


AWS A5.36/A5.36M:2012
An American National Standard



**Specification for
Carbon and Low-
Alloy Steel Flux
Cored Electrodes
for Flux Cored Arc
Welding and Metal
Cored Electrodes
for Gas Metal Arc
Welding**



American Welding Society®



AWS A5.36/A5.36M:2012
An American National Standard

Approved by the
American National Standards Institute
December 20, 2011

**Specification for Carbon and
Low-Alloy Steel Flux Cored Electrodes for
Flux Cored Arc Welding and Metal Cored
Electrodes for Gas Metal Arc Welding**

1st Edition

Supersedes AWS A5.20/A5.20M:2005 and AWS A5.29/A5.29M: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

This specification prescribes the requirements for classification of carbon and low-alloy steel flux cored electrodes for flux cored arc welding and metal cored electrodes for gas metal arc welding. The requirements include chemical composition and mechanical properties of the weld metal and certain usability characteristics. Optional, supplemental designators are also included for diffusible hydrogen and to indicate conformance to special mechanical property requirements when the weld metal is deposited using low heat input, fast cooling rate and high heat input, slow cooling rate procedures. Additional requirements are included or referenced for standard sizes, marking, manufacturing, and packaging. A guide is appended to the specification as a source of information concerning the classification system employed and the intended use of carbon and low-alloy steel flux cored and metal cored electrodes.

This specification makes use of both U.S. Customary Units and the International System of Units (SI). Since these are not equivalent, each system must be used independently of the other.



American Welding Society®

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

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 is entrusted to appropriately qualified and competent personnel.

This standard may be superseded by the issuance of new editions. This standard may also be corrected through publication of amendments or errata. It may also be supplemented by publication of addenda. Information on the latest editions of AWS standards including amendments, errata, and addenda are posted on the AWS web page (www.aws.org). Users should ensure that they have the latest edition, amendments, errata, and addenda.

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.

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.

Personnel

AWS A5 Committee on Filler Metals and Allied Materials

H. D. Wehr, Chair	<i>Arcos Industries, LLC</i>
J. J. DeLoach Jr., 1st Vice Chair	<i>Naval Surface Warfare Center</i>
R. D. Fuchs, 2nd Vice Chair	<i>Böhler Welding Group USA, Incorporated</i>
R. K. Gupta, Secretary	<i>American Welding Society</i>
T. Anderson	<i>Miller Electric Manufacturing Co.</i>
J. M. Blackburn	<i>Naval Sea Systems Command</i>
J. C. Bundy	<i>Hobart Brothers Company</i>
D. D. Crockett	<i>Consultant, The Lincoln Electric Company</i>
R. V. Decker	<i>Weldstar</i>
D. A. DelSignore	<i>Consultant</i>
J. DeVito	<i>ESAB Welding and Cutting Products</i>
H. W. Ebert	<i>Consulting Welding Engineer</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 and Cutting Products</i>
D. A. Fink	<i>The Lincoln Electric Company</i>
G. L. Franke	<i>Naval Surface Warfare Center</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. G. Kvidahl	<i>Ingalls Shipbuilding</i>
A. Y. Lau	<i>Canadian Welding Bureau</i>
J. S. Lee	<i>Chevron</i>
T. Melfi	<i>The Lincoln Electric Company</i>
K. M. Merlo	<i>Edison Welding Institute</i>
M. T. Merlo	<i>RevWires LLC</i>
B. Mosier	<i>Polymet Corporation</i>
A. K. Mukherjee	<i>Siemens Energy, Incorporated</i>
T. C. Myers	<i>Oceaneering Intervention Engineering</i>
C. L. Null	<i>Consultant</i>
B. A. Pletcher	<i>CB&I, Incorporated</i>
K. C. Pruden	<i>Hydril Company</i>
K. Roossinck	<i>Northrop Grumman Ship Systems</i>
P. K. Salvesen	<i>Det Norske Veritas (DNV)</i>
K. Sampath	<i>Consultant</i>
W. S. Severance	<i>ESAB Welding and Cutting Products</i>
M. J. Sullivan	<i>NASSCO—National Steel & Shipbuilding</i>
R. C. Sutherland	<i>ATI Wah Chang</i>
R. A. Swain	<i>Euroweld, Limited</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>Soldaduras West Arco Ltda.</i>
J. E. Beckham	<i>Chrysler LLC</i>
M. L. Caruso	<i>Special Metals Welding Products Company</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>
W. A. Marttila	<i>WAMcom Consulting LLC</i>
R. Menon	<i>Stoody Company</i>
D. R. Miller	<i>ABS</i>
M. P. Parekh	<i>Consultant</i>
M. A. Quintana	<i>The Lincoln Electric Company</i>
E. S. Surian	<i>National University of Lomas de Zamora</i>
H. J. White	<i>HAYNES International</i>

AWS A5M Subcommittee on Carbon and Low-Alloy Steel Electrodes for Flux Cored Arc Welding and Metal Cored Electrodes for Gas Metal Arc Welding

D. D. Crockett, Chair	<i>Consultant, The Lincoln Electric Company</i>
M. T. Merlo, Vice Chair	<i>RevWires LLC</i>
R. K. Gupta, Secretary	<i>American Welding Society</i>
J. C. Bundy	<i>Hobart Brothers Company</i>
J. J. DeLoach Jr.	<i>Naval Surface Warfare Center</i>
S. E. Ferree	<i>ESAB Welding and Cutting Products</i>
G. L. Franke	<i>Naval Surface Warfare Center</i>
D. W. Haynie	<i>Kobelco Welding of America, Incorporated</i>
L. L. Kuiper	<i>Euroweld, Limited</i>
A. Y. Lau	<i>Canadian Welding Bureau</i>
R. Menon	<i>Stoody Company</i>
K. M. Merlo	<i>Edison Welding Institute</i>
T. C. Myers	<i>Oceaneering Intervention Engineering</i>
J. S. Ogborn	<i>The Lincoln Electric Company</i>
B. A. Pletcher	<i>CB&I, Incorporated</i>
M. F. Sinfield	<i>Naval Surface Warfare Center</i>
R. B. Smith	<i>Select-Arc</i>
R. A. Swain	<i>Euroweld, Limited</i>

Advisors to the AWS A5M Subcommittee on Carbon and Low-Alloy Steel Electrodes for Flux Cored Arc Welding and Metal Cored Electrodes for Gas Metal Arc Welding

J. E. Campbell	<i>WeldTech Solutions Corporation</i>
D. D. Childs	<i>Mark Steel Corporation</i>
K. K. Gupta	<i>Westinghouse Electric Corporation</i>
S. Imaoka	<i>Kobe Steel Limited</i>
W. E. Layo	<i>Midalloy</i>
D. R. Miller	<i>ABS</i>
M. P. Parekh	<i>Consultant</i>
M. A. Quintana	<i>The Lincoln Electric Company</i>
H. D. Wehr	<i>Arcos Industries, LLC</i>

Special Contributor

Janet Morse	<i>The Lincoln Electric Company</i>
-------------	-------------------------------------

Foreword

This foreword is not part of AWS A5.36/A5.36M:2012, *Specification for Carbon and Low-Alloy Steel Flux Cored Electrodes for Flux Cored Arc Welding and Metal Cored Electrodes for Gas Metal Arc Welding*, but is included for informational purposes only.

This specification combines the two specifications previously issued by the American Welding Society for the classification of carbon and low-alloy steel flux cored electrodes (AWS A5.20/A5.20M, *Specification for Carbon Steel Electrodes for Flux Cored Arc Welding*, and AWS A5.29/A5.29M, *Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding*). In addition, this specification includes provisions for the classification of carbon and low-alloy steel metal cored electrodes. Heretofore, carbon steel metal cored electrodes were classified under AWS A5.18/A5.18M, *Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding*, and low-alloy steel metal cored electrodes were classified under A5.28/A5.28M, *Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding*. The user should be advised that the requirements for low-alloy metal cored electrodes classified under this specification may vary somewhat from those prescribed in AWS A5.28/A5.28M. This document uses both U.S. Customary Units and the International System of Units (SI) throughout. The measurements are not exact equivalents; therefore, each system must be used independently of the other, without combining values in any way. In selecting rational metric units, AWS A1.1, *Metric Practice Guide for the Welding Industry*, and 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 new AWS A5.36/A5.36M specification utilizes two classification systems. The first of these is a “fixed classification system” which has been carried over to this specification from AWS A5.20/A5.20M or AWS A5.18/A5.18M, as applicable, for the classification of those carbon steel flux cored electrodes or carbon steel metal cored electrodes which, with the specific mechanical properties specified for them in AWS A5.20/A5.20M or AWS A5.18/A5.18M, have gained wide acceptance for single and multiple pass applications. The classification designations and requirements for these specific electrodes are unchanged from those previously specified in AWS A5.20/A5.20M or AWS A5.18/A5.18M. A listing of these electrodes with their requirements is given in Table 1.

This AWS A5.36/A5.36M specification also utilizes a new, “open classification system” which is introduced in this document for the classification of carbon and low-alloy steel flux cored and metal cored electrodes. The open classification system uses designators to indicate electrode type (Usability Designator), welding position capability, tensile strength, impact strength, shielding gas (with more options and new designations), condition of heat treatment, if any, and weld deposit composition. The change to an open classification system is being made to allow for the classification of flux cored and metal cored electrodes with classification options which (1) better define the performance capabilities of the advanced electrode designs that have been developed, and (2) reflect the application requirements of today’s marketplace. In addition, the provision has been made in this document for the classification of metal cored electrodes (usability Designator T15) and two new electrode types (Usability Designators T16 and T17) for the classification of metal cored and flux cored electrodes designed for use with AC power sources with or without modified waveforms. The EXXT-2X classification has been discontinued. Electrodes previously classified as EXXT-2X can now be classified under the new open classification system without requiring a unique “2” Usability Designator. The EXXT-13 electrode classification has been discontinued due to lack of commercial significance. For a complete listing of the affected existing electrode classifications and the corresponding equivalent classifications using the open classification system under AWS A5.36/A5.36M, refer to A9 in Annex A.

Two additional changes to note are (1) the fillet weld test, previously required under AWS A5.20/A5.20M and AWS A5.29/A5.29M (and also detailed in ISO 15792-3) is not a required test under AWS A5.36/A5.36M, and (2) the preheat

and interpass temperature requirements for the “D” optional, supplemental designator have been modified for better agreement with AWS D1.8/D1.8M, *Structural Welding Code—Seismic Supplement.*”

The A5.20/A5.20M:2005 specification being replaced is the fourth revision of the joint ASTM/AWS A5.20 document first issued in 1969. The A5.29/A5.29M:2005 specification being replaced is the third revision of AWS A5.29 that was introduced in 1980. The historical progressions of these two documents appear below:

Historical Background

AWS A5.20-69 ANSI W3.20-1973	<i>Specifications for Mild Steel Electrodes for Flux Cored Arc Welding</i>
ANSI/AWS A5.20-79	<i>Specification for Carbon Steel Electrodes for Flux Cored Arc Welding</i>
ANSI/AWS A5.20-95	<i>Specification for Carbon Steel Electrodes for Flux Cored Arc Welding</i>
AWS A5.20/A5.20M:2005	<i>Specification for Carbon Steel Electrodes for Flux Cored Arc Welding</i>
ANSI/AWS A5.29-80	<i>Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding</i>
ANSI/AWS A5.29: 1998	<i>Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding</i>
AWS A5.29/A5.29M:2005	<i>Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding</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.

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	3
4. Acceptance	9
5. Certification	12
6. Rounding-Off Procedure	12
7. Summary of Tests	13
8. Retest	15
9. Test Assemblies	17
10. Chemical Analysis	20
11. Radiographic Test	22
12. Tension Test	23
13. Bend Test	23
14. Impact Test	25
15. Diffusible Hydrogen Test	25
16. “D” and “Q” Optional Supplemental Designator Tests	26
17. Method of Manufacture	28
18. Standard Sizes	28
19. Finish and Uniformity	28
20. Standard Package Forms	28
21. Winding Requirements	28
22. Electrode Identification	28
23. Packaging	28
24. Marking of Packages	28
Annex A (Informative)—Guide to AWS <i>Specification for Carbon and Low-Alloy Steel Flux Cored Electrodes for Flux Cored Arc Welding and Metal Cored Electrodes for Gas Metal Arc Welding</i>	29
Annex B (Informative)—Guidelines for the Preparation of Technical Inquiries	49
AWS Filler Metal Specifications by Material and Welding Process	51
AWS Filler Metal Specifications and Related Documents	53

List of Tables

Table	Page No.
1 Electrode Classifications with Fixed Requirements	4
2 Tension Test Requirements	6
3 Charpy Impact Test Requirements	6
4 Electrode Usability Characteristics	7
5 Composition Requirements for Shielding Gases	9
6 Weld Metal Chemical Composition Requirements	10
7 Tests Required for Classification	12
8 Preheat, Interpass, and PWHT Temperatures	13
9 Mechanical Property Requirements for “D” and “Q” Optional Supplemental Designators	16
10 Procedure Requirements for “D” and “Q” Optional Supplemental Designators	16
11 Base Metal for Test Assemblies	21
12 Heat Input Requirements and Suggested Pass and Layer Sequence for Multiple Pass Electrode Classifications	22
13 Diffusible Hydrogen Limits for Weld Metal	26
A.1 Existing A5.20/A5.20M Classifications and Equivalent A5.36/A5.36M Classifications Utilizing the Open Classification System	41
A.2 Existing A5.29/A5.29M Classifications and Equivalent A5.36/A5.36M Classifications Utilizing the Open Classification System	42
A.3 Existing A5.18/A5.18M and A5.28/A5.28M Classifications and Equivalent A5.36/A5.36M Classifications Utilizing the Open Classification System	45

List of Figures

Figure	Page No.
1 A5.36/A5.36M Open Classification System	14
2 Test Assembly for Mechanical Properties and Soundness of Weld Metal for Welds made with Multiple-Pass Electrodes	18
3 Test Assembly for Transverse Tension and Longitudinal Guided Bend Tests for Welds made with Single-Pass Electrodes	19
4 Pad for Chemical Analysis of Deposited Weld Metal	20
5 Radiographic Standard for Test Assembly in Figure 2	24