AWS D14.9/D14.9M:2026
An American National Standard

# Specification for the Welding of Hydraulic Cylinders




American Welding Society®



**AWS D14.9/D14.9M:2026**
**An American National Standard**

**Approved by the**
**American National Standards Institute**
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# Specification for the Welding of Hydraulic Cylinders

**3rd Edition**

**Revises AWS D14.9/D14.9M:2022-AMD1**

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 clauses defining procedure qualification, performance qualification, workmanship and quality requirements as well as inspection requirements and repair requirements.

American Welding Society®

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# Foreword

This foreword is not part of this standard 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 is the third edition of AWS D14.9/D14.9M, *Specification for the Welding of Hydraulic Cylinders*. This third edition includes:

- Addition of 1.4 Responsibilities
- Addition of 1.5 Qualifications
- Addition of Design, Manufacturing, and Inspection Authorities
- Revised Figures 6.2(A) – (D)
- New Figures 7.6 to 7.10

All errata to a standard shall be published in the *Welding Journal* and posted on the AWS website.

A vertical line in the margin or underlined text in clauses, tables, or figures indicates a technical or significant change from the previous edition.

Comments and suggestions for the improvement of this standard are welcome. They should be sent to the Secretary, AWS D14 Committee on Machinery and Equipment, American Welding Society, 8669 NW 36th St #130, Miami, FL 33166.

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# Specification for the Welding of Hydraulic Cylinders

## 1. General Requirements

**1.1 Scope.** This specification provides requirements for the design and manufacture of welded joints of hydraulic cylinders. When specified in the contract 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.

**1.2 Units of Measure.** This standard makes use of both U.S. Customary Units and the International System of Units (SI). The latter are shown within brackets ([ ]) or in appropriate columns in tables and figures. The measurements may not be exact equivalents; therefore, each system must be used independently.

**1.3 Safety.** Safety and health issues and concerns are beyond the scope of this standard, and therefore are not 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) Safety Data Sheets (SDSs) supplied by materials manufacturers

(2) Operating Manuals supplied by equipment manufacturers

Applicable Regulatory Agencies:

Work performed in accordance with this standard may involve the use of materials that have been deemed hazardous, and may involve operations or equipment that may cause injury or death. This standard does not purport to address all safety and health risks that may be encountered. The user of this standard should establish an appropriate safety program to address such risks as well as to meet applicable regulatory requirements. ANSI Z49.1 should be considered when developing the safety program.

**1.4 Responsibilities.** As demonstrated in Table 1.1, the Design, Manufacturing, and Inspection Authority may all reside with one company or separate companies. The division of responsibilities and/or deviations from this practice shall be specified in contract documents. The following entities shall be responsible, at a minimum, for the listed activities:

**1.4.1** The Design Authority shall specify the following on design documents:

**(1)** Full details of the required welds, including the type, size, and length.

**(2)** The base metals to be used (see 4.1).

**(3)** Whether the cylinder design is for high cycle or low cycle application (see Clause 3, Terms and Definitions).

**1.4.2** The Design Authority shall specify the following in Contract Documents, when applicable:

**(1)** Provisions for low temperature operations.

**(2)** Provisions for high temperature operations.

**(3)** Provisions for corrosive environments.

**(4)** NDE requirements not addressed by this specification (see 8.11.2).

**(5)** When testing is required to verify the effective weld size (see 6.5).

**(6)** All requirements that add to, subtract from, or otherwise modify the requirements of this specification.

**1.4.3** The Manufacturing Authority shall:

**(1)** Have a quality system in place that addresses welding. The requirements of AWS B5.17, *Specification for the Qualification of Welding Fabricators*, or ISO 3834, *Quality requirements for fusion welding of metallic materials*, may be used as a guide in establishing this quality program. Accreditation of quality systems of welding fabricators may be obtained through the AWS Certified Welding Fabricator (CWF) or equivalent programs.

**(2)** Produce welds meeting the requirements of this specification and as designated on drawings (see Clause 8).

**(3)** Provide and follow written welding procedure specifications (WPSs) (see 7.1).

**(4)** Ensure that qualified welders, welding operators, and Operators of Automatic Welding Equipment are used to make welds (see 7.2).

**(5)** Record and maintain the results of all welding procedure qualification and welder performance qualification tests (see 7.1 and 7.2).

**(6)** Control the use of designated base metals and consumables (see Clauses 4 and 5).

**1.4.4** The Inspection Authority shall:

**(1)** Ensure inspection personnel are qualified in accordance with 1.5.3.

**(2)** Ensure inspection requirements are met in accordance with this specification and contract documents.

**(3)** Ensure visual inspection is conducted in accordance with 8.11.

**(4)** Ensure NDE technicians are qualified and that data is interpreted by a qualified person in accordance with 1.5.3.

**(5)** Ensure welds are made in accordance with the proper welding procedure and by a welder qualified for that procedure (see Clause 7).

**1.4.5** The Inspection Authority shall be responsible for NDE not addressed by this specification per 1.4.2 (4), when applicable.

**Table 1.1**
**Examples of Typical Division of Responsibilities**

| # | Title | Description | Design Authority | Manufacturing Authority | Inspection Authority |
|---|---|---|---|---|---|
| 1 | Stock Hydraulic Cylinder | Hydraulic cylinder manufacturer designs and manufactures standard hydraulic cylinders or sub-components. | Hydraulic cylinder manufacturer | Hydraulic cylinder manufacturer | Hydraulic cylinder manufacturer |
| 2 | Custom Hydraulic Cylinder | Collaborative design between the Owner/customer/OEM and the hydraulic cylinder manufacturer. | Shared responsibility as agreed upon between Owner/customer/OEM, and hydraulic cylinder manufacturer | Hydraulic cylinder manufacturer | Specified in contract documents |
| 3 | Other | Any situation that deviates from the examples cited above | Specified in contract documents | Specified in contract documents | Specified in contract documents |

**1.5 Qualifications**

**1.5.1** The Design Authority shall have the technical design expertise necessary to interpret and comply with this specification. The individual(s) may be on staff or contracted, and shall possess one or more of the following qualifications:

**(1)** Professional or Chartered Engineer—Mechanical, Welding, Civil, Structural, Agricultural.

**(2)** An individual who by degree, training, or experience is qualified in design of welded connections.

**1.5.2** The Manufacturing Authority shall have the technical welding expertise necessary to interpret and comply with this specification. The individual(s) may be on staff or contracted, and shall possess one of the following qualifications:

**(1)** An AWS Certified Welding Engineer in conformance with the provisions of AWS B5.16, *Specification for the Qualification of Welding Engineers*,

**(2)** IIW International Welding Engineer (IWE),

**(3)** Professional Engineer (PE) with expertise in welding,

**(4)** Current certification as an AWS Senior Certified Welding Inspector (SCWI) in conformance with the requirements of AWS QC1, *Specification for AWS Certification of Welding Inspectors*,

**(5)** An individual who, by degree, training, or experience is qualified in welding engineering disciplines.

**1.5.3** The Inspection Authority shall have the technical inspection expertise necessary to interpret and comply with this specification. The individual(s) may be on staff or contracted, and shall possess one of the following qualifications:

**(1)** Current certification as an AWS Certified Welding Inspector (CWI) or Senior Certified Welding Inspector (SCWI) in conformance with the requirements of AWS QC1, *Specification for AWS Certification of Welding Inspectors*,

**(2)** Current qualification as a Welding Inspector (WI) or Senior Welding Inspector (SWI) in conformance with the requirements of AWS B5.1, *Specification for the Qualification of Welding Inspectors*,

**(3)** Current certification as a Level 2 or Level 3 Welding Inspector in conformance with the requirements of Canadian Standards Association (CSA) Standard W178.2, *Certification of Welding Inspectors*,

**(4)** Current qualification as an ASNT SNT-TC–1A-VT Level II in conformance with the requirements of ASNT Recommended Practice No. SNT-TC–1A, *Personnel Qualification and Certification in Nondestructive Testing*, or ANSI/ASNT CP–189 *ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel,* or

**(5)** An individual who, by training or experience, or both, in metals fabrication, inspection and testing, is competent to perform inspection of the work.

**1.6 Symbols.** Welding symbols shown on drawings shall be compatible with those shown in AWS A2.4, *Standard Symbols for Welding, Brazing, and Nondestructive Examination*. In addition, welding symbols not conforming to the requirements of AWS A2.4, but conforming to the requirements of this specification, may be allowed on drawings. Special conditions or deviations shall be fully explained by added notes, details, or definitions on the drawings. Combination groove weld symbols may not match those in AWS A2.4; the perpendicular leg of the groove weld symbol may or may not be included.

## 2. Normative References

The documents listed below are referenced within this publication and are mandatory to the extent specified herein. For undated references, the latest edition of the referenced standard shall apply. For dated references, subsequent amendments or revisions of the publications may not apply since the relevant requirements may have changed.

American Welding Society (AWS) standards:

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

AWS A2.4, *Standard Symbols for Welding, Brazing, and Nondestructive Examination*

AWS A3.0M/A3.0, *Standard Welding Terms and Definitions Including Terms for Additive Manufacturing, Adhesive Bonding, Brazing, Soldering, Thermal Cutting, Thermal Spraying, and Nondestructive Examination*

AWS A5.01M/A5.01 (ISO 14344 MOD), *Welding and Brazing Consumables—Procurement of Filler Metals and Fluxes*

AWS A5.32M/A5.32 (ISO 14175 MOD), *Welding Consumables—Gases and Gas Mixtures for Fusion Welding and Allied Processes*

AWS B2.1/B2.1M, *Specification for Welding Procedure and Performance Qualification*

AWS B4.0, *Standard Methods for Mechanical Testing of Welds (US Customary Units)*

AWS B4.0M, *Standard Methods for Mechanical Testing of Welds (Metric Customary Units)*

AWS B5.16, *Specification for the Qualification of Welding Engineers*

AWS B5.17, *Specification for the Qualification of Welding Fabricators*

AWS C4.1-77, *Criteria for Describing Oxygen-Cut Surfaces*

AWS C6.2/C6.2M, *Specification for Friction Welding of Metals*

AWS D14.0/D14.0M, *Machinery and Equipment Welding Specification*

AWS QC1, *Specification for AWS Certification of Welding Inspectors*

CSA standards:

CSA W178.2, *Certification of Welding Inspectors*

## 3. Terms and Definitions

AWS A3.0M/A3.0, *Standard Welding Terms and Definitions*, provides the basis for terms and definitions used herein. However, the following terms and definitions are included below to accommodate usage specific to this document.

**Design Authority.** The individual or organization responsible for all decisions and specifications with respect to the design of hydraulic cylinders.

**fracture toughness variable (T).** A qualification variable required when fracture toughness is specified by the Engineer.

**groove width.** The opening between groove faces in a groove joint. See Figure 6.1.

**high cycle cylinder.** A cylinder designed for an expected fatigue life equal to or greater than one million cycles.

**Inspection Authority.** The individual or organization responsible for all decisions and requirements with respect to the inspection requirements of hydraulic cylinders.

**low cycle cylinder**. A cylinder designed for an expected fatigue life of less than one million cycles.

**Manufacturing Authority.** The individual or organization responsible for all decisions and requirements with respect to the manufacturing of hydraulic cylinders.

**Operator of Automatic Welding Equipment.** A person who operates equipment requiring only occasional or no observation and no manual adjustment of the controls.

**performance qualification variable.** One of a set of requirements defining the limits of qualification of welders and welding operators. A change beyond the limits used in qualification requires requalification.

**procedure qualification variable.** One of a set of requirements defining the limits of use of a welding procedure specification. A change beyond the limits used in qualification requires requalification.

**qualification variable (Q).** See performance qualification variable and procedure qualification variable.

**welding consumables.** Filler metals, consumable inserts, fluxes, and shielding gases used in the welding process.

**welding variable.** Any controllable detail of a welding procedure which is required to be addressed on the WPS.

**WPS data variable (D).** A welding variable that if changed, does not require requalification. However, a revised WPS or new WPS shall be prepared.