

AWS D16.4M/D16.4:2025
An American National Standard

Specification for the Qualification of Robotic Arc Welding Personnel



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An American National Standard

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American National Standards Institute
January 16, 2025

Specification for the Qualification of Robotic Arc Welding Personnel

4th Edition

Revises AWS D16.4M/D16.4:2015

Prepared by the
American Welding Society (AWS) D16 Committee on Robotic and Automatic Welding

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

Abstract

This specification provides requirements for the qualification of robotic arc welding personnel at three different classifications—Associate Technician (AT), Technician (T), and Engineer (Eng).



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This standard is subject to revision at any time by the AWS D16 Committee on Robotic and Automatic Welding. It must be reviewed every five years, and if not revised, it must be either reaffirmed or withdrawn.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 requested and should be addressed to AWS Headquarters. Such comments will receive careful consideration by the AWS D16 Committee on Robotic and Automatic Welding 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 D16 Committee on Robotic and Automatic Welding 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 NW 36 St, # 130, Miami, FL 33166.

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Foreword

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

The AWS D16 Committee on Robotic and Automatic Welding was organized in 1985 to provide a centralized source for the exchange of technical information between manufacturers, installers, and operators of robotic and automated equipment.

The first edition of AWS D16.4 (AWS D16.4:1999, *Specification for the Qualification for Robotic Arc Welding Personnel*) provided guidelines for the qualification of arc welding personnel. The second edition (AWS D16.4M/D16.4:2005) included revisions based on the experience of the certification program for robotic arc welding personnel. The third edition reduced the levels of qualification from four to three and aligned education and experience requirements more realistically with those in industry.

The third edition changed the levels of qualification to Level 1—Certified Robotic and Automated Welding Operator (CRAW-O), Level 2—Certified Robotic and Automated Welding Technician (CRAW-T), and Level 3—Certified Robotic and Automated Welding Engineer (CRAW-E) from the second edition's qualification designations of Level 1—CRAW-L1, Level 2—CRAW-O, and Level 3—CRAW-T. Those certified under the second edition certification level designations were grandfathered into the corresponding third edition level designation.

The third edition also included changes to the figures from the second edition. Figures 1 and 2 were revised and Figure 3 removed.

The fourth edition changes the levels of qualification and titles to Level 1—Certified Robotic and Automated Welding Associate Technician (CRAW-AT), Level 2—Certified Robotic and Automated Welding Technician (CRAW-T), and Level 3—Certified Robotic and Automated Welding Engineer (CRAW-Eng) from the third edition's qualification designations of Level 1—CRAW-O, Level 2—CRAW-T, and Level 3—CRAW-E. An additional figure on suggested areas for cross-sections was added. A vertical line in the margin or underlined text in clauses, tables, or figures indicates an editorial or technical change from the 2015 edition.

The requirements for certification of Robotic Arc Welders are located in the QC19 document.

Comments and suggestions for the improvement of this standard are welcome. They should be sent to the Secretary, AWS D16 Committee on Robotic and Automatic Welding, American Welding Society, 8669 NW 36 St, # 130, Miami, FL 33166.

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Specification for the Qualification of Robotic Arc Welding Personnel

1. General Requirements

1.1 Scope. This standard provides requirements for the qualification of robotic arc welding personnel. This standard does not prevent a manufacturer, fabricator, or contractor from continuing to qualify robotic welding personnel according to other standards.

Qualification is limited to those performance variables provided in Tables 1 through 4 in this standard. There are three different levels in which qualification can be achieved. The three levels and acronyms are Level 1—Certified Robotic and Automated Welding Associate Technician (CRAW-AT), Level 2—Certified Robotic and Automated Welding Technician (CRAW-T), and Level 3—Certified Robotic and Automated Welding Engineer (CRAW-Eng).

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

1.3 Safety. Safety and health issues and concerns are beyond the scope of this standard; some safety and health information is provided, but such issues 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) Safety Data Sheets 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.

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:

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 QC19, *Standard for the AWS Certification of Robotic Arc Welding Personnel.*

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.

inspection. Examination or measurement to verify whether an item or activity conforms to specified requirements.

inspector. A person who performs an inspection or exam function to verify conformance to specific requirements.

qualification. Verification by testing of the characteristics or abilities gained through training, experience, or both that enables individuals to perform certain functions.

robotic arc welding associate technician. The person designated to start, monitor, and stop the intended productive operation of a robot or robot system. An associate technician may also interface with a robot for productive purposes.

robotic arc welding personnel. Individuals who may be robotic associate technicians, technicians, engineers, or maintenance support personnel for robotic arc welding applications.

robotic arc welding personnel qualification. The verification of robotic arc welding personnel's ability to meet prescribed standards for performance qualification.

verification. The act of reviewing, inspecting, testing, checking, auditing, or otherwise determining and documenting whether items, processes, services, or documents conform to specified requirements.

4. Specifications for Qualification of Robotic Arc Welding Personnel

Tables 1 through 3 provide the specifications for the qualification of robotic arc welding personnel at the three levels designated by this standard. Table 1 lists the skill requirements, experience and educational requirements, and training recommendations for a Robotic and Automated Arc Welding Associate Technician–Level 1 applicant. Table 2 lists skill requirements, experience and educational requirements, and training recommendations for a Robotic and Automated Arc Welding Technician–Level 2 applicant. Table 3 lists skill requirements, experience and educational requirements, and training recommendations for a Robotic and Automated Arc Welding Engineer–Level 3 applicant.

To qualify at a specific Level, one shall demonstrate the ability to complete the required performance objectives for that Level. Table 4 summarizes the requirements and at which level(s) they apply. For exam preparation, refer to the AWS QC19, *Standard for the AWS Certification of Robotic Arc Welding Personnel.*

The components for the specimen used to conduct the performance welding test shall be of the dimensions and layout shown in Figure 1. Assembly of the components of the test specimen shall be as shown in Figure 2. Suggested areas for cross-sections are shown in Figure 3.

This fourth edition changes the levels of qualification to Level 1–Certified Robotic and Automated Welding Associate Technician (CRAW-AT), Level 2–Certified Robotic and Automated Welding Technician (CRAW-T), and Level 3–Certified Robotic and Automated Welding Engineer (CRAW-Eng) from the third edition's qualification designations of Level 1–CRAW-O, Level 2–CRAW-T, and Level 3–CRAW-E. Those certified under the third edition certification level designations shall be grandfathered into the corresponding fourth edition level designation.

Table 1
Performance Qualifications for Robotic Arc Welding Associate Technician–Level 1

To qualify as a Robotic Arc Welding Associate Technician (AT), the applicant shall meet the requirements in Sections A and B of Table 1. Section C lists training recommendations.

A. Skill and Ability Requirements

1. Identify sources of input power and demonstrate a working knowledge of how to power up the robot and robot ancillary equipment along with peripheral devices such as wire feeders, coolant pumps, and torch cleaner, etc.
2. Demonstrate routine maintenance of the robotic welding torch including but not limited to demonstrating changing the contact tips, welding electrode feeding equipment, gas diffusers, insulators, and nozzles.
3. Demonstrate a familiarity with and demonstrate working knowledge of the robot teaching pendant and any robot ancillary control device that is required for the startup, operation, maintenance, and supervision of the robot system.
4. Identify all safeguarding devices consistent with D16.2 that are incorporated into the robot system. Identification of the safeguards also includes an explanation of their purpose, activation, and recovery.
5. Demonstrate a working knowledge of the robot system and welding process equipment and a familiarity with the operating instructions.
6. Demonstrate good mechanical aptitude through the use of tools to maintain the robot system and tooling.
7. Demonstrate good verbal and written communication skills.
8. Exhibit knowledge required to create, adjust, and modify robot system programs.

B. Experience and Education Requirements

1. Have a minimum of 40 hours arc welding experience. Note: hours consist of time on the job employed as a welder, student, engineer and not actual arc on time while under the hood.
2. High school diploma or equivalent hours of training.

C. Training Recommendations

1. Receive instructions in the safe use of an arc welding robot system.
2. Receive instruction in visual weld inspection. For example, the online course offered by the AWS.
3. Receive training to include information and knowledge required to create, adjust, and modify robot system programs.

Table 2
Performance Qualifications for Robotic Arc Welding Technician–Level 2

To qualify as a Robotic Arc Welding Technician (T), the applicant shall meet the requirements in Sections A and B of Table 2. Section C lists training recommendations.

A. Skill and Ability Requirements

1. Satisfy the Robotic Arc Welding Associate Technician skill and ability requirements in Table 1.
2. Demonstrate the ability to visually inspect welds consistent with the requirements of the applicable welding quality standard.
3. Perform basic welding inspection using the cross-section, cut, polish, and etch methodology.
4. Create a robot program from initial requirement to finished welded product using an approved welding procedure.
5. Modify robot program and parameters using the teach pendant.

B. Experience and Education Requirements

1. Have a minimum of 6 months arc welding experience. The experience includes manufacturing technician, weld inspection, teaching welding, weld procedure development or welding experience that is related to the robot arc welding experience.
2. An associate's degree or Certified Welding Inspector (CWI) or ten (10) years of equivalent experience.

C. Training Recommendations

1. Receive instruction in robotic arc welding, inspection and testing, advanced performance functions and related disciplines including but not limited to the science of robot programming and the design and fabrication of welding fixtures and related disciplines.
2. Receive training to include basic maintenance tasks and knowledge of preventative maintenance requirements.
3. Receive appropriate robot training.
4. Receive training to include information and knowledge emphasizing the science of arc welding based upon the AWS D16 suite of standards and the references in Annex A of this standard.

Table 3
Performance Qualifications for Robotic Arc Welding Engineer–Level 3

To qualify as a Robotic Arc Welding Engineer (Eng), the applicant shall meet the requirements in Sections A and B of Table 3. Section C lists training recommendations.

A. Skill and Ability Requirements

1. Satisfy the Robotic Arc Welding Technician skill and ability requirements in Table 2.
2. Demonstrate the ability to be responsible for the overall design and implementation of a robotic or automated welding process.
3. Demonstrate proficiency to work from technical drawings and create welding process specifications to produce a manufacturing process that includes one or more automated welding processes. For example, the online course offered by the AWS.
4. Demonstrate familiarity with physical properties, attributes and features that are critical to producing finished weldments and engineering concepts related to materials, NDE, and destructive testing. For example, the online course offered by the AWS.

B. Experience and Education Requirements

1. A four-year bachelor's degree or equivalent in engineering or an associates of science in a weld related field and 10 years of experience, or a high school diploma and 15 years of welding-based working experience.
2. AWS CWI certification or equivalent.

C. Training Recommendations

1. All trainings listed in Table 1 and Table 2.
2. Receive training to include more extensive information and knowledge emphasizing the science of arc welding based upon the AWS D16 suite of standards and the references in Annex A of this standard.
3. The candidate should be proficient with robot software, programming, and should be able to demonstrate the ability to troubleshoot system errors.

Table 4
Summary of Specifications for Robotic Arc Welding Personnel

A. Skill and Ability Requirements		Level
1.	Identify all sources of input power and demonstrate a working knowledge of how to power up all robot and robot ancillary equipment along with peripheral devices such as wire feeders, coolant pumps, and torch cleaners, etc.	<u>1 / 2 / 3</u>
2.	Provide for routine maintenance of the robotic welding torch including but not limited to demonstrating changing the contact tips, gas diffusers, insulators, and nozzles.	<u>1 / 2 / 3</u>
3.	Demonstrate a familiarity with and demonstrate working knowledge of the robot teaching pendant and any robot ancillary control device is required for the startup, operation, maintenance, and supervision of the robot system.	<u>1 / 2 / 3</u>
4.	Identify all safeguarding devices, E-stops, systems, and procedures that are incorporated into the robot system production environment. Identification of the safeguards also includes an explanation of their purpose, activation, and recovery.	<u>1 / 2 / 3</u>
5.	Demonstrate a working knowledge of the robot and welding process equipment and a familiarity with the manufacturer's operating instructions.	<u>1 / 2 / 3</u>
6.	Demonstrate the proper procedures for changing the wire feed roll used on robot systems that utilize a wire feeding mechanism. Must demonstrate good mechanical aptitude through the use of tools to maintain the robot or robot tooling.	<u>1 / 2 / 3</u>
7.	Demonstrate good communication skills	<u>1 / 2 / 3</u>
8.	Demonstrate the ability to visually inspect welds consistent with the requirements of the applicable welding quality standard. <u>For example, an online course offered by the AWS.</u>	<u>2 / 3</u>
9.	Perform basic welding inspection using the cross-section, cut, etch, and polish methodology. <u>For example, the online course offered by the AWS.</u>	<u>2 / 3</u>
10.	Create a robot program from initial requirement to finished welded product using an approved welding procedure.	<u>2 / 3</u>
11.	Adjust robot program and parameters using the teach pendant.	<u>2 / 3</u>
12.	Demonstrate the ability to be responsible for the overall design and implementation of a robotic or automated welding process.	<u>3</u>
13.	Able to work from technical drawings and create welding process specifications to produce a manufacturing process that includes one or more automated welding processes.	<u>3</u>
14.	Must be familiar with physical properties, attributes and features that are critical to producing finished weldments and engineering concepts related to materials, NDE, and destructive testing.	<u>3</u>
B. Experience and Education Requirements		
1.	Have minimum of <u>40</u> hours arc welding. Note: hours consist of time on the job employed as a welder, student, engineer, and not actual arc on time while under the hood.	<u>1 / 2</u>
2.	High school diploma or equivalent.	<u>1 / 2 / 3</u>
3.	Have a minimum of <u>6 months</u> arc welding experience. The experience includes manufacturing <u>technician, weld inspection or weld procedure development or welding</u>	<u>2</u>
4.	An associate's degree or equivalent in a technical field of study or experience <u>or number 5 below.</u>	<u>2 / 3</u>
5.	A four-year bachelor's degree or equivalent in engineering <u>or an associates of science in a weld related field and 10 years of experience, or a high school diploma and 15 years of welding-based working experience.</u>	<u>3</u>
6.	AWS CWI certification or equivalent.	<u>2 / 3</u>

Table 4 (Continued)
Summary of Specifications for Robotic Arc Welding Personnel

C. Training Recommendations		Level
1.	Receive instruction in the safe use of arc welding robots and welding power source equipment.	<u>1 / 2 / 3</u>
2.	Receive instruction in visual weld inspection. <u>For example, the online course offered by the AWS.</u>	<u>1 / 2 / 3</u>
3.	Receive information and knowledge required to create, adjust, and modify robot system programs.	<u>1 / 2 / 3</u>
4.	Receive training to include basic maintenance tasks and knowledge of preventative maintenance requirements.	<u>1 / 2 / 3</u>
5.	Receive training to include information and knowledge emphasizing the science of arc welding based upon the AWS D16 suite of standards and the references in Annex A of this standard.	<u>2 / 3</u>
6.	Receive appropriate robot training.	<u>2 / 3</u>
7.	Receive instruction in robotic arc welding, inspection and testing, advanced performance functions and related disciplines including but not limited to the science of robot programming and the design and fabrication of welding fixtures and related disciplines.	<u>2 / 3</u>
8.	Receive training to include more extensive information and knowledge emphasizing the science of arc welding based upon the AWS D16 suite of standards and the references in Annex A of this standard.	<u>3</u>
9.	The candidate should be conversant with robot software, programming, and should be able to demonstrate the ability to troubleshoot system errors.	<u>3</u>

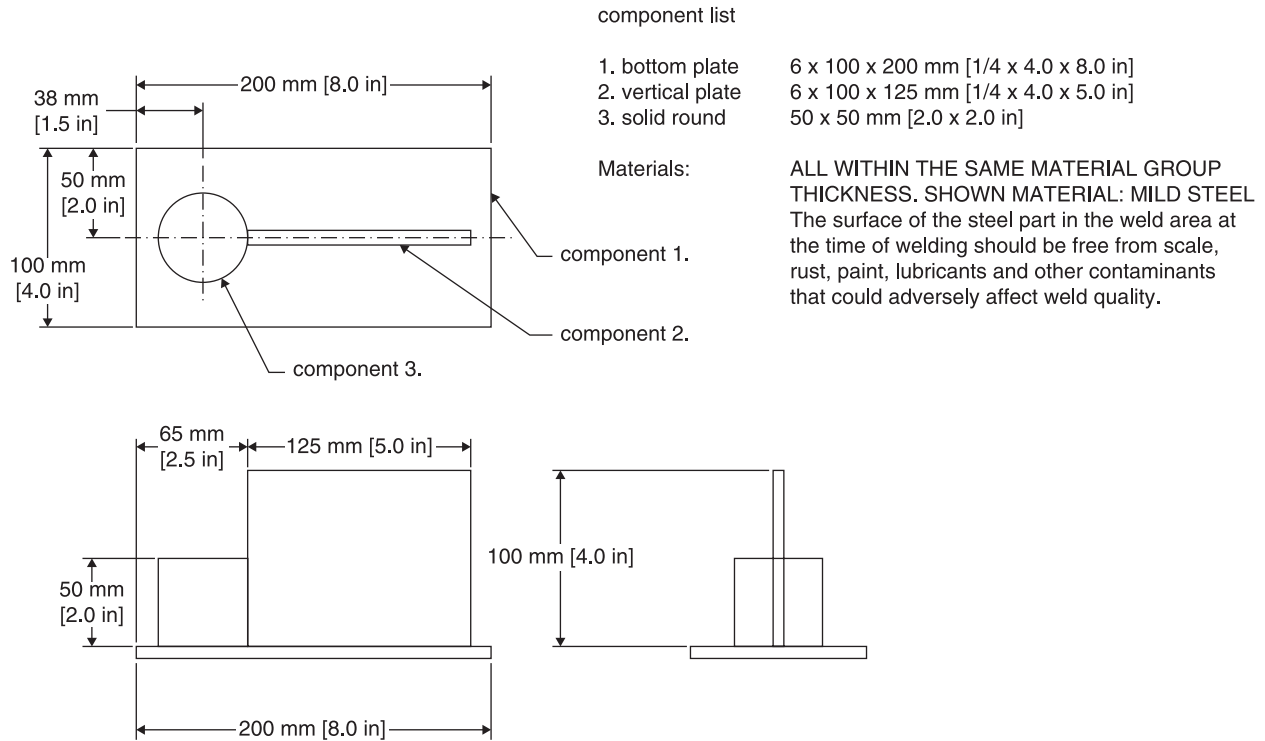


Figure 1—Test Specimen Components, Dimensions, and Layout

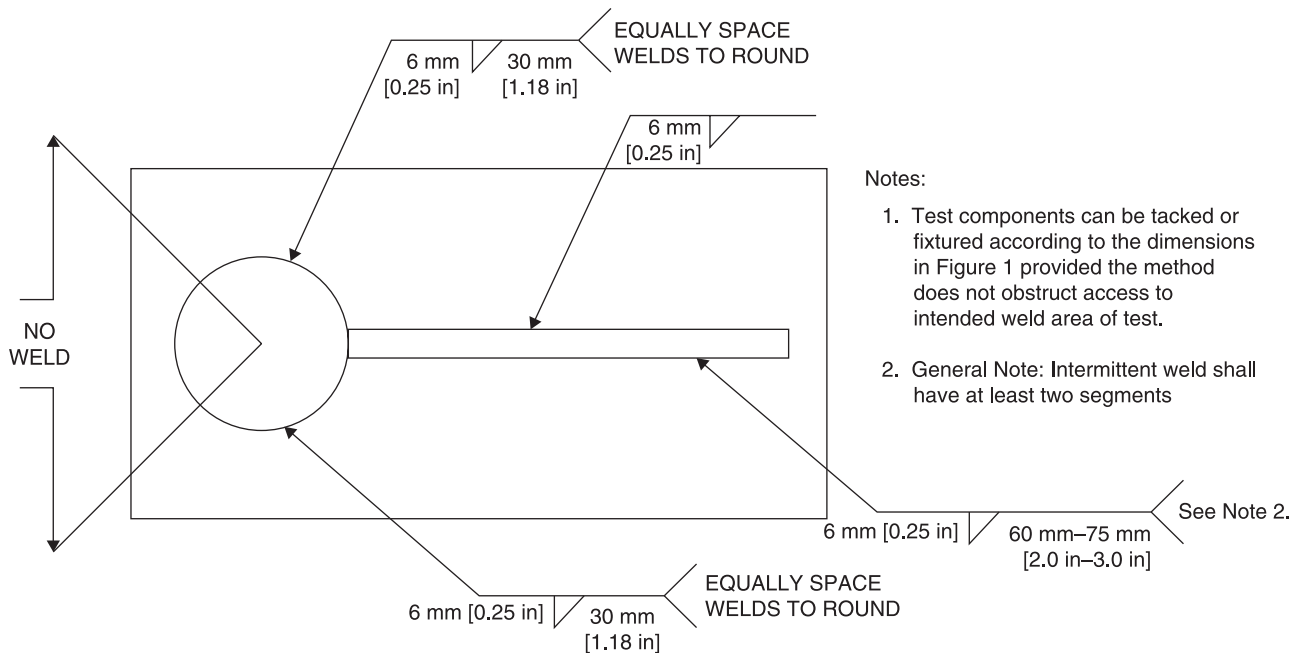


Figure 2—Assembly Specifications for Test Specimens

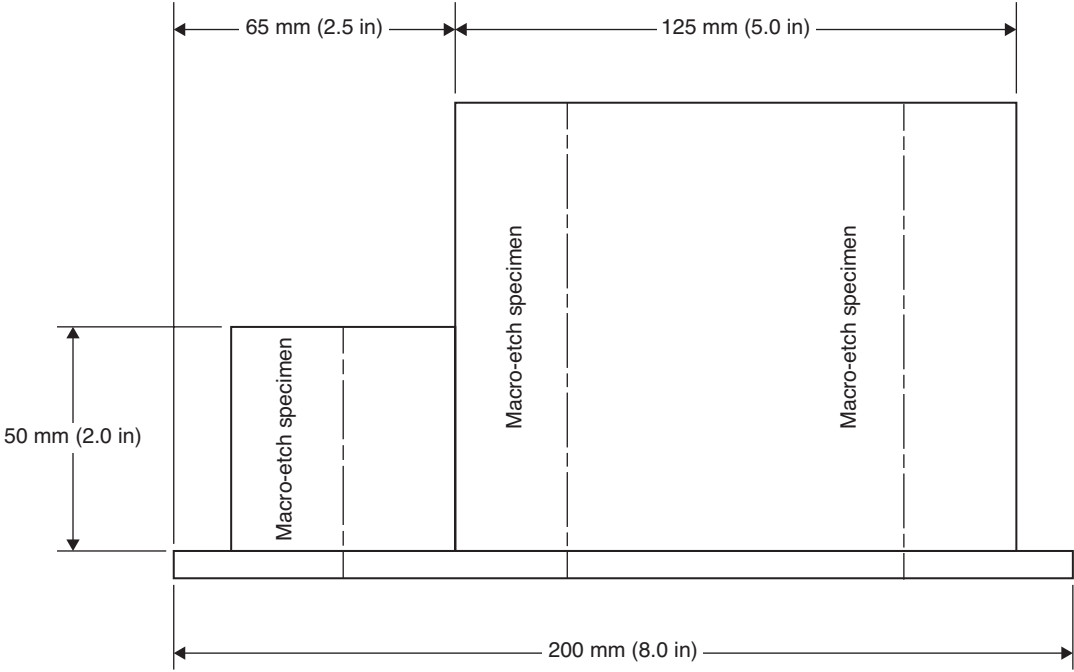


Figure 3—Suggested Areas for Cross-Sections

Annex A (Informative)

Informative References

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

AWS D16.1, *Specification for Robotic Arc Welding Safety*

AWS/NEMA D16.2, *Standard for Components of Robotic and Automatic Welding Installation*

AWS D16.3, *Risk Assessment Guide for Robotic Arc Welding*

AWS D16.5, *Training Guide for Robotic Arc Welding Personnel*

AWS AWR, *Arc Welding With Robots: Do's and Don'ts*

AWS Safety and Health Fact Sheets

ANSI B11.0, *Safety of Machinery: General Requirements and Risk Assessment*

ANSI B11.18, *Machine Tools-Safety Requirements for Machines Processing or Slitting Coiled or Non-Coiled Metal*

ANSI B11.19, *Performance Requirements for Safeguarding*

ANSI/RIA 15.06, *Robot Safety Standards*

ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes* (published by the American Welding Society)

ISO 10218, *Robots and robotic devices — Safety requirements for industrial robots*

NFPA 51B, *Standard for Fire Prevention during Welding, Cutting, and other Hot Work*

NFPA 70, *National Electrical Code*

NFPA 79, *Electrical Standard for Industrial Machinery*

UL 1740, *Safety Standard for Industrial Robots and Robotic Equipment*

US Code of Federal Regulations, 29 CFR 1910 *Occupational Safety and Health Standards*

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Annex B (Informative)

Requesting an Official Interpretation on an AWS Standard

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

B1. Introduction

The following procedures are here to assist standard users in submitting successful requests for official interpretations to AWS standards. Requests from the general public submitted to AWS staff or committee members that do not follow these rules may be returned to the sender unanswered. AWS reserves the right to decline answering specific requests; if AWS declines a request, AWS will provide the reason to the individual why the request was declined.

B2. Limitations

The activities of AWS technical committees regarding interpretations are limited strictly to the interpretation of provisions of standards prepared by the committees. Neither AWS staff nor the committees are in a position to offer interpretive or consulting services on (1) specific engineering problems, (2) requirements of standards applied to fabrications outside the scope of the document, or (3) points not specifically covered by the standard. In such cases, the inquirer should seek assistance from a competent engineer experienced in the particular field of interest.

B3. General Procedure for all Requests

B3.1 Submission. All requests shall be sent to the Managing Director, AWS Standards Development. For efficient handling, it is preferred that all requests should be submitted electronically through standards@aws.org. Alternatively, requests may be mailed to:

Managing Director
Standards Development
American Welding Society
8669 NW 36 St, # 130
Miami, FL 33166

B3.2 Contact Information. All inquiries shall contain the name, address, email, phone number, and employer of the inquirer.

B3.3 Scope. Each inquiry shall address one single provision of the standard unless the issue in question involves two or more interrelated provisions. The provision(s) shall be identified in the scope of the request along with the edition of the standard (e.g., D1.1:2006) that contains the provision(s) the inquirer is addressing.

B3.4 Question(s). All requests shall be stated in the form of a question that can be answered ‘yes’ or ‘no’. The request shall be concise, yet complete enough to enable the committee to understand the point of the issue in question. When the point is not clearly defined, the request will be returned for clarification. Sketches should be used whenever appropriate, and all paragraphs, figures, and tables (or annexes) that bear on the issue in question shall be cited.

B3.5 Proposed Answer(s). The inquirer shall provide proposed answer(s) to their own question(s).

B3.6 Background. Additional information on the topic may be provided but is not necessary. The question(s) and proposed answer(s) above shall stand on their own without the need for additional background information.

B4. AWS Policy on Interpretations

The American Welding Society (AWS) Board of Directors has adopted a policy whereby all official interpretations of AWS standards are handled in a formal manner. Under this policy, all official interpretations are approved by the technical committee that is responsible for the standard. Communication concerning an official interpretation is directed through the AWS staff member who works with that technical committee. The policy requires that all requests for an official interpretation be submitted in writing. Such requests will be handled as expeditiously as possible, but due to the procedures that must be followed, some requests for an official interpretation may take considerable time to complete.

B5. AWS Response to Requests

Upon approval by the committee, the interpretation is an official interpretation of the Society, and AWS shall transmit the response to the inquirer, publish it in the *Welding Journal*, and post it on the AWS website.

B6. Telephone Inquiries

Telephone inquiries to AWS Headquarters concerning AWS standards should be limited to questions of a general nature or to matters directly related to the use of the standard. The AWS Board Policy Manual requires that all AWS staff members respond to a telephone request for an official interpretation of any AWS standard with the information that such an interpretation can be obtained only through a written request. Headquarters staff cannot provide consulting services. However, the staff can refer a caller to any of those consultants whose names are on file at AWS Headquarters.

List of AWS Documents on Robotics and Automatic Welding

Designation	Title
D16.1M/D16.1	<i>Specification for Robotic Arc Welding Safety</i>
D16.2M/D16.2	<i>Guide for Components of Robotic and Automatic Arc Welding Installations</i>
D16.3M/D16.3	<i>Risk Assessment Guide for Robotic Arc Welding</i>
D16.4M/D16.4	<i>Specification for the Qualification of Robotic Arc Welding Personnel</i>
D16.5M/D16.5	<i>Training Guide for Robotic Arc Welding Personnel</i>
D16.6M/D16.6	<i>Specification for Robot Arc Welding Training and Testing System</i>

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