



Specification for the Welding of Hydraulic Cylinders



American Welding Society®



**AWS D14.9/D14.9M:2013
An American National Standard**

**Approved by the
American National Standards Institute
October 30, 2012**

Specification for the Welding of Hydraulic Cylinders

1st Edition

Prepared by the
American Welding Society (AWS) D14 Committee on Machinery and Equipment

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

Abstract

This specification provides standards for the design and manufacture of pressure containing welded joints and structural welded joints used in the manufacture of hydraulic cylinders. Manufacturer's responsibilities are presented as they relate to the welding practices that have been proven successful within the industry in the production of hydraulic cylinders. Included are sections defining welding procedure qualification, welding performance qualification, workmanship and quality requirements as well as inspection requirements and repair requirements.



American Welding Society®

International Standard Book Number: 978-0-87171-831-0
American Welding Society
8669 Doral Blvd., Suite 130, Doral, FL 33166
© 2013 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 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 new editions. This standard may also be corrected through publication of amendments or errata, or supplemented by publication of addenda. Information on the latest editions of AWS standards including amendments, errata, and addenda is 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.

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

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, 8669 Doral Blvd., Suite 130, Doral, FL 33166 (see Annex F). 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 D14 Committee on Machinery and Equipment. 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 D14 Committee on Machinery and Equipment 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 D14 Committee on Machinery and Equipment 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, 8669 Doral Blvd., Suite 130, Doral, FL 33166.

This page is intentionally blank.

Personnel

AWS D14 Committee on Machinery and Equipment

T. J. Landon, Chair	<i>Chicago Bridge & Iron Company</i>
L. L. Schweinegruber, 1st Vice Chair	<i>Consultant</i>
B. K. Banzhaf, 2nd Vice Chair	<i>CNH America LLC</i>
E. H. Abrams, Secretary	<i>American Welding Society</i>
D. B. Ashley	<i>Hartford Steam Boiler</i>
T. J. Bruno	<i>Link-Belt Construction</i>
J. E. Campbell	<i>WeldTech Solutions Corporation</i>
D. J. Landon	<i>Vermeer Corporation</i>
R. Larsen	<i>John Deere Des Moines Works</i>
J. D. Slipke	<i>Rosenboom Machine & Tool, Incorporated</i>
W. A. Svekric	<i>Welding Consultants, Incorporated</i>
J. L. Warren	<i>CNH America LLC</i>
E. G. Yevick	<i>Weld-Met International Group</i>

Advisors to the AWS D14 Committee on Machinery and Equipment

M. D. Bell	<i>Preventive Metallurgy</i>
P. Collins	<i>WeldCon Engineering</i>
R. T. Hemzacek	<i>Consultant</i>
B. D. Horn	<i>Consultant</i>
D. J. Malito	<i>Girard Machine Company, Incorporated</i>
M. R. Malito	<i>Girard Machine Company, Incorporated</i>
D. C. Martinez	<i>Consultant</i>
H. W. Mishler	<i>Consultant</i>
J. G. Nelson	<i>Northrop Grumman</i>
A. R. Olsen	<i>ARO Testing, Incorporated</i>
P. J. Palzkill	<i>Consultant</i>

AWS D14I Subcommittee for the Welding of Hydraulic Cylinders

B. K. Banzhaf, Chair	<i>CNH America LLC</i>
J. D. Slipke, Vice Chair	<i>Rosenboom Machine & Tool, Incorporated</i>
E. H. Abrams, Secretary	<i>American Welding Society</i>
F. D. Borns	<i>Terex</i>
J. E. Campbell	<i>WeldTech Solutions Corporation</i>
J. A. Geelhoed	<i>Seabee Cylinders, a Ligon Company</i>
D. J. Landon	<i>Vermeer Corporation</i>
R. Larsen	<i>John Deere Des Moines Works</i>
J. Price	<i>Thompson Friction Welding</i>
B. D. Rosenboom	<i>Rosenboom Machine & Tool, Incorporated</i>
J. L. Warren	<i>CNH America LLC</i>
E. G. Yevick	<i>Weld-Met International Group</i>

Advisors to the AWS D14I Subcommittee for the Welding of Hydraulic Cylinders

R. A. Anderson	<i>Scot Industries</i>
M. D. Bell	<i>Preventive Metallurgy</i>
A. R. Olsen	<i>ARO Testing Incorporated</i>
M. H. Schultz	<i>Oilgear, Incorporated</i>
P. W. Subtelny	<i>Phelps Dodge Mining Corporation</i>

This page is intentionally blank.

Foreword

This foreword is not part of AWS D14.9/D14.9M:2013, *Specification for the Welding of Hydraulic Cylinders*, but is included for informational purposes only.

This specification reflects the welding processes and practices employed by manufacturers within the industry and it incorporates various methods which have been proven successful by individual manufacturers. No restrictions are placed on the use of any welding process or procedure, provided the weld produced meets the qualification requirements of this specification. No attempt is made to limit or restrict technological progress in the welding of hydraulic cylinders, nor should any such limitation be inferred.

This page is intentionally blank.

Table of Contents

	Page No
<i>Personnel</i>	v
<i>Foreword</i>	vii
<i>List of Tables</i>	xi
<i>List of Figures</i>	xi
1. Scope and General Provisions	1
1.1 Scope	1
1.2 Units of Measure	1
1.3 Safety	1
1.4 Symbols	2
2. Normative References	2
2.1 AWS Standards	2
2.2 CSA Standards	2
3. Terms and Definitions	2
4. Base Materials	3
4.1 Ferrous and Nonferrous Metals	3
4.2 Properties	3
5. Welding Consumables	3
5.1 Shielding Gases	3
5.2 Filler Metals, Consumable Inserts and Fluxes	4
6. Weld Joint Design	4
7. Welding Process Controls	7
7.1 Welding Procedure Qualification	7
7.2 Welding Performance Qualification	13
7.3 Welding Equipment Qualification	23
7.4 Welding Process Audits	24
8. Workmanship and Quality Requirements	25
8.1 Scope	25
8.2 General Requirements	25
8.3 Equipment	25
8.4 Preparation of Materials	25
8.5 Assembly	25
8.6 Preheat	27
8.7 Arc Strikes	27
8.8 Cleaning of Welds	27
8.9 Peening	28
8.10 Stress Relief	28
8.11 Quality of Welds	28
8.12 Repair of Weld Defects	30

9. Quality Assurance 31

10. Repair and Modification 32

Annex A (Informative)—Commonly Used Welding Processes and Hydraulic Cylinder Component Nomenclature . . . 33

Annex B (Informative)—Preheat and Postweld Heat Treatment Recommendations 37

Annex C (Informative)—Recommended Practices for Storage and Treatment of Electrodes and Fluxes 41

Annex D (Informative)—Magnetism, a cause of Arc Blow 45

Annex E (Informative)—Informative References 47

Annex F (Informative)—Guidelines for the Preparation of Technical Inquiries. 49

List of Tables

Table	Page No.
1	Effective Weld Sizes of Flare Groove Welds 7
2	Qualification and WPS Data for Welding Procedure Qualification 14
3	Qualification Variables for Welding Performance Qualification 20
4	Minimum Fillet Weld Size for Small Diameter Studs 24
C.1	Electrodes Covered by AWS A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding. 42
C.2	Electrodes Covered by AWS A5.5/A5.5M, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding. 42

List of Figures

Figure	Page No.
1	Fillet Weld Symbol for Groove Width Less Than or Equal to 3/32" [2.5 mm] 4
2	Non-Standard Welding Symbol for Combination Weld Types 5
3	Non-Standard Welding Symbol for Combination J and Single Bevel Groove. 7
4	Typical Location for Cross-Sections in an End Cap Weld 9
5	Typical Location of Cross-Sections for Rod Welds with Groove Width Less than 3/32" [2.5 mm] 10
6	Typical Location of Cross-Sections for Rod Welds with Groove Width 3/32" [2.5 mm] and Greater 10
7	Typical Location for Cross-Sections in a Port Weld. 11
8	Micro-Hardness Locations 12
9	Fillet Weld Break Specimen—Tack Welder Qualification. 21
10	Method for Rupturing Specimen—Tack Welder Qualification 22
11	Groove Weld Break Specimen—Tack Welder 22
12	Method of Evaluating Tack Welder Qualification for Grooves 23
13	Flat Based Port Design on Round Tube 26
14	Coped Port Design 26
15	Spot Faced Port Design 27
16	Acceptable and Unacceptable Weld Profiles 29
A.1	Hydraulic Cylinder Component Nomenclature. 36

This page is intentionally blank.

Specification for the Welding of Hydraulic Cylinders

1. Scope and General Provisions

1.1 Scope

1.1.1 This specification provides requirements for the design and manufacture of welded joints of hydraulic cylinders. When specified in the purchasing documents, compliance with all the requirements shall be required. This specification does not apply to the manufacture of welded tubing used for hydraulic cylinders which is covered under ASTM and other recognized specifications. This specification does not specify load determination, design assumptions, safety factors, or calculation methods for non-weld related areas of the hydraulic cylinder.

1.1.2 The Manufacturer's adherence to this specification shall include responsibility for the following:

- (1) welding, as defined in 1.1.1, in accordance with this specification;
- (2) producing welds as designated on drawings by appropriate symbols and notes, with sufficient detail to show joint preparation compatible with applied processes;
- (3) providing written welding procedure specifications (WPSs);
- (4) recording and maintaining results of all welding procedure and welder performance qualification tests;
- (5) controlling use of designated base metals and welding consumables;
- (6) inspecting the welds to the requirements of this specification;
- (7) having a welding quality program in place. The requirements of AWS B5.17, *Specification for the Qualification of Welding Fabricators* may be used as a guide in establishing this welding quality program. Accreditation of quality systems of welding fabricators may be obtained through the AWS Certified Welding Fabricator (CWF) or equivalent programs.

1.2 Units of Measure. This specification makes use of both U.S. Customary Units and the International System of Units (SI). The measurements may not be exact equivalents; therefore each system must be used independently of the other without combining them in any way. The specification with the designation D14.9 uses U.S. Customary Units. The specification D14.9M uses SI Units. The latter are shown in appropriate columns in tables and figures or within brackets [] when used in the text. Detailed dimensions on figures are in inches. A separate tabular form that relates the U.S. Customary Units with SI units may be used in tables and figures.

1.3 Safety. Safety and health issues and concerns are beyond the scope of this standard, and therefore are not fully addressed herein. Safety and health information is available from the following sources:

American Welding Society:

- (1) ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*
- (2) AWS Safety and Health Fact Sheets
- (3) Other safety and health information on the AWS website

Material or Equipment Manufacturers:

- (1) Material Safety Data Sheets supplied by materials manufacturers
- (2) Operating Manuals supplied by equipment manufacturers