Specification for Welding Earthmoving, Construction, and Agricultural Equipment

An American National Standard
Specification for Welding Earthmoving, Construction, and Agricultural Equipment

6th 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 producing structural welds used in the manufacture and repair of earthmoving, construction, and agricultural equipment. Such equipment is defined as self-propelled, on- and off-highway machinery and associated implements. Manufacturer’s responsibilities are presented as they relate to the welding practices that have been proven successful within the industry in the production of weldments on this equipment. Basic dimensional weld details are defined and interpreted for application throughout the document. Provisions are made to identify base metals used in these weldments. Procedures to ensure that they are welded with compatible, identifiable welding processes and consumables are included with consideration given to factors that affect weldability.
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 are entrusted to appropriately qualified and competent personnel.

This standard may be superseded by the issuance of new editions. Users should ensure that they have the latest edition.

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.

Finally, 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 E). 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, 550 N.W. LeJeune Road, Miami, FL 33126.
Personnel

AWS D14 Committee on Machinery and Equipment

J. L. Warren, Chair  CNH America LLC
L. L. Schweinegruber, Vice-Chair  Robinson Fans, Incorporated
M. Rubin, Secretary  American Welding Society
D. B. Ashley  Hartford Steam Boiler Inspection and Insurance Company
B. K. Banzhaf  CNH America LLC
T. J. Bruno  Link-Belt Construction Equipment Company
J. E. Campbell  WeldTech Solutions Corporation
D. J. Landon  Vermeer Manufacturing Company
T. J. Landon  Chicago Bridge and Iron Company
R. Larsen  Vermeer Manufacturing Company
M. R. Malito  Girard Machine Company, Incorporated
A. P. Mortale  Deere & Company
A. R. Olsen  ARO Testing, Incorporated
J. D. Slipke  Rosenboom Machine and Tool, Incorporated
W. A. Svekric  Welding Consultants, Incorporated
E. G. Yevick  Weld-Met International Group

Advisors to the AWS D14 Committee on Machinery and Equipment

M. D. Bell  Preventive Metallurgy
P. Collins  Weldcon Engineering
R. T. Hemzacek  Consultant
B. D. Horn  Consultant
D. J. Malito  Girard Machine Company, Incorporated
D. C. Martinez  Danmar Engineering Company, Incorporated
H. W. Mishler  Consultant
J. G. Nelson  Northrop Grumman
P. J. Palzkill  Consultant
V. R. Zegers  R. E. Technical Services, Incorporated

AWS D14C Subcommittee on Earthmoving and Construction Equipment

T. J. Landon, Chair  Chicago Bridge and Iron Company
M. Rubin, Secretary  American Welding Society
B. K. Banzhaf  CNH America LLC
F. G. Bries  John Deere Dubuque Works
T. J. Bruno  Link-Belt Construction Equipment Company
J. E. Campbell  WeldTech Solutions Corporation
H. B. Craft  Trinity Industries, Incorporated
G. D. Fairbanks  Fairbanks Inspection and Testing Services
R. M. Gneiting  John Deere Dubuque Works
D. J. Landon  Vermeer Manufacturing Company
A. P. Mortale  Deere and Company
A. R. Olsen  ARO Testing, Incorporated
R. T. Taylor  Caterpillar, Incorporated
J. L. Warren  CNH America LLC
E. G. Yevick  Weld-Met International Group

Advisors to the AWS D14C Subcommittee on Earthmoving and Construction Equipment

M. D. Bell  Preventive Metallurgy
W. E. Mumford  Production Welding Systems, Incorporated
P. J. Palzkill  Consultant
A. D. Wilson  ISG Incorporated Lukens Plate
This page is intentionally blank.
Foreword

This foreword is not part of AWS D14.3/D14.3M:2010, Specification for Welding Earthmoving, Construction, and Agricultural Equipment, but is included for informational purposes only.

AWS first published the Specification for Welding Earthmoving and Construction Equipment in 1977 to provide a welding specification where none previously existed. By definition, the types of equipment covered by the specification are numerous and varied. Every effort was made to reflect the best welding practices employed by manufacturers within the industry and to incorporate all the various methods which have proven successful by individual manufacturers. This edition builds on these foundations to improve interpretation and effect implementation. Text, tables, and figures have been updated or clarified to reflect more recent developments and promote standardization.

Changes in this 6th edition of D14.3 include the following:

1. Updated requirements in Clause 7 for prequalified procedures using single wire SAW;
2. Updated Clauses 7 and 8 to reference AWS B2.1 as the primary source of requirements for procedure and performance qualifications and removed redundant information from this standard;
3. Clarified the qualification of individuals responsible for performance test evaluations as described in Clause 8;
4. Added some general statements to the Workmanship and Welding Quality Requirements in Clause 9.

Underlined areas in text, tables, or figures indicate changes from the previous edition. A vertical line in the margin next to a figure, equation, or other item indicates a revision of that item from the previous edition.
This page is intentionally blank.
# Table of Contents

**Personnel** .................................................................................................................. v
**Foreword** ....................................................................................................................... vii
**List of Tables** ................................................................................................................. xi
**List of Figures** ................................................................................................................ xii

1. **Scope and General Provisions** .................................................................................. 1
   1.1 Scope .......................................................................................................................... 1
   1.2 Units of Measure ......................................................................................................... 1
   1.3 Safety ........................................................................................................................ 2
   1.4 Symbols ..................................................................................................................... 2

2. **Normative References** ............................................................................................... 2

3. **Definitions** ................................................................................................................... 2

4. **Basic Weld Detail** ........................................................................................................... 3
   4.1 Weld Size Considerations ......................................................................................... 3
   4.2 Groove Welds ........................................................................................................... 3
   4.3 Fillet Welds ............................................................................................................... 3
   4.4 Combinations of Groove and Fillet Welds ............................................................... 5
   4.5 Intermittent Welds .................................................................................................. 5

5. **Base Metals** ................................................................................................................. 6
   5.1 Structural Steels and Nonferrous Metals .............................................................. 6
   5.2 Properties ............................................................................................................... 6
   5.3 Weldability and Procedure Qualification ............................................................... 7

6. **Welding Processes and Consumables** ....................................................................... 7
   6.1 Processes .................................................................................................................. 7
   6.2 Consumables ........................................................................................................... 7

7. **Welding Procedure Qualification** ............................................................................. 7
   7.1 Scope ......................................................................................................................... 7
   7.2 General Requirements ............................................................................................ 7
   7.3 Method I—Prototype Testing ................................................................................. 8
   7.4 Method II—Procedure Qualification Tests for Partial Joint Penetration Groove Welds ...................................................................................................................... 11
   7.5 Method III—Prequalified Welding Procedure ....................................................... 13

8. **Welding Personnel Qualification** ............................................................................... 20
   8.1 Scope ......................................................................................................................... 20
   8.2 General ..................................................................................................................... 20
   8.3 Welder Qualification ............................................................................................... 20
   8.4 Welding Operator Qualification ............................................................................ 22
   8.5 Operators of Automatic Welding Equipment ....................................................... 23
   8.6 Qualification of Tack Welders ............................................................................... 23
9. Workmanship and Welding Quality Requirements .................................................. 25
   9.1 Scope ................................................................. 25
   9.2 General Requirements ................................................ 25
   9.3 Preparation of Materials .............................................. 25
   9.4 Assembly ............................................................. 25
   9.5 Quality of Welds ...................................................... 26
   9.6 Repair of Weld Defects ............................................... 27
   9.7 Cleaning ............................................................... 29
   9.8 Dimensional Tolerance ............................................... 29

10. Inspection .................................................................................. 29

11. Field Repair and Modification ...................................................... 29

Annex A (Normative)—Prequalified Weld Joints ............................................. 31
Annex B (Informative)—Suggested Welding Procedure Specification and Qualification Test Record Forms ....... 69
Annex C (Informative)—Recommended Practices for Storage and Treatment of Electrodes and Fluxes ........ 71
Annex D (Informative)—Roadmap for Welding Procedure Specification (WPS) Development .................. 75
Annex E (Informative)—Guidelines for the Preparation of Technical Inquiries ................................. 77
Annex F (Informative)—Informative References ............................................. 79

List of AWS Documents on Machinery and Equipment ........................................ 81
List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Z-Loss Dimensions Nontubular</td>
</tr>
<tr>
<td>3</td>
<td>Heat Input Calculations</td>
</tr>
<tr>
<td>4</td>
<td>Weldability Classification—Typical Steel Products</td>
</tr>
<tr>
<td>5</td>
<td>Weldability Classification</td>
</tr>
<tr>
<td>6</td>
<td>Minimum Preheat and Interpass Temperatures</td>
</tr>
<tr>
<td>7</td>
<td>Filler Metal Requirements for Prequalified Complete-Joint-Penetration Groove Welds</td>
</tr>
<tr>
<td>7M</td>
<td>Filler Metal Requirements for Prequalified Complete-Joint-Penetration Groove Welds</td>
</tr>
<tr>
<td>8</td>
<td>Welding Personnel Qualification—Type and Position Limitations</td>
</tr>
<tr>
<td>9</td>
<td>Workmanship Tolerances for Groove Welds</td>
</tr>
<tr>
<td>C.1</td>
<td>Electrodes Covered by AWS A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding</td>
</tr>
<tr>
<td>C.2</td>
<td>Electrodes Covered by AWS A5.5/A5.5M, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding</td>
</tr>
<tr>
<td>D.1</td>
<td>Roadmap for Development of Welding Procedure Specifications (WPSS)</td>
</tr>
</tbody>
</table>

List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Skewed Groove Weld</td>
</tr>
<tr>
<td>2</td>
<td>Concave Fillet Weld Profiles</td>
</tr>
<tr>
<td>3</td>
<td>Convex Fillet Weld Profiles</td>
</tr>
<tr>
<td>4</td>
<td>Skewed T-Joint</td>
</tr>
<tr>
<td>5</td>
<td>Combination of Bevel-Groove and Fillet Weld Profile</td>
</tr>
<tr>
<td>6</td>
<td>Positions of Groove Welds</td>
</tr>
<tr>
<td>7</td>
<td>Positions of Fillet Welds</td>
</tr>
<tr>
<td>8</td>
<td>Positions of Test Plates for Groove Welds</td>
</tr>
<tr>
<td>9</td>
<td>Positions of Test Plates for Fillet Welds</td>
</tr>
<tr>
<td>10</td>
<td>Example 1 of Workmanship Sample</td>
</tr>
<tr>
<td>11</td>
<td>Example 2 of Workmanship Sample</td>
</tr>
<tr>
<td>12</td>
<td>Example 3 of Workmanship Sample</td>
</tr>
<tr>
<td>13</td>
<td>Fillet Weld Break Specimen—Tack Welder Qualification</td>
</tr>
<tr>
<td>14</td>
<td>Method of Rupturing Specimen—Tack Welder Qualification</td>
</tr>
<tr>
<td>15</td>
<td>Acceptable and Unacceptable Weld Profiles</td>
</tr>
<tr>
<td>A.1</td>
<td>Prequalified Complete-Joint-Penetration Weld Joints—Shielded Metal Arc Welding</td>
</tr>
<tr>
<td>A.2</td>
<td>Prequalified Partial-Joint-Penetration Weld Joints—Shielded Metal Arc Welding</td>
</tr>
<tr>
<td>A.3</td>
<td>Prequalified Complete-Joint-Penetration Weld Joints—Submerged Arc Welding</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>A.4</td>
<td>Prequalified Partial-Joint-Penetration Weld Joints—Submerged Arc Welding</td>
</tr>
<tr>
<td>A.5</td>
<td>Prequalified Complete-Joint-Penetration Weld Joints—Gas Metal and Flux Cored Arc Welding</td>
</tr>
<tr>
<td>A.6</td>
<td>Prequalified Partial-Joint-Penetration Weld Joints—Gas Metal and Flux Cored Arc Welding</td>
</tr>
<tr>
<td>A.7</td>
<td>Details for Prequalified Fillet Welds of Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW), Submerged Arc Welding (SAW), and Flux Cored Arc Welding (FCAW)</td>
</tr>
</tbody>
</table>

1.1 Scope

1.1.1 This specification applies to all structural welds used in the manufacture and repair of earthmoving, construction, and agricultural equipment.¹ It reflects the welding practices employed by manufacturers within the industry and 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 the welding technology progression of earthmoving, construction, and/or agricultural equipment manufacturing and repair, nor should any such limitation be inferred. Design criteria for allowable stresses for the base and weld metal and the fatigue analysis for welded joints are not published in the specification. The user shall utilize AWS D14.4, Specification for Welded Joints in Machinery and Equipment, or appropriate engineering practices and principles for design criteria.

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 and using written welding procedure specifications (WPSs);
4. ensuring that qualified welders are used to make welds;
5. recording and maintaining results of all welder performance and procedure qualification tests;
6. controlling use of designated base metals and consumables;
7. inspecting the welds to the requirements of this specification;
8. ensuring a safe welding environment and safe welding practice;
9. having a quality system in place. The requirements of AWS B5.17, Specification for the Qualification of Welding Fabricators 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.

1.2 Units of Measure. This specification makes use of both the 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 in any way. The specification with the designation D14.3 uses U.S. Customary Units. The specification D14.3M 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 For purposes of this specification, earthmoving, construction, and agricultural equipment are described as self-propelled, on and off-highway machinery and associated implements. Such products as crawlers, tractors, graders, loaders, off-highway trucks, power shovels, backhoes, mobile cranes, draglines, and similar equipment are considered to be included in this specification.