AWS D14.6/D14.6M:2024
An American National Standard

Specification for Welding of Rotating Elements of Equipment

American Welding Society®

Approved American National Standard
ANSI

AWS D14.6/D14.6M:2024
An American National Standard

Approved by the
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Specification for Welding of Rotating Elements of Equipment

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Prepared by the
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 establishes material and workmanship standards for manufacturers, fabricators, repair organizations, purchasers, and owner/operators of rotating equipment which are fabricated or repaired by welding. Included are clauses defining process qualifications, operator qualifications, quality control, inspection requirements, and repair requirements.

American Welding Society®

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Foreword

This foreword is not a part of this standard but is included for informational purposes only.

This is the fifth edition of the D14.6 specification. AWS first published the specification for Welding of Rotating Elements of Equipment in 1981 to provide a welding specification that would apply to dynamic applications for new, modified, or the repair of welded rotating elements. Rotating elements can range from a few inches in diameter to over 200 in [5 m] in diameter. This specification is directed toward (but not limited to) crushers, fans, impellers, centrifugal impellers, kilns, pulpers, gears, sheaves, drive trains, crankshafts, flywheels, power transmission shafts, air moving devices, blowers, and rotating elements of hydroelectric generating equipment. By definition, the types of equipment covered by the specification are numerous and varied. The specifications that were used prior to this specification were ASME *Boiler and Pressure Vessel Code* in part or in whole and AWS D1.1/D1.1M, *Structural Welding Code-Steel*. AWS D14.6/D14.6M:2024 utilizes information from these codes. The clauses on design have been omitted. It is felt that a separate study of how practices do or should differ in design of welding rotating equipment from those published for stationary structures is needed. Such a study was beyond the scope of this subcommittee.

No restrictions are placed on the use of any welding process or procedure provided the weld produced by the process meets the qualification requirements of the specification. No attempt is made to limit or restrict technology progression on the Welding of Rotating Elements, nor should any such limitation be inferred. Similarly, no limitation is intended on the use of any base metal, weld joint preparation, or welding consumable capable of being qualified.

Previous editions of this standard are as follows:

AWS D14.6/D14.6M:2012, *Specification for Welding of Rotating Elements of Equipment*

AWS D14.6/D14.6M:2005, *Specification for Welding of Rotating Elements of Equipment*

AWS D14.6:1996, *Specification for Welding of Rotating Elements of Equipment*

AWS D14.6:1981, *Specification for Welding of Rotating Elements of Equipment*

Underlined text or a vertical line in the margin indicates a revision from the previous edition. Revisions to tables, figures, or annexes are marked with a vertical line in the margin.

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.

Official interpretations of any of the technical requirements of this standard may only be obtained by sending a request, in writing, to the Managing Director, Technical Services Division, American Welding Society. A formal reply will be issued after it has been reviewed by the appropriate personnel following established procedures.

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

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Specification for Welding of Rotating Elements of Equipment

1. General Requirements

1.1 Scope. This specification establishes minimum acceptable requirements for weld joint detail and fabrication by welding of rotating elements in new equipment. This specification also applies to the modification or repair by welding of rotating elements in existing equipment. Equipment types covered by this specification include, but are not limited to: crushers, fans, impellers, centrifugal impellers, kilns, pulpers, gears, sheaves, drive trains, crankshafts, flywheels, power transmission shafts, air moving devices, blowers, and rotating elements of hydroelectric generating equipment. The intent of this specification is not to include steam or combustion turbine rotors, blading, or camshafts. This specification also applies to such products and procedures that are agreed to by the Manufacturer, Fabricator, or Repair Organization and the Buyer.

Requirements contained herein are not intended to nullify or void the requirements of any law or governmental agency regulation or other codes applied to components. Additional requirements may be invoked by contract documents. The specification establishes the minimum acceptable practice at the time of its publication. It is not intended to restrict new developments or in any way to inhibit advances in the art and science of welding.

This specification is intended to promote the following:

(1) High quality construction and repair of welded rotating elements of equipment;

(2) Adequate initial and sustained performance of welded rotating elements of equipment;

(3) Clear, concise fabrication practices that will be readily understood by the Manufacturer, Fabricator, Repair Organization, or Buyer; and

(4) Conservation of human and material resources in the fabrication of welded rotating elements of equipment.

1.1.1 The Manufacturer, Fabricator, or Repair Organization's adherence to this specification shall include responsibility for the following:

(1) Welding, as defined in 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 (see 8.1.4). 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.

1.1.2 Buyer's Responsibility. The Buyer shall:

(1) Specify in the contract documents, and prior to manufacture, any additional fabrication or testing requirements (see Clauses 7 and 8.4).

(2) Specify in the contract documents the conditions under which the Buyer, User, or both may conduct in-plant or onsite inspection to meet this specification.

(3) Ensure, when Inspectors are provided by the Buyer, that they meet the personnel requirements of Clause 8.

1.1.3 Additional Responsibilities. For modification and/or repair, additional responsibilities are listed in Clause 9.

1.2 Units of Measurement. This specification 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 supplied by materials manufacturers

(2) Operating Manuals supplied by equipment manufacturers

Applicable RegulatoryAgencies

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 Welding 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.

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 to, or revisions of, any of these publications do not apply.

American Welding Society (AWS) standards:

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

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

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

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

AWS A5.X, See all pertinent A5 electrode standards.

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

AWS B4.0, *Standard Methods for Mechanical Testing of Welds, U.S Customary Only*

AWS B4.0M, *Standard Methods for Mechanical Testing of Welds, Metric Only*

AWS D1.1/D1.1M, *Structural Welding Code—Steel*

AWS D14.8M (ISO/TR 17844:2004 IDT), *Standard Methods for the Avoidance of Cold Cracks*

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

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

American Society of Mechanical Engineers (ASME) standards:

ASME Boiler and Pressure Vessel Code:

a. Section V, *Nondestructive Examination*

b. Section VIII*, Rules for Construction of Pressure Vessels*

c. Section IX*, Qualification Standard for Welding, Brazing, and Fusion Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators*

ASME B16.9, *Factory-Made Wrought Steel Buttwelding Fittings*

ASME B16.11, *Forged Fittings, Socket-Welding and Threaded*

ASME B16.28, *Wrought Steel Buttwelding Short Radius Elbows and Returns*

ASME B31.1, *Power Piping*

ASME B46.1, *Surface Texture (Surface Roughness, Waviness and Lay)*

American Society for Nondestructive Testing (ASNT) standard:

SNT TC-1A*, Recommended Practice, Personnel Qualification and Certification in Nondestructive Testing*

American Society for Testing and Materials (ASTM) standards:

ASTM E94/E94M, *Standard Guide for Radiographic Examination Using Industrial Radiographic Film*

ASTM E164, *Standard Practice for Contact Ultrasonic Testing of Weldments*

ASTM E165*, Standard Practice for Liquid Penetrant Testing for General Industry*

ASTM E317, *Standard Practice for Evaluating Performance Characteristics of Ultrasonic Pulse-Echo Testing Instruments and Systems without the Use of Electronic Measurement Instruments*

ASTM E709, *Standard Guide for Magnetic Particle Testing*

ASTM E747, *Standard Practice for Design, Manufacture and Material Grouping Classification of Wire Image Indicators (IQI) Used for Radiology*

ASTM E1025, *Standard Practice for Design, Manufacture, and Material Grouping Classification of Hole-Type Image Quality Indicators (IQI) Used for Radiology*

ASTM E1316, *Standard Terminology for Nondestructive Examinations*

Military Standard:

MIL-STD-2035A, *Department of Defense Test Method: Nondestructive Testing Acceptance Criteria*

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.

Buyer. The organization or party that issues the purchase order. This may be the end user or the end user's designated agent.

Engineer. The responsible technical authority.

Fabricator. The person, shop, contractor, or agency performing the actual welding. The person may be employed by the Manufacturer's company, or the Fabricator may be an independent shop doing work on a subcontract basis.

heat treatment. A combination of heating and cooling operations applied to a metal or alloy in the solid state to obtain desired conditions or properties.

Inspector. The person designated by the Manufacturer, Buyer, or Repair Organization who shall ascertain that all fabrication by welding is performed in conformance to the requirements of this specification.

Manufacturer. The person, company, or agency responsible for the performance of a rotating component.

penetrameter. Also identified as an Image Quality Indicator (IQI). A penetrameter is used to measure the contrast sensitivity and the definition of a radiograph, which verifies that the smallest required indication can be seen on the radiograph and density changes are not lost due to unsharpness.

post weld heat treatment (PWHT). Any heat treatment subsequent to welding.

Repair Organization. The organization that provides repair or modification to a rotating component.

User. The person, company, or agency that utilizes rotating equipment.

4. Materials

4.1 Base Metals

4.1.1 As appropriate for design conditions, materials selected for welding procedure qualifications and fabrication of rotating elements may be based on those listed in AWS B2.1/B2.1M, *Specification for Welding Procedure and Performance Qualification* or in the latest AWS B2.1/B2.1M-BMG, *Base Metal Grouping for Welding Procedure and Performance Qualification.* Other materials may be used based upon agreement between Buyer and Manufacturer, Fabricator, or Repair Organization.

4.1.2. Materials listed in the AWS B2.1 standards are listed by material number and group number, based on mechanical properties, chemical composition, and metallurgical compatibility to minimize the number of welding qualifications where this can logically be done. Base metals have been divided into general categories and further subdivided into groups. The grouping does not imply that base metals may be indiscriminately substituted for a base metal that was used in the qualification test without consideration of the compatibility from the standpoint of metallurgical properties, post weld heat treatment (PWHT), design, mechanical properties, and service requirements.

4.2 Welding Electrodes, Filler Metals, and Consumables

4.2.1 Welding electrodes, filler metals, and fluxes shall conform to the pertinent AWS specifications (AWS A5 standards) shown in the filler metal grouping annex in AWS B2.1/B2.1M, *Specification for Welding Procedure and Performance Qualification*. Welding electrodes, filler metals, and fluxes not covered by an AWS standard shall require a separate welding procedure qualification.

5. Welding Processes

All of the welding processes listed below may be used in the fabrication or repair of rotating elements. Welding processes and process variables are discussed in detail later in Clause 6. Processes not listed below may be utilized provided the Manufacturer, Fabricator, or Repair Organization can show evidence that the process used consistently produces welds which meet the requirements of Clause 6, and the Buyer agrees to use the process.

(1) Shielded Metal Arc Welding (SMAW)

(2) Submerged Arc Welding (SAW)

(3) Flux-Cored Arc Welding (FCAW)

(4) Gas Metal Arc Welding (GMAW)