CSA Group

W48-18

Filler metals and allied materials for metal arc welding

Legal Notice for Standards

Canadian Standards Association (operating as "CSA Group") develops standards through a consensus standards development process approved by the Standards Council of Canada. This process brings together volunteers representing varied viewpoints and interests to achieve consensus and develop a standard. Although CSA Group administers the process and establishes rules to promote fairness in achieving consensus, it does not independently test, evaluate, or verify the content of standards.

Disclaimer and exclusion of liability

This document is provided without any representations, warranties, or conditions of any kind, express or implied, including, without limitation, implied warranties or conditions concerning this document's fitness for a particular purpose or use, its merchantability, or its non-infringement of any third party's intellectual property rights. CSA Group does not warrant the accuracy, completeness, or currency of any of the information published in this document. CSA Group makes no representations or warranties regarding this document's compliance with any applicable statute, rule, or regulation.

IN NO EVENT SHALL CSA GROUP, ITS VOLUNTEERS, MEMBERS, SUBSIDIARIES, OR AFFILIATED COMPANIES, OR THEIR EMPLOYEES, DIRECTORS, OR OFFICERS, BE LIABLE FOR ANY DIRECT, INDIRECT, OR INCIDENTAL DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES, HOWSOEVER CAUSED, INCLUDING BUT NOT LIMITED TO SPECIAL OR CONSEQUENTIAL DAMAGES, LOST REVENUE, BUSINESS INTERRUPTION, LOST OR DAMAGED DATA, OR ANY OTHER COMMERCIAL OR ECONOMIC LOSS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE), OR ANY OTHER THEORY OF LIABILITY, ARISING OUT OF OR RESULTING FROM ACCESS TO OR POSSESSION OR USE OF THIS DOCUMENT, EVEN IF CSA GROUP HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES.

In publishing and making this document available, CSA Group is not undertaking to render professional or other services for or on behalf of any person or entity or to perform any duty owed by any person or entity to another person or entity. The information in this document is directed to those who have the appropriate degree of experience to use and apply its contents, and CSA Group accepts no responsibility whatsoever arising in any way from any and all use of or reliance on the information contained in this document.

CSA Group is a private not-for-profit company that publishes voluntary standards and related documents. CSA Group has no power, nor does it undertake, to enforce compliance with the contents of the standards or other documents it publishes.

Intellectual property rights and ownership

As between CSA Group and the users of this document (whether it be in printed or electronic form), CSA Group is the owner, or the authorized licensee, of all works contained herein that are protected by copyright, all trade-marks (except as otherwise noted to the contrary), and all inventions and trade secrets that may be contained in this document, whether or not such inventions and trade secrets are protected by patents and applications for patents. Without limitation, the unauthorized use, modification, copying, or disclosure of this document may violate laws that protect CSA Group's and/or others' intellectual property and may give rise to a right in CSA Group and/or others to seek legal redress for such use, modification, copying, or disclosure. To the extent permitted by licence or by law, CSA Group reserves all intellectual property rights in this document.

Patent rights

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. CSA Group shall not be held responsible for identifying any or all such patent rights. Users of this standard are expressly advised that determination of the validity of any such patent rights is entirely their own responsibility.

Authorized use of this document

This document is being provided by CSA Group for informational and non-commercial use only. The user of this document is authorized to do only the following:

If this document is in electronic form:

- load this document onto a computer for the sole purpose of reviewing it;
- search and browse this document; and
- print this document if it is in PDF format.

Limited copies of this document in printed or paper form may be distributed only to persons who are authorized by CSA Group to have such copies, and only if this Legal Notice appears on each such copy.

In addition, users may not and may not permit others to

- alter this document in any way or remove this Legal Notice from the attached standard;
- sell this document without authorization from CSA Group; or
- make an electronic copy of this document.

If you do not agree with any of the terms and conditions contained in this Legal Notice, you may not load or use this document or make any copies of the contents thereof, and if you do make such copies, you are required to destroy them immediately. Use of this document constitutes your acceptance of the terms and conditions of this Legal Notice.

CSA Group

Standards Update Service

W48-18
January 2018

Title: *Filler metals and allied materials for metal arc welding*

To register for e-mail notification about any updates to this publication
- go to **shop.csa.ca**
- click on **CSA Update Service**

The **List ID** that you will need to register for updates to this publication is **24253**.

If you require assistance, please e-mail **techsupport@csagroup.org** or call 416-747-2233.

Visit CSA Group's policy on privacy at **www.csagroup.org/legal** to find out how we protect your personal information.

W48-18

Filler metals and allied materials for metal arc welding

Published in January 2018 by CSA Group
A not-for-profit private sector organization
178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3

*To purchase standards and related publications, visit our Online Store at **shop.csa.ca***
or call toll-free 1-800-463-6727 or 416-747-4044.

ISBN 978-1-4883-0869-7

Contents

Technical Committee on Welding Filler Metals

T. Van Loon	SELECT-SAI Inc., Green Valley, Ontario *Category: Producer Interest*	*Chair*
N. LaCarte	North American NDT Services, Charlton, Ontario *Category: User Interest*	*Vice-Chair*
R. Perry	Lincoln Electric Company of Canada LP, Toronto, Ontario *Category: Producer Interest*	*Vice-Chair*
V. Andrisani	Omniweld Integrated Solutions, Burlington, Ontario	*Associate*
N. Armstrong	ESAB Group Canada Inc., Mississauga, Ontario *Category: Producer Interest*	
C. Blackmore	Husky Oil Operations Limited, Carstairs, Alberta *Category: General Interest*	
A. Boulianne	CWB Group, Milton, Ontario	*Associate*
J.E. Braid	Ottawa, Ontario *Category: General Interest*	
J.G. Galloway	Conestoga College, Cambridge, Ontario *Category: General Interest*	
R. Gupta	American Welding Society, Miami, Florida, USA	*Associate*
D. Kotecki	Damian Kotecki Welding Consultants, Inc., Chapel Hill, North Carolina, USA *Category: General Interest*	

J. Kowalchuk	CWB Group, Milton, Ontario	*Associate*
G. Mills	Lincoln Electric Company of Canada LP, Toronto, Ontario	*Associate*
G.C. Poon	G. Poon and Associates, Mississauga, Ontario *Category: User Interest*	
J.L. Smith	Services en Soudage Joseph Lester Smith Welding Services, L'Epiphanie, Québec *Category: User Interest*	
S. McDiarmid	CSA Group, Toronto, Ontario	*Project Manager*

Preface

This is the fourth edition of CSA W48, *Filler metals and allied materials for metal arc welding*. It supersedes the previous editions, published in 2014, 2006, and 2001.

Filler metals standards are intended to provide a generic method of classification and evaluation that allows the end-user to select appropriate welding consumables for a given welding process and product or application. The procedures and tests set out in this Standard, when correctly followed, are designed to produce a consistent product with test results that are as reproducible as possible.

Non-mandatory annexes in this Standard provide general information and an explanation of the classification system (Annexes B and C); descriptions and intended uses of the welding filler metals and allied materials (Annexes D, E, F, G, and H); information on storage and conditioning of electrodes (Annex I); and information on diffusible hydrogen (Annex J).

This Standard was prepared by the Technical Committee on Welding Filler Metals, under the jurisdiction of the Strategic Steering Committee on Construction and Infrastructure, and has been formally approved by the Technical Committee.

Notes:

1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
3) *This Standard was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
4) *To submit a request for interpretation of this Standard, please send the following information to inquiries@csagroup.org and include "Request for interpretation" in the subject line:*
   a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
   b) *provide an explanation of circumstances surrounding the actual field condition; and*
   c) *where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.*

   Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization *and are available on the* Current Standards Activities *page at* ***standardsactivities.csa.ca****.*
5) *This Standard is subject to review within five years from the date of publication. Suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line:*
   a) *Standard designation (number);*
   b) *relevant clause, table, and/or figure number;*
   c) *wording of the proposed change; and*
   d) *rationale for the change.*

W48-18
Filler metals and allied materials for metal arc welding

0 Introduction

The first edition of a Canadian standard for welding consumables was published in 1938 as Canadian Engineering Standards Association (CESA) Tentative Standard S48T (CESA became the Canadian Standards Association in 1944). It covered shielded metal arc welding (SMAW) electrodes for mild and low alloy steels. Together with two other Standards, CESA W47, *Welding Qualification Code for the Application to Fabricating and Contracting Firms, Their Welding Personnel and Equipment*, and CESA W59, *Welding of Bridges, Buildings and Machinery*, it was designed to cover all aspects of the welding of structural steels. However, the advent of World War II prevented the adoption of these Standards.

Weld quality depends to a very large degree on the skill and training of the personnel directly involved in welding operations, and usually cannot be determined by visual inspection methods. For this reason, many municipal authorities and design engineers had reservations about using welding in the many projects that were necessary for growth after the cessation of hostilities. The Canadian Institute of Steel Construction (CISC) was aware of the advantages of welding over other forms of joining. As a result, CISC promoted a program that would provide third-party verification of a company's competency to undertake welding of steel structures. This development culminated in the revision (published in 1947) and adoption (through CSA S16) of new versions of CSA W47, CSA W48, and CSA W59. In January 1947, the Canadian Welding Bureau (CWB) was inaugurated for the purpose of qualifying Canadian organizations and operators engaged in welding operations in structural steel and mechanical fields, and the consumables used by them. This innovation proved so popular that the application of these Standards has expanded to many areas outside the originally intended field.

Following publication in 1947, further revisions of the CSA W48 series of Standards were published to acknowledge the many strides made in the manufacture and application of welding consumables. In the early 1950s, it was decided that one standard was insufficient to cover the many types of electrodes available, and CSA W48.1 and CSA W48.2 were published in 1952 and 1953, respectively. Further revisions were made as follows: CSA W48.1 was revised in 1962, 1969, 1976, 1980, and 1991; CSA W48.2 was revised in 1977, 1980, and 1992; CSA W48.3 was first published in 1968 and revised in 1976, 1982, and 1993; CSA W48.4 was first published in 1970 and revised in 1978 and 1995; CSA W48.5 was first published in 1970 and revised in 1982 and 1990; and CSA W48.6 was first published in 1970 and revised in 1980 and 1996.

The first edition of W48-01 consolidated and superseded the previous CSA W48 series of Standards (CSA W48.1 to CSA W48.6) and contained several technical changes, including changes intended to harmonize with other regional and international standards. During preparation, close liaison was maintained between the American Welding Society (AWS), International Institute of Welding (IIW), and International Organization for Standardization (ISO). The Technical Committee was also in contact with other organizations, such as the European Committee for Standardization (CEN) and the Japan Welding Engineering Society (JWES).

In W48-06 classification requirements for solid wire gas metal arc consumables were replaced by references to CAN/CSA-ISO 14341. Annex A provides classification equivalencies for the first edition of this Standard.

In W48-14 all specifications and classifications related to carbon steel electrodes for flux-cored arc welding and metal-cored arc welding were replaced by the addition of references to AWS A5.36/A5.36M. Annex M provides classification equivalencies for electrodes with fixed requirements under AWS A5.36/A5.36M and the 2006 edition of this Standard.

In this edition, all specifications and classifications related to chromium and chromium-nickel steel electrodes for shielded metal arc welding (SMAW) have been replaced by references to AWS A5.4/A5.4M. Specifications and classifications related to chromium and chromium-nickel steel electrodes for gas-shielded metal arc welding (GMAW), gas tungsten arc welding (GTAW), and submerged arc welding (SAW) have been added by including references to AWS A5.9/A5.9M. Specifications and classifications related to chromium and chromium-nickel steel electrodes for FCAW and MCAW have been added by including references to AWS A5.22/A5.22M and A5.9/A5.9M as appropriate. Specifications and classifications related to carbon steel rods and deposits specifically for GTAW and plasma arc welding (PAW) have been added by including references to AWS A5.18/A5.18M. Specifications and classifications related to low alloy steel rods and deposits specifically for GTAW and PAW have been added by including references to AWS A5.28/A5.28M. Specifications related to low alloy steel FCAW and MCAW electrodes have been added as specified in AWS A5.36/A5.36M.

1 Scope

1.1

This Standard specifies requirements for the classification and certification of

a) carbon steel covered electrodes for shielded metal arc welding (SMAW);
b) chromium and chromium-nickel steel covered electrodes for SMAW, including electrodes designated for welding heat-resistant steels containing more than 11% chromium and less than 50% nickel, as specified in Clause 1.2;
c) low alloy steel covered electrodes for SMAW;
d) wire electrodes and deposits for gas-shielded metal arc welding (GMAW) of non-alloy and fine-grain steels, as specified in Clause 1.3;
e) wire electrodes, rods, and deposits for GMAW, gas tungsten arc welding (GTAW), and submerged arc welding (SAW) of chromium and chromium-nickel steel, as specified in Clause 1.4
f) wire rods and deposits for GTAW and plasma arc welding (PAW) of carbon and low alloy steels, as specified in Clause 1.5;
g) carbon and low alloy steel electrodes for flux-cored arc welding (FCAW) and metal-cored arc welding (MCAW), as specified in Clause 1.6;
h) chromium and chromium-nickel steel electrodes for FCAW and MCAW, as specified in Clause 1.7;
i) fluxes and solid carbon steel electrodes for SAW; and
j) fluxes and composite carbon steel electrodes for SAW.

1.2

Covered electrodes and deposits for SMAW of chromium and chromium-nickel steel are classified and CWB approved using the designations and classification requirements specified in AWS A5.4/A5.4M. Package marking is specified in Clause 8.1.

1.3
Wire electrodes and deposits for GMAW of non-alloy and fine-grain steels are classified and CWB approved using the designations and classification requirements specified in CAN/CSA-ISO 14341 for strength levels up to 550 MPa. For strength levels above 620 MPa, AWS A5.28/A5.28M is used for classification requirements and testing. The procedures and conditions for required tests, including radiographic test requirements, are specified in Clause 7. Package marking is specified in Clause 8.1.

1.4
Wire electrodes and deposits for GMAW, GTAW, and SAW of chromium and chromium-nickel steel are classified and CWB approved using the designations and classification requirements specified in AWS A5.9/A5.9M. Package marking is specified in Clause 8.1.

1.5
Wire rods and deposits specifically for GTAW and PAW of carbon and low alloy steels are classified and CWB approved using the designations and classification requirements specified in AWS 5.18/A5.18M and AWS A5.28/A5.28M. Package marking is specified in Clause 8.1.

1.6
Wire electrodes and deposits for carbon and low alloy steel FCAW and MCAW electrodes are classified and CWB approved using the designations and classification requirements specified in AWS A5.36/A5.36M, and the requirements of Annex M of this Standard. Package marking is specified in Clause 8.1.

1.7
Wire electrodes and deposits for FCAW and MCAW of chromium and chromium-nickel steel are classified and CWB approved using the designations and classification requirements specified in AWS A5.22/A5.22M. For chemical analysis of MCAW, chromium and chromium-nickel steel electrodes the requirements for single diameter testing defined in AWS A5.9/A5.9M is acceptable. Package marking is specified in Clause 8.1.

1.8
The filler metals and allied materials covered by this Standard are classified in accordance with requirements based on one or more of the following criteria:

a) chemical composition;
b) usability characteristics;
c) type of covering (for covered electrodes);
d) diffusible hydrogen in weld metal (hydrogen-controlled classifications);
e) mechanical properties of weld metal (including heat treatment condition); and
f) positions of welding for which electrodes are suitable.

The clause and table references for the classification requirements for each consumable type specified in Clause 1.1 are as follows:

Classification*	SMAW			GMAW	GMA-W / GTA-W / SAW	GTA-W / PAW	FCAW and MCAW		SAW	
	a)†	b)†	c)†	d)†	e)†	f)†	g)†	h)†	i)†	j)†
Chemical composition of undiluted weld metal	Table 1	Clause 1.2	Table 2		Clause 1.4	Clause 1.5	Clause 1.6	Clause 1.7	—	Table 4
Chemical composition of solid wires	—	—	—	Clause 1.3	Clause 1.4	Clause 1.5	—	—	Table 3	—
Usability and type of covering	Table 5	Clause 1.2	Table 6	—	—	—	—	—	—	—
Usability characteristics	—	—	—	—	—	—	Clause 1.6	Clause 1.7	—	—
Mechanical properties of weld metal	Table 7	Clause 1.2	Table 8	Clause 1.3	—	Clause 1.5	Clause 1.6	Clause 1.7	Table 9	Table 9
Diffusible hydrogen in weld metal	Clauses 7.13.3 and 7.13.4	—	Clauses 7.13.3 and 7.13.4	Clause 1.3	—	—	Clause 1.6	—	Clause 7.13.1 (optional)	Clause 7.13.1 (optional)
Heat treatment condition	—	Clause 1.2	Clause 7.4.3	Clause 1.3	—	Clause 7.4.3	Clause 7.4.3	Clause 7.4.3	Clause 7.4.3	Clause 7.4.3
Position of welding	Table 10	Clause 1.2	Table 10	Clause 1.3	Clause 1.4	Clause 1.5	Clause 1.6	See Clause 1.7	—	—

* *Refer to Table 13 for required tests.*
† *The letters in parentheses correspond to the items in Clause 1.1.*

Note: *These requirements are not intended to preclude the use of electrodes or fluxes, or both, classified in this Standard with any other process or any other shielding gas, combination of shielding gases, or flux for which they are found suitable.*

1.9

This Standard does not allow an electrode certified under one classification to be certified under another classification for the same welding process, with the following exceptions:

a) For SAW:
   i) A composite electrode may be certified under different classifications in combination with different fluxes.
   ii) Fluxes may be classified under any number of classifications, for weld metal in either or both the as-welded and post-weld heat-treated conditions, or using different electrode classifications.

b) For FCAW and MCAW:
   i) E49XT-12C may also be listed as E49XT-9C and E49XT-1C.
   ii) E49XT-9C may also be listed as E49XT-1C.
   iii) E49C-6 may also be listed as E49C-3.
   iv) E49XT-12M may also be listed as E49XT-9M and E49XT-1M.

v) E49XT-9M may also be listed as E49XT-1M.
vi) E49XT-XC may also be listed as E49XT-XM, or vice versa, provided the electrode meets the requirements of both classifications.

c) For chromium and chromium-nickel steel covered electrodes, materials classified under one classification may be classified under any other classification of AWS A5.4/A5.4M, provided they meet all the requirements for those classifications, except that a material may not be classified under more than one of the following: EXXX-15, EXXX-16, EXXX-17, or EXXX-26 designations.
d) For wire electrodes and deposits for GMAW of non-alloy and fine-grain steel, materials classified under one classification on the "A" side may be classified under another classification on the "B" side, and vice versa, as allowed by CAN/CSA-ISO 14341.
e) Electrodes and wire flux combinations where the only differences are in the hydrogen designators.
f) For wire electrodes, rods, and deposits for GMAW, GTAW, and SAW of chromium and chromium-nickel steel, materials classified under one classification may be classified under any other classification of AWS A5.9/A5.9M, provided they meet all the requirements for those classifications.
g) For wire electrodes and deposits for FCAW and MCAW of chromium and chromium-nickel steel, materials classified under one classification may be classified under another classification of AWS A5.22/A5.22M on the basis of carbon content and shielding gas provided that they meet all of the requirements for those classifications.

1.10

For purposes of determining compliance with the requirements of this Standard, the actual test values obtained are to be subjected to the rounding off rules of ISO 80000-1, Clause B.3, Rule A. If the measured values are obtained by equipment calibrated in units other than those of this Standard, the measured values are converted to the units of this Standard before rounding. If an arithmetic average value is to be compared to the requirements of this Standard, rounding is to be done only after calculating the arithmetic average. If a test method used in this Standard contains instructions for rounding that conflict with the instructions of this Standard, the rounding requirements of the test method will apply. The rounded results will satisfy the requirements of the appropriate table for the classification under test.

1.11

This Standard does not address safety associated with welding and welding practices.

Note: *CAN/CSA-W117.2 addresses safety in welding and should be followed in addition to applicable workplace health and safety legislation. It is the responsibility of the users of this Standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.12

In this Standard, "shall" is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the Standard; "should" is used to express a recommendation or that which is advised but not required; and "may" is used to express an option or that which is permissible within the limits of the Standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

1.13

The values given in SI units are the units of record for the purposes of this Standard. The values given in Annex L are for information and comparison only.

1.14

The metric version of AWS Standards are used to certify consumables (for example A5.4M), except for wire diameter tolerances (see Clause 5.2.5).

2 Reference publications

This Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below, including all amendments published thereto.

Note: *See Annex N for additional publications.*

CSA Group

CAN/CSA-ISO 9001:16
Quality management systems — Requirements

CAN/CSA-ISO 14341:06
Welding consumables — Wire electrodes and deposits for gas shielded metal arc welding of non alloy and fine grain steels — Classification

CAN/CSA-ISO 14341:11 (R2016)
Wire electrodes and weld deposits for gas shielded metal arc welding of non alloy and fine grain steels — Classification

G40.20-13/G40.21-13
General requirements for rolled or welded structural quality steel/Structural quality steel

W47.1-09 (R2014)
Certification of companies for fusion welding of steel

W59-13
Welded steel construction (metal arc welding)

CAN/CSA-W117.2-12
Safety in welding, cutting, and allied processes

Z234.1-00 (withdrawn)
Metric practice guide

ASM International

ASM handbook, Vol. 6: Welding, brazing, and soldering (1993)

