo-3 ^k	N06625	0.10	0.50	5.0	0.02	0.015	0.50	0.50	58.0 min.	—	0.40	0.40	20.0 to 23.0	3.15 to 4.15	8.0 to 10.0	—	—	0.50
ERNiCrMo-4	N10276	0.02	1.0	4.0 to 7.0	0.04	0.03	0.08	0.50	Rem	2.5	—	—	14.5 to 16.5	—	15.0 to 17.0	0.35	3.0 to 4.5	0.50
ERNiCrMo-7	N06455	0.015	1.0	3.0	0.04	0.03	0.08	0.50	Rem	2.0	—	0.70	14.0 to 18.0	—	14.0 to 18.0	—	0.50	0.50

(Continued)

Table 1 (Continued)
Chemical Composition Requirements for Nickel and Nickel-Alloy Electrodes and Rods

AWS Classification ^m	UNS Number ^c	Weight Percent ^{a,b}																Other Elements, Total
		C	Mn	Fe	P	S	Si	Cu	Ni ^d	Co	Al	Ti	Cr	Nb(Cb) Plus Ta	Mo	V	W	
ERNiCrMo-8	N06975	0.03	1.0	Rem	0.03	0.03	1.0	0.7 to 1.2	47.0 to 52.0	—	—	0.70 to 1.50	23.0 to 26.0	—	5.0 to 7.0	—	—	0.50
ERNiCrMo-9	N06985	0.015	1.0	18.0 to 21.0	0.04	0.03	1.0	1.5 to 2.5	Rem	5.0	—	—	21.0 to 23.5	0.50	6.0 to 8.0	—	1.5	0.50
ERNiCrMo-10	N06022	0.015	0.50	2.0 to 6.0	0.02	0.010	0.08	0.50	Rem	2.5	—	—	20.0 to 22.5	—	12.5 to 14.5	0.35	2.5 to 3.5	0.50
ERNiCrMo-11	N06030	0.03	1.5	13.0 to 17.0	0.04	0.02	0.80	1.0 to 2.4	Rem	5.0	—	—	28.0 to 31.5	0.30 to 1.50	4.0 to 6.0	—	1.5 to 4.0	0.50
ERNiCrMo-13	N06059	0.010	0.5	1.5	0.015	0.010	0.10	0.50	Rem	0.3	0.1 to 0.4	—	22.0 to 24.0	—	15.0 to 16.5	—	—	0.50
ERNiCrMo-14	N06686	0.01	1.0	5.0	0.02	0.02	0.08	0.5	Rem	—	0.5	0.25	19.0 to 23.0	—	15.0 to 17.0	—	3.0 to 4.4	0.50
ERNiCrMo-15	N07725	0.03	0.35	Rem	0.015	0.01	0.20	—	55.0 to 59.0	—	0.35	1.0 to 1.7	19.0 to 22.5	2.75 to 4.00	7.0 to 9.5	—	—	0.50
ERNiCrMo-16	N06057	0.02	1.0	2.0	0.04	0.03	1.0	—	Rem	—	—	—	29.0 to 31.0	—	10.0 to 12.0	0.4	—	0.50
ERNiCrMo-17	N06200	0.010	0.5	3.0	0.025	0.010	0.08	1.3 to 1.9	Rem	2.0	0.50	—	22.0 to 24.0	—	15.0 to 17.0	—	—	0.50
ERNiCrMo-18 ^o	N06650	0.03	0.5	12.0 to 16.0	0.020	0.010	0.50	0.30	Rem	1.0	0.05 to 0.50	—	19.0 to 21.0	0.05 to 0.50	9.5 to 12.5	0.30	0.5 to 2.5	0.50
ERNiCrMo-19 ^q	N06058	0.01	0.5	1.5	0.015	0.010	0.10	0.50	Rem	0.3	0.4	—	20.0 to 23.0	—	19.0 to 21.0	—	0.3	0.50

(Continued)

Table 1 (Continued)
Chemical Composition Requirements for Nickel and Nickel-Alloy Electrodes and Rods

AWS Classification ^m	UNS Number ^c	Weight Percent ^{a,b}																Other Elements, Total
		C	Mn	Fe	P	S	Si	Cu	Ni ^d	Co	Al	Ti	Cr	Nb(Cb) Plus Ta	Mo	V	W	
ERNiCrMo-20	N06660	0.03	0.5	2.0	0.015	0.015	0.5	0.3	Rem	0.2	0.4	0.4	21.0 to 23.0	0.2	9.0 to 11.0	—	2.0 to 4.0	—
ERNiCrMo-21	N06205	0.03	0.5	1.0	0.015	0.015	0.5	0.2	Rem	0.2	0.4	0.04	24.0 to 26.0	—	14.0 to 16.0	—	0.3	—
ERNiCrMo-22	N06035	0.050	0.50	2.00	0.030	0.015	0.60	0.30	Rem	1.00	0.40	0.2	32.25 to 34.25	0.5	7.60 to 9.00	0.20	0.60	0.50
ERNiCrCoMo-1	N06617	0.05 to 0.15	1.0	3.0	0.03	0.015	1.0	0.50	Rem	10.0 to 15.0	0.8 to 1.5	0.60	20.0 to 24.0	—	8.0 to 10.0	—	—	0.50
ERNiCoCrSi-1	N12160	0.02 to 0.10	1.0	3.5	0.030	0.015	2.4 to 3.0	0.50	Rem	27.0 to 32.0	0.40	0.20 to 0.60	26.0 to 29.0	0.30	0.7	—	0.5	0.50
ERNiCrWMo-1 ^{h,i}	N06231	0.05 to 0.15	0.3 to 1.0	3.0	0.03	0.015	0.25 to 0.75	0.50	Rem	5.0	0.2 to 0.5	—	20.0 to 24.0	—	1.0 to 3.0	—	13.0 to 15.0	0.50

^a The weld metal shall be analyzed for the specific elements for which values are shown in this table. If the presence of other elements is indicated in the course of the work, the amount of those elements shall be determined to ensure that their total does not exceed the limit specified for "Other Elements, Total" in the last column of the table.

^b Single values are maximum, except where otherwise specified. Rem = remainder.

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

^d Includes incidental cobalt.

^e Co is 0.12 maximum when specified by the purchaser.

^f MIL-E-21562 grade; Ta is 0.30 maximum.

^g Boron is 0.006 maximum.

^h Boron is 0.003 maximum.

ⁱ La is 0.050 maximum.

^j Al + Ti is 1.5 maximum.

^k MIL-E-21562 grade; Pb < 0.010. "Other Elements Total" shall include Pb, Sn, Zn.

^l MIL-E-21562 grades EN82H or RH82H; Carbon is 0.03 to 0.10.

^m For strip, the classification designator "R" shall be replaced with "Q."

ⁿ Ni + Mo is 94.0 to 98.0; Ta is 0.02 maximum; Zr is 0.10 maximum.

^o Nitrogen is 0.05 to 0.20.

^p B is 0.005 maximum and Zr is 0.02 maximum.

^q Nitrogen is 0.02 to 0.15.

^r B is 0.003 maximum and Zr is 0.02 maximum.

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 test specimen(s) or in conducting the test, the test shall be considered invalid, without regard to whether the test was actually completed, or whether 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 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 was 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 1473, supplemented by ASTM E 1019 and ASTM E 354 for nickel base alloys, and ASTM E 76 for nickel-copper alloys, as appropriate.

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

10. Method of Manufacture

The filler metals classified according to this specification may be made by any method that will produce material that meets the requirements of this specification.

11. Standard Sizes

11.1 Standard sizes for filler metal in the different package forms (straight lengths, coils with support, coils without support, and spools) (see Clause 13) are shown in Table 2.

11.2 Standard sizes for strip electrodes in coils (see Clause 13) are shown in Table 3.

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 of material, and welds, when present, shall have been made so as not to interfere with the uniform,

Table 2
Standard Sizes of Electrodes and Rods^a

Standard Package Form	Diameter		Tolerance ^b	
	in	mm	in	mm
Straight length, ^c	1/16	1.6	±0.002	+0.01, −0.07
coils with supports	3/32	2.4		
and coils without	—	2.5		
supports	1/8	3.2		
	5/32	4.0		
	3/16	4.8 ^d		
	—	5.0		
	1/4	6.4 ^d		
Spools	0.020	0.5	+0.001, −0.002	+0.01, −0.04
	0.030	0.8		
	0.035	0.9		
	0.045	1.14 ^d		
	—	1.2		
	0.062	1.6		
	(1/16)			

^a Dimensions, sizes, tolerances, and package forms other than those shown shall be agreed upon by the 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 Metric sizes not shown in ISO 544.

Table 3
Standard Sizes of Strip Electrodes^{a, b}

Width		Thickness	
in	mm	in	mm
1.18	30	0.020	0.5
2.36	60		
3.54	90		
4.72	120		

^a Other sizes shall be as agreed upon by the purchaser and supplier.

^b Strip electrodes shall not vary more than ±0.008 in [±0.20 mm] in width and more than ±0.002 in [±0.05 mm] in thickness.

uninterrupted feeding of the filler metal on automatic and 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 4. Package forms, sizes, and weights other than these shall be as agreed between purchaser and supplier.

Table 4
Standard Package Dimensions and Weights^a

Bare Wire, Rods									
Electrode Size ^b		Net Weight ^c		Width		Diameter ^h Inside		Outside, Max.	
in	mm	lb	kg	in	mm	in	mm	in	mm
Straight Lengths									
1/16–1/4	1.6–6.4	5	2.2	—	—	—	—	—	—
		10	4.5	—	—	—	—	—	—
		25	11	—	—	—	—	—	—
Coils with Support									
1/16–1/4	1.6–6.4	25	11	2.5	65	12	305	17.5	445
		50	23						
1/16–1/4	1.6–6.4	60	27	4.6	120	12	305	17	430
1/16–1/4	1.6–6.4	100	45	5	125	— Not Specified ^d —		31.5	800
		150	68						
		200	91						
Coils without Support									
1/16–1/4	1.6–6.4	— as agreed by the purchaser and supplier —							
Spools ^e									
0.020–0.062	0.5–1.6	2 ^f	0.9 ^f					4	102
		10 ^f	4.5 ^f					8	203
		25 ^g	11.0 ^g					12	305
Strip Electrodes									
Strip Width		Net Weight ^c		Diameter ^h Inside					
in	mm	lb	kg			in	mm		
1.18	30	60	30			12	300		
2.36	60	60	30						
3.54	90	120	55						
4.72	120	120	55						

^a Sizes, weights, and dimensions other than those listed above shall be agreed upon by the purchaser and supplier.

^b The range is inclusive, as shown in Table 2.

^c Net weights shall not vary more than $\pm 10\%$.

^d The inside diameter of the liner shall be agreed upon by the purchaser and the supplier.

^e The dimensions of standard spools are specified in Figure 1.

^f Tolerance is $\pm 20\%$.

^g Tolerance is $\pm 20\%$, except that 20% of any lot may contain spools that vary in net weight from 12.5 lb to 20 lb [5.76 kg to 9.11 kg].

^h Tolerance is $\pm 1/8$ in [± 3 mm].

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.

13.3 Spools shall be designed and constructed to prevent distortion of the filler metal during normal handling and use and shall be clean and dry enough to maintain the cleanliness of the filler metal (see Figure 1).

14. Winding Requirements

14.1 Filler metal on spools and in coils shall be 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 readily located and shall be fastened to avoid unwinding.

14.2 The cast and helix of filler metal in coils shall be such that the filler metal will feed in an uninterrupted manner on automatic and semiautomatic 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 do the following:

(1) form a circle not less than 2.5 in [60 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 do the following:

(1) form a circle not less than 10 in [250 mm] nor more than 35 in [890 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 do the following:

(1) form a circle not less than 15 in [380 mm] nor more than 50 in [1300 mm] in diameter, and

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

15. Filler Metal Identification

15.1 The product information and the precautionary information required in Clause 17 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 filler metal at 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.

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 designation (year of issue may be excluded). Additionally, the numerical classification number from ISO 18274 may be applied as a reference designation, provided the requirements of ISO 18274 are satisfied (see A2.4 in Annex A and Table A.1).

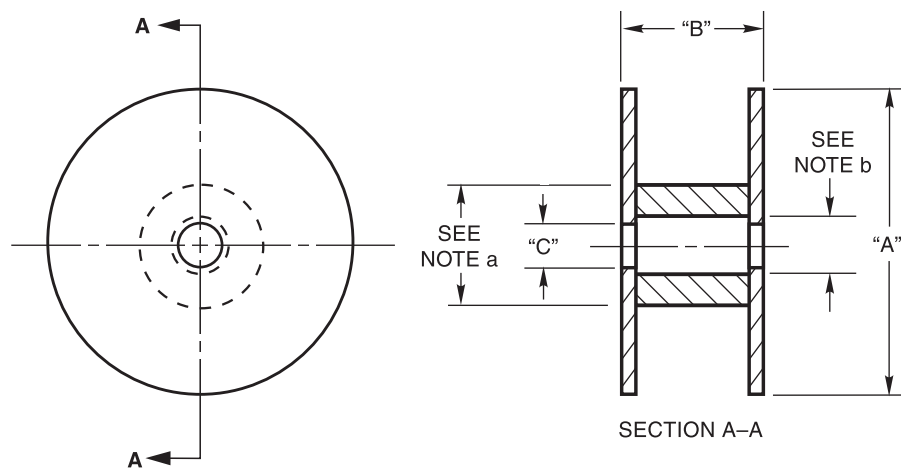
(2) Supplier's name and trade designation

(3) Size and net weight

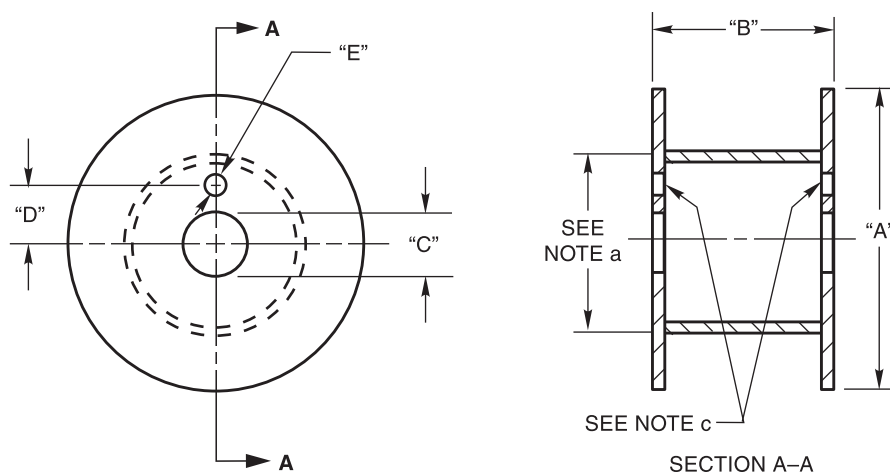
(4) Lot, control, or heat number

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

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



DIMENSIONS OF STANDARD 4 in [100 mm] SPOOL



DIMENSIONS OF STANDARD 8 in AND 12 in [200 mm AND 300 mm] SPOOLS

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. ^d	4.0	100	8.0	200	12	300
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 ^c	—	—	0.44	10	0.44	10
	Tolerance	—	—	+0, -0.06	+1, -0	+0, -0.06	+1, -0

^a Outside diameter of barrel shall be such as to permit proper feeding of the filler metals.

^b 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 core of the spool being less than the inside diameter of the flanges (dimension "C").

^c Holes are provided on each flange, but they need not be aligned.

^d Metric dimensions and tolerances conform to ISO 544 except that "A" specifies ± tolerances on the nominal diameter, rather than a plus tolerance only, which is shown here as a maximum.

Figure 1—Dimensions of Standard Spools

This page is intentionally blank.

Annex A (Informative)

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

This annex is not part of AWS A5.14/A5.14M: 2009, *Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods*, but is included for informational purposes only.

A1. Introduction

The purpose of this guide is to correlate the nickel and nickel-alloy bare welding electrodes and rods classifications with their intended applications so they can be used effectively. Reference to appropriate base-metal specifications is made whenever that can be done and when it would be helpful. Such references are intended only as examples rather than a complete listing of the materials for which each filler metal is suitable.

A2. Classification System

A2.1 The system for classifying the filler metals in this specification follows the standard pattern used in other AWS filler metal specifications. The 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 substitution of the letters “EQ” for “ER” at the beginning of a classification indicates that the product is being supplied as strip electrode (see Table 1, Note m).

A2.2 Since the filler metals are classified according to their chemical composition, the chemical symbol “Ni” appears immediately after the “ER” (or “EQ”) as a means of identifying the filler metal as a nickel-base alloy. The other symbols (Al, Cr, Co, Cu, Fe, Mo, Si, and W) in the designations are intended to group the filler metals according to their principal alloying elements. The individual designations are made up of these symbols plus a number at the end of the designation (ERNiMo-1 or ERNiMo-2, for example). These numbers separate one composition from another within a group and are not repeated within that group.

A2.3 From an application point of view, most of the filler metal classifications in this specification have a corresponding classification in AWS A5.11/A5.11M, *Specification for Nickel and Nickel-Alloy Covered Welding Electrodes*. For those cases in which there is a corresponding application for a bare electrode or rod “ER” and a covered electrode “E,” Table A.1 correlates the “ER” classification in this edition with those in the previous edition of this specification and with the corresponding covered electrode “E” classification in AWS A5.11/A5.11M. It also lists the current designation for each classification as it is given in Military Specification MIL-E-21562E, when such a designation exists.

A2.4 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 those used in ISO 18274 specification for comparison with comparable classifications in this specification. To understand the proposed international designation system, one is referred to Table 10C of the annex of the AWS document IFS:2002, *International Index of Welding Filler Metal Classifications*.

A3. Acceptance

Acceptance of all welding materials classified under this specification is in accordance with AWS A5.01M/A5.01, 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 AWS A5.01M/A5.01. In the absence of any such statement in the purchase order, the supplier may ship the material

Table A.1
Comparison of Classifications^a

Present Classification ^b	UNS Number	Military Designation ^c	Corresponding Classification in A5.11/A5.11M	ISO 18274 Designation ^d
ERNi -1	N02061	EN61 & RN61	ENi -1	SNi 2061
ERNiCu-7	N04060	EN60 & RN60	ENiCu-7	SNi 4060
ERNiCu-8	N05504	EN64 & RN64	—	SNi 5504
ERNiCr-3	N06082	EN82 & RN82 EN82H & RN82H	ENiCrFe-3	SNi 6082
ERNiCr-4	N06072	—	—	SNi 6072
ERNiCr-6	N06076	EN6N & RN6N	—	SNi 6076
<i>ERNiCr-7</i>	<i>N06073</i>	—	—	—
ERNiCrFe-5	N06062	EN62 & RN62	ENiCrFe-1	SNi 6062
ERNiCrFe-6	N07092	EN6A & RN6A	ENiCrFe-2	SNi 7092
ERNiCrFe-7	N06052	—	ENiCrFe-7	SNi 6052
ERNiCrFe-7A	N06054	—	—	—
ERNiCrFe-8	N07069	RN69	—	SNi 7069
ERNiCrFe-11	N06601	—	—	SNi 6601
ERNiCrFe-12	N06025	—	ENiCrFe-12	SNi 6025
<i>ERNiCrFe-13</i>	<i>N06055</i>	—	—	—
ERNiCrFeSi-1	N06045	—	ENiCrFeSi-1	—
ERNiCrFeAl-1	N06693	—	—	SNi 6693
ERNiFeCr-1	N08065	RN65	—	SNi 8065
ERNiFeCr-2	N07718	—	—	SNi 7718
ERNiMo-1	N10001	—	ENiMo-1	SNi 1001
ERNiMo-2	N10003	—	—	SNi 1003
ERNiMo-3	N10004	—	ENiMo-3	SNi 1004
ERNiMo-7	N10665	—	ENiMo-7	SNi 1066
ERNiMo-8	N10008	—	ENiMo-8	SNi 1008
ERNiMo-9	N10009	—	ENiMo-9	SNi 1009
ERNiMo-10	N10675	—	ENiMo-10	SNi 1067
ERNiMo-11	N10629	—	ENiMo-11	SNi 1069
ERNiMo-12	N10242	—	—	—
ERNiCrMo-1	N06007	—	ENiCrMo-1	—
ERNiCrMo-2	N06002	—	ENiCrMo-2	SNi 6002
ERNiCrMo-3	N06625	EN625 & RN625	ENiCrMo-3	SNi 6625
ERNiCrMo-4	N10276	—	ENiCrMo-4	SNi 6276
ERNiCrMo-7	N06455	—	ENiCrMo-7	SNi 6455
ERNiCrMo-8	N06975	—	—	SNi 6975
ERNiCrMo-9	N06985	—	ENiCrMo-9	SNi 6985
ERNiCrMo-10	N06022	—	ENiCrMo-10	SNi 6022
ERNiCrMo-11	N06030	—	ENiCrMo-11	SNi 6030
ERNiCrMo-13	N06059	—	ENiCrMo-13	SNi 6059
ERNiCrMo-14	N06686	—	ENiCrMo-14	SNi 6686
ERNiCrMo-15	N07725	—	—	SNi 7725
ERNiCrMo-16	N06057	—	—	SNi 6057
ERNiCrMo-17	N06200	—	ENiCrMo-17	SNi 6200
ERNiCrMo-18	N06650	—	ENiCrMo-18	SNi 6650
ERNiCrMo-19	N06058	—	ENiCrMo-19	—
ERNiCrMo-20	N06660	—	—	SNi 6660
ERNiCrMo-21	N06205	—	—	SNi 6205
<i>ERNiCrMo-22</i>	<i>N06035</i>	—	—	—
ERNiCrCoMo-1	N06617	—	ENiCrCoMo-1	SNi 6617
ERNiCoCrSi-1	N12160	—	—	SNi 6160
ERNiCrWMo-1	N06231	—	ENiCrWMo-1	SNi 6231

^a The requirements for the equivalent classifications shown are not necessarily identical in every respect.

^b For strip, the classification designator “R” shall be replaced with “Q.”

^c MIL-E-21562E.

^d For strip, the classification designator “S” shall be replaced with “B.”

with whatever testing is normally conducted on material of that classification, as specified in Schedule F, Table 1, of AWS A5.01M/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 made. The basis for the certification required by the specification is the classification tests of "representative material" cited above, and the "Manufacturer's Quality Assurance System" in AWS A5.01M/A5.01.

A5. Ventilation During Welding

A5.1 Five major factors that govern the quantity of fumes in the atmosphere to which welders and welding operators are exposed during welding are listed below:

- (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 the 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 dust in the space in which the welder is working; and
- (5) The ventilation provided to the space in which the welding is done.

A5.2 American National Standard 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 clause of that document dealing with ventilation.

A6. Welding Considerations

A6.1 The filler metals in this specification can be used with any of a variety of welding processes. Most notable among them are gas tungsten arc welding (GTAW), gas metal arc welding (GMAW), submerged arc welding (SAW), and plasma arc welding (PAW). SAW and PAW are quite specialized, and the supplier of the filler metals should be consulted for recommendations concerning their use. General suggestions are given below for the other two processes.

A6.2 Before welding or heating any nickel-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 often used, but mixtures of argon and helium are also commonly used.

A7. Description and Intended Use of Electrodes and Rods

A7.1 ERNi-1 Classification. The nominal composition (wt %) of filler metal of this classification is 96 Ni, 3 Ti. Filler metal of this classification is intended for welding wrought and cast forms of commercially pure nickel alloy (ASTM B 160, B 161, B 162, and B 163 having UNS number N02200 or N02201) to itself using the GTAW, GMAW, SAW, and PAW processes. The filler metal contains sufficient titanium to control weld-metal porosity with these welding processes.

A7.2 ERNiCu-X Classifications

A7.2.1 ERNiCu-7 Classification. The nominal composition (wt %) of filler metal of this classification is 65 Ni, 30 Cu, 3 Mn, and 2 Ti. Filler metal of this classification is used for welding nickel-copper alloy (ASTM B 127, B 163, B 164, and B 165 having UNS number N04400) to itself using the GTAW, GMAW, SAW, and PAW processes. The filler metal contains sufficient titanium to control porosity with these welding processes.

A7.2.2 ERNiCu-8 Classification. The nominal composition (wt %) of filler metal of this classification is 66 Ni, 29 Cu, 3 Al, 1 Fe, and 0.5 Ti. Filler metal of this classification is used for welding age-hardening nickel-copper alloy (ASTM F 467 and F 468 having UNS number N05500) to itself using the GTAW, GMAW, SAW, and PAW processes. The filler metal will age harden on heat treatment. For specific information concerning age hardening, consult the supplier or the supplier's technical literature.

A7.3 ERNiCr-X Classifications

A7.3.1 ERNiCr-3. The nominal composition (wt %) of filler metal of this classification is 72 Ni, 20 Cr, 3 Mn, 2.5 Nb plus Ta. Filler metal of this classification is used for welding nickel-chromium-iron alloy (ASTM B 163, B 166, B 167, and B 168 having UNS number N06600) to itself, for the clad side of joints in steel clad with nickel-chromium-iron alloy, for surfacing steel with nickel-chromium-iron weld metal, for dissimilar welding of nickel-base alloys, and for joining steel to stainless steel or nickel-base alloys using the GTAW, GMAW, SAW, and PAW processes.

A7.3.2 ERNiCr-4. The nominal composition (wt %) of filler metal of this classification is 55 Ni, 44 Cr. Filler metal of this classification is used for GTAW of 50/50 nickel/chromium alloy, cladding nickel/chromium alloy onto nickel-iron-chromium tubing, and casting repair. The filler metal is resistant to high-temperature corrosion, including fuel-ash corrosion in atmospheres containing sulfur and vanadium.

A7.3.3 ERNiCr-6. The nominal composition (wt %) of filler metal of this classification is 78 Ni, 20 Cr, 1 Fe, and 0.4 Ti. Filler metal of this classification is used for welding nickel-chromium-iron alloy (ASTM B 163, B 166, B 167, and B 168 having UNS number N06600) to itself, for the clad side of joints in steel clad with nickel-chromium-iron alloy, for surfacing steel with nickel-chromium-iron weld metal, and for joining steel to nickel-base alloys using the GTAW, GMAW, SAW, and PAW processes.

A7.3.4 ERNiCr-7. *The nominal composition (wt %) of filler metal of this classification is 60 Ni, 37.5 Cr, 0.95*

Al, and 0.6 Nb. Filler metal of this classification is used for the overlay cladding of ferrous materials used in high temperature applications, and the welding of nickel-chromium-iron alloy (ASTM B 163, B 166, B 167, and B 168 having UNS number N06690) to itself, and to steels, using the GTAW, GMAW, SAW, ESW, and PAW processes. Welds made with this composition are particularly resistant to high temperature oxidation, carburization, and sulfidation.

A7.4 ERNiCrFe-X Classifications

A7.4.1 ERNiCrFe-5. The nominal composition (wt %) of filler metal of this classification is 74 Ni, 16 Cr, 8 Fe, 2 Nb plus Ta. Filler metal of this classification is used for welding nickel-chromium-iron alloy (ASTM B 163, B 166, B 167, and B 168 having UNS number N06600) to itself using the GTAW, GMAW, SAW, and PAW processes. The higher niobium content of the filler metal is intended to minimize cracking where high welding stresses are encountered, as in thick-section base metal.

A7.4.2 ERNiCrFe-6. The nominal composition (wt %) of filler metal of this classification is 71 Ni, 16 Cr, 6 Fe, 3 Ti, and 2.5 Mn. Filler metal of this classification is used for cladding steel with nickel-chromium-iron weld metal and for joining steel to nickel-base alloys using the GTAW, GMAW, SAW, and PAW processes. The filler metal will age harden on heat treatment. For specific information concerning age hardening, consult the supplier or the supplier's technical literature.

A7.4.3 ERNiCrFe-7. The nominal composition (wt %) of filler metal of this classification is 60 Ni, 29 Cr, and 9 Fe. Filler metal of this classification is used for welding nickel-chromium-iron alloy (ASTM B 163, B 166, B 167, and B 168 having UNS number N06690) to itself, to steels, to overlay on steels, and to weld steels clad with the nickel-chromium-iron alloys using the GTAW, GMAW, SAW, and PAW processes.

A7.4.4 ERNiCrFe-7A. The nominal composition (wt %) of filler metal of this classification is 60 Ni, 29 Cr, 9 Fe, 0.75 Nb. Filler metal of this composition is used for welding nickel-chromium-iron alloy (ASTM B 163, B 166, B 167, and B 168 having UNS number N06690) to itself, to steels, and to weld overlay steels using the GTAW, GMAW, SAW, ESW, and PAW processes. Welds made with this composition are particularly resistant to ductility-dip-cracking (DDC), and oxide inclusions.

A7.4.5 ERNiCrFe-8. The nominal composition (wt %) of filler metal of this classification is 73 Ni, 15.5 Cr, 7 Fe, 2.4 Ti, 1 Nb, and 0.7 Al. Filler metal of this classification is used for cladding steel with nickel-chromium-iron weld metal and for joining steel to

nickel-base alloys using the GTAW, GMAW, SAW, and PAW processes. The weld metal will age harden on heat treatment. For specific information concerning age hardening, consult the supplier or the supplier's technical literature.

A7.4.6 ERNiCrFe-11. The nominal composition (wt %) of filler metal of this classification is 61 Ni, 23 Cr, 14 Fe, and 1.4 Al. Filler metal of this classification is used for welding nickel-chromium-iron-aluminum alloy (ASTM B 166, B 167, and B 168 having UNS number N06601) to itself and to other high-temperature compositions using the GTAW process. It is used for severe applications where the exposure temperature can exceed 2100°F [1150°C].

A7.4.7 ERNiCrFe-12. The nominal chemical composition (wt-%) of filler metal of this classification is 63 Ni, 25 Cr, 9.5 Fe, 2.1 Al. Filler metal of this classification is used for welding UNS number N06025, welding nickel-chrome-iron to steel and to other nickel base alloys. The ASTM specifications for UNS number N06025 are B 163, B 166, B 167, B 168, B 366, B 516, B 517, B 546, and B 564.

A7.4.8 ERNiCrFe-13. The nominal composition (wt %) of filler metal of this classification is 55 Ni, 30 Cr, 8 Fe, 4 Mo, and 3 Nb. Filler metal of this classification is used for welding nickel-chromium-iron alloy (ASTM B 163, B 166, B 167, and B 168 having UNS number N06690) to itself, to steels, and to weld overlay steels using the GTAW, GMAW, SAW, ESW, and PAW processes. Welds made with this composition are particularly resistant to ductility-dip-cracking (DDC), and oxide inclusions.

A7.5 ERNiFeCr-X Classifications

A7.5.1 ERNiFeCr-1. The nominal composition (wt %) of filler metal of this classification is 42 Ni, 30 Fe, 21 Cr, 3 Mo, and 2 Cu. Filler metal of this classification is used for welding the nickel-iron-chromium-molybdenum-copper alloy (ASTM B 423 having UNS number N08825) to itself using the GTAW and GMAW processes.

A7.5.2 ERNiFeCr-2. The nominal composition (wt %) of filler metal of this classification is 52 Ni, 18 Fe, 19 Cr, 5 Nb plus Ta, 3 Mo, 1Ti. Filler metal of this classification is used for welding nickel-chromium-niobium-molybdenum alloy (ASTM B 637 and AMS 5589 having UNS number N07718) to itself using the GTAW processes. The weld metal will age harden on heat treatment. For specific information concerning age hardening, consult the supplier or the supplier's technical literature.

A7.6 ERNiCrFeSi-1 Classification. The nominal chemical composition (wt %) of filler metal of this classifica-

tion is 46 Ni, 28 Cr, 2.75 Si, 23 Fe. Filler metal of this classification is used for welding nickel-chromium-iron alloy (ASTM B 163, B 166, B 167, B 168, B 366, B 516, B 517, B 546, and B 564 having UNS number N06045) to itself, to steel, and to other nickel base alloys.

A7.7 ERNiCrFeAl-1 Classification. The nominal composition (wt %) of filler metal of this classification is 59 Ni, 29 Cr, 4 Fe, 3 Al. Filler metal of this classification is used for welding nickel-chromium-iron alloy (ASTM B 166, B 167, and B 168 having UNS number N06693) to itself, to steels, and to weld overlay steels using the GTAW and GMAW processes. Welds made with this composition are particularly resistant to metal dusting in chemical and petrochemical applications. The alloy is resistant to carburization, sulfidation, and other high temperature corrosion forms.

A7.8 ERNiMo-X Classifications

A7.8.1 ERNiMo-1. The nominal composition (wt %) of filler metal of this classification is 66 Ni, 28 Mo, and 5.5 Fe. Filler metal of this classification is used for welding nickel-molybdenum alloy (ASTM B 333 having UNS number N10001) to itself using the GTAW and GMAW processes.

A7.8.2 ERNiMo-2. The nominal composition (wt %) of filler metal of this classification is 71 Ni, 16 Mo, 7 Cr, and 3 Fe. Filler metal of this classification is used for welding nickel-molybdenum alloy (ASTM B 366, B 434, and B 573 having UNS number N10003) to itself, to steel, to other nickel-base alloys, and for cladding steel with nickel-molybdenum weld metal using the GTAW and GMAW processes.

A7.8.3 ERNiMo-3. The nominal composition (wt %) of filler metal of this classification is 63 Ni, 24 Mo, 6 Fe, and 5 Cr. Filler metal of this classification is used for weld repair of various nickel-, cobalt-, and iron-base alloys and for dissimilar joining applications of nickel-, cobalt-, and iron-base alloys.

A7.8.4 ERNiMo-7. The nominal composition (wt %) of filler metal of this classification is 69 Ni, 28 Mo. Filler metal of this classification is used for welding nickel-molybdenum alloy (ASTM B 333 and B 335 having UNS number N10665) to itself and for cladding steel with nickel-molybdenum weld metal using the GTAW and GMAW processes.

A7.8.5 ERNiMo-8. The nominal composition (wt %) of filler metal of this classification is 70 Ni, 19 Mo, 5 Fe, 3 W, and 2 Cr. Filler metal of this classification is used for welding 9% nickel steel (ASTM A 333, A 334, A 353, and A 553 having UNS number K81340) to itself using the GTAW and SAW processes.

A7.8.6 ERNiMo-9. The nominal composition (wt %) of filler metal of this classification is 70 Ni, 20 Mo, 1 Fe, and 3 W. Filler metal of this classification is used for welding 9% nickel steel (ASTM A 333, A 334, A 353, A 553 having UNS number K81340) to itself using the GTAW and SAW processes.

A7.8.7 ERNiMo-10. The nominal composition (wt %) of filler metal of this classification is 68 Ni, 28.5 Mo, 1.5 Cr, 1.5 Fe and low carbon. Filler metal of this classification is used for welding nickel-molybdenum alloy (ASTM B 333, B 335, B 366, B 564, B 619, B 622, and B 626 having UNS number N10675) to itself, for welding the clad side of joints in steel clad with nickel-molybdenum alloy and for welding nickel-molybdenum alloys to steel and to other nickel-base alloys using the GTAW, GMAW, and PAW processes.

A7.8.8 ERNiMo-11. The nominal composition (wt %) of filler metal of this classification is 67 Ni, 28 Mo, 3 Fe, 1.3 Cr and low carbon. Filler metal of this classification is used for welding nickel-molybdenum alloy with a UNS number N10629, covered in ASTM specifications B 333, B 335, B 366, B 564, B 619, B 622, and B 626, to itself, for welding the clad side of joints clad with nickel-molybdenum alloy and for welding Ni-Mo alloys to steel and other nickel base alloys using the GTAW, GMAW, and PAW processes.

A7.8.9 ERNiMo-12. The nominal composition (wt %) of filler metal of this classification is 65 Ni, 25 Mo, 8 Cr. Filler metal of this classification is used for welding nickel-molybdenum alloy (ASTM B 366, B 434, B 564, B 619, B 622, and B 626 having UNS number N10242) to itself and for cladding steel with nickel-molybdenum weld metal using the GTAW and GMAW processes.

A7.9 ERNiCrMo-X Classifications

A7.9.1 ERNiCrMo-1. The nominal composition (wt %) of filler metal of this classification is 44 Ni, 22 Cr, 20 Fe, 6.5 Mo, 2 Nb plus Ta, 2 Cu, 1.5 Mn. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 581 and B 582 having UNS number N06007) to itself, to steel, to other nickel-base alloys, and for cladding steel with nickel-chromium-molybdenum weld metal using the GTAW, GMAW, and PAW processes.

A7.9.2 ERNiCrMo-2. The nominal composition (wt %) of filler metal of this classification is 47 Ni, 22 Cr, 18 Fe, 9 Mo, and 1.5 Co. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 366, B 435, and B 572 having UNS number N06002) to itself, to steel, to other nickel-base alloys, and for cladding steel with nickel-chromium-

molybdenum weld metal using the GTAW, GMAW, and PAW processes.

A7.9.3 ERNiCrMo-3. The nominal composition (wt %) of filler metal of this classification is 61 Ni, 22 Cr, 9 Mo, 3.5 Nb plus Ta. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 443, B 444, and B 446 having UNS number N06625) to itself, to steel, to other nickel-base alloys, for cladding steel with nickel-chromium-molybdenum weld metal, and for welding the clad side of joints in steel with nickel-chromium-molybdenum alloy using the GTAW, GMAW, SAW, and PAW processes. This filler metal is recommended for applications where the operating temperature ranges from cryogenic to 1000°F [540°C].

A7.9.4 ERNiCrMo-4. The nominal composition (wt %) of filler metal of this classification is 57 Ni, 16 Cr, 15.5 Mo, 5.5 Fe, and 4 W. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 574, B 575, B 19, B 622, and B 628 having UNS number N10276) to itself, to steel, to other nickel-base alloys, and for cladding steel with nickel-chromium-molybdenum weld metal using the GTAW and GMAW processes.

A7.9.5 ERNiCrMo-7. The nominal composition (wt %) of filler metal of this classification is 65 Ni, 16 Cr, 15.5 Mo, and 2 Fe. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 574, B 575, B 619, B 622, and B 628 having UNS number N06455) to itself, to steel, to other nickel-base alloys, and for cladding steel with nickel-chromium-molybdenum weld metal using the GTAW, GMAW, and PAW processes.

A7.9.6 ERNiCrMo-8. The nominal composition (wt %) of filler metal of this classification is 50 Ni, 25 Cr, 17 Fe, 6 Mo, and 1 Cu. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 581, B 582, B 619, B 622 and B 626 having UNS number N06975) to itself, to steel, to other nickel-base alloys, and for cladding steel with nickel-chromium-molybdenum weld metal using the GTAW, GMAW, and PAW processes.

A7.9.7 ERNiCrMo-9. The nominal composition (wt %) of filler metal of this classification is 44 Ni, 22 Cr, 20 Fe, 7 Mo, 2 Co, and 2 Cu. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 581, B 582, B 619, B 622, and B 626 having UNS number N06007 or N06985) to itself, to steel, to other nickel-base alloys, and for cladding steel with nickel-chromium-molybdenum weld metal using the GTAW, GMAW, and PAW processes.

A7.9.8 ERNiCrMo-10. The nominal composition (wt %) of filler metal of this classification is 56 Ni, 22 Cr, 13 Mo, 4 Fe, and 3 W. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 574, B 575, B 619, B 622, and B 628 having UNS number N06022) to itself, to steel, to other nickel-base alloys, and for cladding steel with nickel-chromium-molybdenum weld metal using the GTAW, GMAW, and PAW processes.

A7.9.9 ERNiCrMo-11. The nominal composition (wt %) of filler metal of this classification is 43 Ni, 30 Cr, 15 Fe, 5 Mo, 2 Co, 3 W, and 2 Cu. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 581, B 582, B 619, B 622, and B 626 having UNS number N06030) to itself, to steel, to other nickel-base alloys, and for cladding steel with nickel-chromium-molybdenum weld metal using the GTAW, GMAW, and PAW processes.

A7.9.10 ERNiCrMo-13. The nominal composition (wt %) of filler metal of this classification is 59 Ni, 23 Cr, 16 Mo, 1 Fe, and low carbon. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (B 564, B 574, B 575, B 619, B 622, and B 626 having UNS number N06059) to itself, to steel, to other nickel-base alloys, and for cladding steel using the GTAW, GMAW, SAW, and PAW processes.

A7.9.11 ERNiCrMo-14. The nominal composition (wt %) of the filler metal of this classification is 57 Ni, 21 Cr, 16 Mo, and 4 W. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 574, B 575, B 619, B 622, and B 628 having UNS number N06686) to itself, to steel, to other nickel-base alloys, and for cladding steel using the GTAW, GMAW, and SAW processes.

A7.9.12 ERNiCrMo-15. The nominal composition (wt %) of filler metal of this classification is 57 Ni, 21 Cr, 8 Mo, 7 Fe, 3 Nb plus Ta, 1.4 Ti. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 805, UNS number N07725) to itself, and for cladding steel using the GMAW and GTAW processes. The weld metal age hardens on heat treatment. For specific information concerning age hardening, consult the supplier or the supplier's technical literature.

A7.9.13 ERNiCrMo-16. The nominal composition (wt %) of filler metal of this classification is 60 Ni, 30 Cr and 10 Mo. Filler metal of this classification is used for corrosion-resistant (especially excellent to crevice corrosion) overlaying by the GTAW, GMAW, and PAW processes.

A7.9.14 ERNiCrMo-17. The nominal composition (wt %) of filler metal of this classification is 59 Ni, 23 Cr, 16 Mo, 1.6 Cu. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 574, B 575, B 619, B 622 and B 629 having UNS number N06200) to itself, to steel, to other nickel-base alloys, and for cladding steel with nickel-chromium-molybdenum weld metal using the GTAW, GMAW, and PAW processes.

A7.9.15 ERNiCrMo-18. The nominal composition (wt %) of filler metal of this classification is 50 Ni, 20 Cr, 11.5 Mo, 14 Fe, and 1.5 W. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloys having UNS number N06650 to itself, to steel, to super-austenitic stainless steels, to other nickel-base alloys, and for cladding steel with nickel-chromium-molybdenum weld metal using the GTAW, GMAW, and PAW processes.

A7.9.16 ERNiCrMo-19. The nominal composition (wt %) of filler metal of this classification is 58 Ni, 21 Cr, 20 Mo, and 1 Fe. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 574, B 575, B 366, B 564, B 619, B 622, and B 626) having UNS N06058 to itself, to steel, to other nickel-base alloys, and for cladding steel with nickel-chromium-molybdenum weld metal using the GTAW, GMAW, PAW processes.

A7.9.17 ERNiCrMo-20. The nominal composition (wt %) of filler metal of this classification is 64 Ni, 22 Cr, and 9 Mo (niobium free). The properties of this filler metal are suitable to weld super duplex stainless steels for low temperature applications with high impact toughness. Filler metal of this composition is used for welding of nickel-chromium-molybdenum alloys of similar composition as well as for cladding using GTAW, GMAW, SAW, and PAW processes.

A7.9.18 ERNiCrMo-21. The nominal composition (wt %) of filler metal of this classification is 55 Ni, 25 Cr, 15 Mo, 1 Fe. Filler metal of this classification is used for welding of nickel-chromium-molybdenum alloys (ASTM B 574, B 575, B 366, B 564, B 619, B 622, and B 626) having UNS number N06205 to itself, to steel, to other nickel base alloys, and for cladding steel with nickel-chromium-molybdenum weld metal using the GTAW, GMAW, and PAW processes.

A7.9.19 ERNiCrMo-22. *The nominal composition (wt %) of filler metal of this classification is 58 Ni, 33 Cr, and 8 Mo. Filler metal of this classification is used for welding nickel-chromium-molybdenum alloy (ASTM B 366, B 434, B 564, B 619, B 622, and B 626 having UNS number N06035) to itself, and for cladding*

steel with nickel-chromium-molybdenum weld metal using the GTAW and GMAW processes.

A7.10 ERNiCrCoMo-1 Classification. The nominal composition (wt %) of filler metal of this classification is 53 Ni, 23 Cr, 12 Co, 9 Mo, and 1 Fe. Filler metal of this classification is used for welding nickel-chromium-cobalt-molybdenum alloy (UNS number N06617) to itself using the GTAW and GMAW processes.

A7.11 ERNiCoCrSi-1 Classification. The nominal composition (wt %) of filler metal of this classification is 38 Ni, 30 Co, 28 Cr, 2.8 Si and 1 Fe. Filler metal of this classification is used for welding nickel-cobalt-chromium-silicon alloy (ASTM B 435, B 572, B 619, and B 626 having UNS number N12160) to itself using the GTAW, GMAW, and PAW processes. This alloy is sensitive to iron pick-up, therefore its use is not recommended for the welding of the nickel-cobalt-chromium-silicon alloy to iron based alloys.

A7.12 ERNiCrWMo-1 Classification. The nominal composition (wt %) of filler metal of this classification is 57 Ni, 22 Cr, 14 W, 2 Co, 2 Fe, and 2 Mo. Filler metal of this classification is used for welding nickel-chromium-tungsten-molybdenum-lanthanum alloy (ASTM B 366, B 435, B 564, and B 572 having UNS number N06230) to itself using the GTAW and GMAW processes.

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 A5.01M/A5.01 contains provisions for ordering such tests. This clause is included to give guidance to those who desire to specify such special tests. Those tests shall be conducted as agreed upon between supplier and purchaser.

A8.1 Corrosion or Scaling Tests. Although welds made with electrodes and rods classified in this specification are commonly used in corrosion and heat-resisting applications, tests for those properties are not included in the specification. When required for a particular application, testing can be conducted on specimens taken from either a weld pad or a welded joint.

A8.1.1 Specimens from a joint are suitable for qualifying the welding procedure (for a specific application involving corrosion or oxidation resistance) but not for qualifying the filler metal. Tests on specimens from a joint have the disadvantage of being a combined test of

the properties of the weld metal, the heat-affected zone, and the unaffected base metal. With such specimens, it is more difficult to obtain reproducible data (when a difference exists in the properties of the metal in the various parts of the specimen). Specimens taken from a joint do have the advantage of being able to duplicate the joint design and the welding sequence planned for fabrication.

A8.1.2 Specimens for testing corrosion or oxidation resistance of the weld metal alone are prepared by following the procedure normally used for the preparation of pads for chemical analysis (see 9.3 in AWS A5.11/A5.11M). The pad size should be at least 3/4 in [19 mm] in height by 2-1/2 in [65 mm] in width by $(1 + 0.625 n)$ in $[25 + 16 n \text{ mm}]$ in length where n represents the number of specimens required from the pad. Specimens measuring 1/2 in by 2 in by 1/4 in [13 mm by 50 mm by 6.5 mm] are machined from the top of the pad, in a manner such that the 2 in [50 mm] dimension of the specimen is parallel to the 2-1/2 in [65 mm] dimension of the pad and the 1/2 in [13 mm] dimension is parallel with the length of the pad. The heat treatment, surface finish, and marking of the specimens prior to testing should be in accordance with standard practices for tests of similar alloys in the wrought or cast forms. The testing procedures should correspond to ASTM G 4, *Recommended Practice for Conducting Plant Corrosion Tests*.

A8.2 Test for Mechanical Properties. The filler metals in this specification are used with a variety of welding processes and procedures. For this reason, weld metal tests have not been included in the specification. The tensile properties, bend ductility, and soundness of welds produced with these filler metals are determined during qualification of the procedure.

Variables in the procedure (current, voltage, and welding speed), in the shielding medium (the specific gas mixture or the flux), in the manual dexterity of the welder, and in the composition of the base metal and the filler metal all influence the results that can be obtained. Typical tensile values for weld metals are shown in Table A.2. When supplementary tests for mechanical properties are specified, the testing procedures should be in accordance with AWS B4.0 or AWS B4.0M, *Standard Methods for Mechanical Testing of Welds*.

A9. Discontinued Classifications

Some classifications have been discontinued from one revision of this specification to another. This resulted from either changes in commercial practice or changes in the classification system used in the specification. The

Table A.2
Typical Weld Metal Tensile Strengths^a

AWS Classification	Tensile Strength (typical)	
	ksi	MPa
ERNi-1	55	380
ERNiCu-7	70	480
ERNiCu-8	100 ^b	690 ^b
ERNiCr-3	80	550
ERNiCr-4	100	690
ERNiCr-6	80	550
<i>ERNiCr-7</i>	<i>100</i>	<i>690</i>
ERNiCrFe-5	80	550
ERNiCrFe-6	80	550
ERNiCrFe-7	80	550
ERNiCrFe-7A	85	590
ERNiCrFe-8	125 ^c	860 ^c
ERNiCrFe-11	94	650
ERNiCrFe-12	95	660
<i>ERNiCrFe-13</i>	<i>85</i>	<i>590</i>
ERNiCrFeSi-1	90	620
ERNiCrFeAl-1	85	590
ERNiFeCr-1	80	550
ERNiFeCr-2	165 ^d	1140 ^d
ERNiMo-1	100	690
ERNiMo-2	100	690
ERNiMo-3	100	690
ERNiMo-7	110	760
ERNiMo-8	95	660
ERNiMo-9	95	660
ERNiMo-10	110	760
ERNiMo-11	100	690
ERNiMo-12	100	690
ERNiCrMo-1	85	590
ERNiCrMo-2	95	660
ERNiCrMo-3	110	760
ERNiCrMo-4	100	690
ERNiCrMo-7	100	690
ERNiCrMo-8	85	590
ERNiCrMo-9	85	590
ERNiCrMo-10	100	690
ERNiCrMo-11	85	590
ERNiCrMo-13	110	760
ERNiCrMo-14	110	760
ERNiCrMo-15	174 ^e	1200 ^e
ERNiCrMo-16	85	590
ERNiCrMo-17	100	690
ERNiCrMo-18	95	660
ERNiCrMo-19	120	830
ERNiCrMo-20	110	750
ERNiCrMo-21	115	780
<i>ERNiCrMo-22</i>	<i>85</i>	<i>590</i>
ERNiCrCoMo-1	90	620
ERNiCoCrSi-1	90	620
ERNiCrWMo-1	110	760

^a Tensile strength in the as-welded condition, unless otherwise specified.

^b Age-hardened condition: Heat treated at 1475°F [802°C] for 2 hours plus 1100°F [593°C] for 16 hours, then furnace cooled at 25°F [14°C] per hour to 900°F [482°C], then air cooled.

^c Age-hardened condition: Heat treated at 1950°F [1066°C] for 2 hours plus 1300°F [704°C] for 20 hours, then air cooled.

^d Age-hardened condition: Heat treated at 1325°F [718°C] for 8 hours, then furnace cooled at 100°F [56°C] per hour to 1150°F [620°C] and held for 8 hours, then air cooled.

^e Age-hardened condition: Heat treated at 1900°F [1038°C] for 1 hour plus 1350°F [732°C] for 8 hours, then furnace cooled at 100°F [56°C] per hour to 1150°F [621°C] and held for 8 hours, then air cooled.

discontinued classifications are listed in Table A.3, along with the year last included in the specification.

A10. Safety Considerations

NOTE: 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. Safety and health information is available from other sources, including, but not limited to Safety and Health Fact Sheets listed in A10.2, ANSI Z49.1 Safety in Welding, Cutting and Allied Processes,⁹ and applicable federal and state regulations.

A10.1 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.

⁹ ANSI Z49.1 is published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

Table A.3
Discontinued Classifications

Discontinued Classification	Last Year Published
RNi-2	1969
ERNi-3	1969
RNiCu-5	1969
RNiCu-6	1969
RNiCrFe-4	1969
ERNiMo-4 ^a	1969
ERNiMo-5	1969
ERNiMo-6 ^b	1969

^a Reclassified as ERNiMo-1 in 1976.

^b Reclassified as ERNiMo-3 in 1976.

A10.2 AWS Safety and Health Fact Sheets Index (SHF)¹⁰

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 Welding 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*

¹⁰ AWS standards are published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

Annex B (Informative)

Guidelines for the Preparation of Technical Inquiries

This annex is not part of AWS A5.14/A5.14M: 2009, *Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods*, 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 of Directors' policy 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	A5.14		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	

This page is intentionally blank.

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 of 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>
A5.01M/A5.01 (ISO 14344:2002 MOD)	<i>Procurement Guidelines for Consumables—Welding and Allied Processes—Flux and Gas Shielded Electrical Welding Processes</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/A5.6M	<i>Specification for Copper and Copper-Alloy Electrodes for Shielded Metal Arc Welding</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 Electrode Gas 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>

.....

This page is intentionally blank.

