AWS D8.8M:2007
An American National Standard

# Specification for Automotive Weld Quality—Arc Welding of Steel


**AWS D8.8M:2007**
**An American National Standard**

**Approved by the**
**American National Standards Institute**
**January 8, 2007**

# Specification for Automotive Weld Quality—Arc Welding of Steel

**4th Edition**

**Supersedes ANSI/AWS D8.8-97**

Prepared by the
American Welding Society (AWS) D8 Committee on Automotive Welding

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

## Abstract

This specification provides the minimum quality requirements for arc welding of various types of automotive and light truck components. This specification covers the arc and hybrid arc welding of coated and uncoated steels.

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**550 N.W. LeJeune Road, Miami, FL 33126**

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# Foreword

This foreword is not part of AWS D8.8M:2007, *Specification for Automotive Weld Quality—Arc Welding of Steel*, but is included for informational purposes only.

This specification was developed by the AWS D8C Subcommittee on Automotive Arc Welding of Steel of the AWS D8 Committee on Automotive Welding.

Arc welding of large truck and car frame structures with relatively thick metal parts and gas metal arc welding (GMAW) using $CO_2$ shielding gas are reflected in AWS D8.8-97/SAE HS J1196, *Specification for Automotive and Light Truck Components Weld Quality—Arc Welding*. Prior to AWS D8.8-97, there were two editions of D8.8: AWS D8.8-79/SAE HS J1196 and D8.8-89/SAE HS J1196, *Specification for Automotive Weld Quality—Arc Welding*.

This fourth edition, D8.8M:2007, *Specification for Automotive Weld Quality—Arc Welding of Steel*, includes the following changes: (1) elimination of annexes dealing with various process issues; (2) updated processes to include hybrid welding and tandem arc GMAW; and (3) updated weld measurement requirements to reflect industry standards from Original Equipment Manufacturers (OEMs).

Recent changes in automotive design, caused by the desire to reduce fuel consumption and improve crash performance, have resulted in automotive structures being made of thinner and higher strength metal parts. This specification was undertaken to prepare minimum quality standards for arc welding of various types of components. One objective of the subcommittee was to prepare a specification that would be useful for the OEMs and Tier suppliers of automotive components who may not have quality standards of their own. Another objective is to get as many of the OEMs and Tier suppliers to use and specify this document so there is greater consistency.

Comments and suggestions for the improvement of this standard are welcome. They should be sent to the Secretary, AWS D8 Committee on Automotive Welding, American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

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# Specification for Automotive Weld Quality—Arc Welding of Steel

## 1. Scope

The purpose of this specification is to provide the minimum quality requirements for arc welding of various types of automotive and light truck components. This specification covers the arc and hybrid arc welding of coated and uncoated steels.

This standard makes sole use of the International System of Units (SI).

Safety and health issues are concerns beyond the scope of this specification and, therefore, are not fully addressed herein. Some safety and health information is available from other sources, including, but not limited to ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, and applicable federal and state regulations.

## 2. Normative References

The following specifications contain provisions, which, through reference in this text, constitute provisions of this AWS specification. For these references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this AWS specification are encouraged to investigate the possibility of applying the most recent editions of the documents shown below.

**AWS Documents:**[1]

(1) AWS A2.4, *Standard Symbols for Welding, Brazing, and Nondestructive Examination*; and

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

[1] AWS documents are published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

## 3. Terms and Definitions

All of the terms in this section are used in various parts of this document and require definition for correct interpretation of the instructions. The terms used in this specification shall be interpreted in accordance with the definitions given in the latest edition of AWS A3.0, *Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying*. Some of the terms are listed in AWS A3.0 but their definitions have been enhanced to clarify their use in this document.

For the purposes of this document, the following definitions apply:

**effective weld length.** The portion of a weld that meets all the minimum acceptance requirements of the specification. In a curved weld, the length is measured longitudinally along the axis.

**gap.** The distance between two base components of the joint to be welded (see Figure 1). Note that this distance is typically referred to as the root opening in nonautomotive applications.

**hybrid welding.** Combination of two or more welding processes applied and controlled simultaneously. Designated by HW-XXX/XXX with the dominant process listed first (e.g., HW-LBW/GMAW).

**meltback.** This occurs where the base metal melts back from the edge, but does not become part of the weld. This condition leaves a void between the weld deposit and the base metal (see Figure 2).

**notching.** Gouging of the base metal at the ends or edge of the welded joint (see Figure 3).

**skip.** An unwelded portion of a designated weld (see Figure 2).

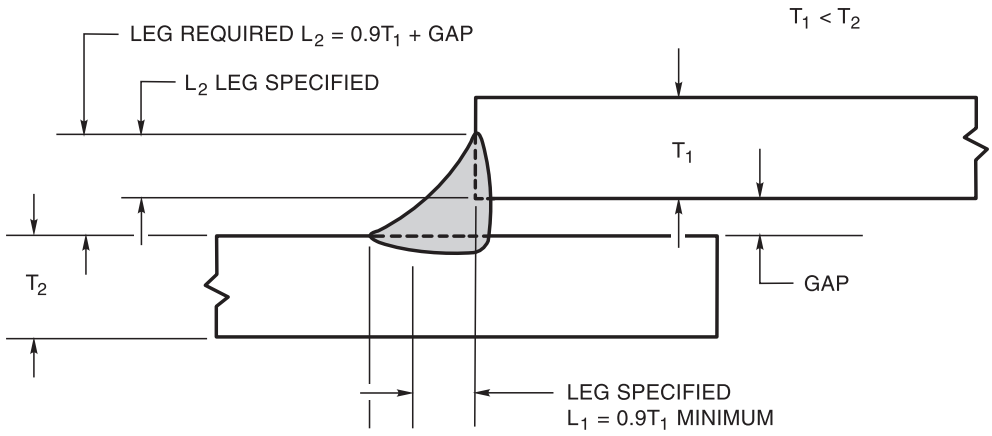



**Figure 1—Fillet Weld**

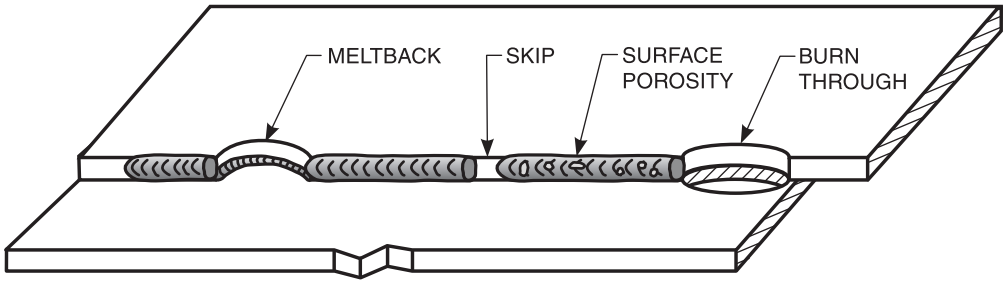



**Figure 2—Examples of Discontinuities Found in Arc Welds**

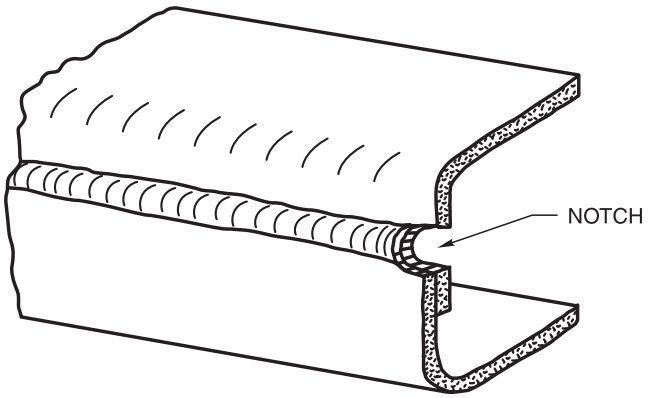



**Figure 3—Example of Notching at End of Weld**

# 4. General Provisions

## 4.1 Application

**4.1.1** This specification provides the minimum quality requirements for arc welding of various types of automotive and light truck components.

**4.1.2** The postweld acceptance requirements contained in this document are mandatory when this specification is referenced on a product drawing, or in a contract. A product that does not conform to the acceptance criteria contained in this specification shall be reworked, scrapped, or accepted by concession.

**4.1.3** Products that are shipped and do not conform may be rejected by the customer, reworked by the customer, or scrapped, all at the producer's expense.

**4.1.4** Any requirements deviating from the limits of this specification shall be designated on the engineering drawings.

**4.1.5** Should any conflict occur between limits specified herein and those specified on the engineering drawings, the latter have precedence.

**4.2 Welding Processes.** This specification covers quality requirements for welds made by the shielded metal arc welding (SMAW), gas metal arc welding (GMAW), metal cored arc welding (MCAW),[2] flux cored arc welding (FCAW), plasma arc welding (PAW), gas tungsten arc welding (GTAW), and hybrid arc welding processes.

**4.2.1 Welding Procedures.** Welding procedures list those variables (and their limits) that influence the quality of the weld. The welding process and weld procedures shall be developed and documented to demonstrate the capability to reliably produce welds on production parts over a specified range of variables. Information pertaining to welding procedure qualification can be found in various AWS and Original Equipment Manufacturer (OEM) standards.

**4.2.2 Filler Metals.** Filler metals shall conform to the requirements of the appropriate AWS filler metal specification. Filler metals used to weld zinc coated steel shall be evaluated for their ability to tolerate the zinc coating.

## 4.3 Limitations

**4.3.1 Material Limitations.** This specification covers the arc and hybrid arc welding of coated and uncoated steels including low carbon steels, stainless steel, high strength low alloy (HSLA) steels, and dual phase (DP) steels with relatively low carbon equivalent (CE) values generally not requiring any preheat or post heat treatment.

[2] Metal Cored Arc Welding is a variation of Gas Metal Arc Welding.

### 4.3.2 Surface Condition of Steel

**4.3.2.1** The surface of the steel part in the weld area, at the time of welding, should be free from scale, rust, paint, lubricants, and other contaminants that could adversely affect the weld quality.

**4.3.2.2** Lubricants for high pressure hydroforming applications tend to be more difficult to remove. Consult with the lubricant supplier for the recommended lubricant removal process.

### 4.3.3 Joint Fit

**4.3.3.1** To ensure proper joint fit, all parts shall be located for maximum weld effectiveness, i.e., minimum gap and repeatable location.

**4.3.3.2** To ensure consistent weld quality in fillet welds, the joint gap should not exceed $0.3T_1$ where $T_1$ is the thickness of the thinnest part. Additionally, the gap should not exceed the diameter of the filler wire. This should be true for all thicknesses in the range from 2 mm to 5 mm for single arc processes. For tandem arc welding, the range from 2 mm to 5 mm material thickness would allow a maximum gap of 2.0 mm. Note that this size gap only applies for welding done in the flat or horizontal positions. For lap penetration joints with high power density processes such as hybrid laser, the joint gap should not exceed 0.2 mm. The specific range of gap values listed above is dependent on the welding process and joint configuration. Larger gaps than specified can adversely affect structural performance or fatigue life.

**4.3.3.3** On lap joints, the edge trim (land) shall leave adequate stock so as to not restrict the ability to make a 1T-leg ($T_1$ = thickness of thinnest member) fillet weld.

**4.4 Welding Symbols.** Welding symbols on product drawings shall be those in AWS A2.4, *Standard Symbols for Welding, Brazing, and Nondestructive Examination*. Special conditions shall be fully explained by added notes or details.

## 4.5 Types of Weld Joints and Applicable Welds

**4.5.1 Butt Joints.** Applicable butt joint welds are as follows:

(1) Square-groove welds

(2) V-groove welds

(3) Bevel-groove welds

(4) U-groove welds

(5) J-groove welds

(6) Flare-V-groove welds

(7) Flare-bevel-groove welds

**4.5.2 T-Joints.** Applicable T-joint welds are as follows:

(1) Fillet welds

(2) Plug welds

(3) Slot welds

**4.5.3 Lap Joints.** Applicable lap joint welds are as follows:

(1) Fillet welds

(2) Plug welds

(3) Slot welds

(4) Arc spot welds

**4.6 Weld Identification and Inspection.** All welding and inspection requirements on the engineering drawing shall be identified per the latest edition of AWS A2.4, *Standard Symbols for Welding, Brazing, and Nondestructive Examination*. All weld symbols on the engineering drawing shall be approved by the engineering authority.

# 5. Weld Quality Requirements

**5.1 Weld Discontinuities.** If not specified on the drawing, the following discontinuities shall not exceed the limits stated below.

**5.1.1 Undercut.** Undercut shall not be permitted within 13 mm of the start or end of the weld. Undercut is permitted to range from 0 to 0.2T over a maximum cumulative length of 1/8 the specified weld length when material thickness exceeds 1 mm. Undercut allowables deviating from this specification shall be specified on the drawing (see Figure 4). Material less than 1mm in thickness shall have no undercut.

**5.1.2 Craters.** Weld craters shall not be considered a part of the effective weld length unless they are filled and meet all the requirements of this specification.

**5.1.3 Cracks.** Cracks shall not be permitted. This applies to craters whether they are considered part of the effective weld length or not.

**5.1.4 Porosity**

**5.1.4.1 Surface Porosity.** Individual pores, separated by at least their own diameter, and other scattered surface porosity shall be permitted. The total length of porosity (sum of diameters) shall not exceed 6 mm in any 25 mm of weld. The maximum pore dimension shall not exceed 1.6 mm.

**5.1.4.2 Internal Porosity.** Internal porosity shall not exceed 15% of the area of the weld being examined.

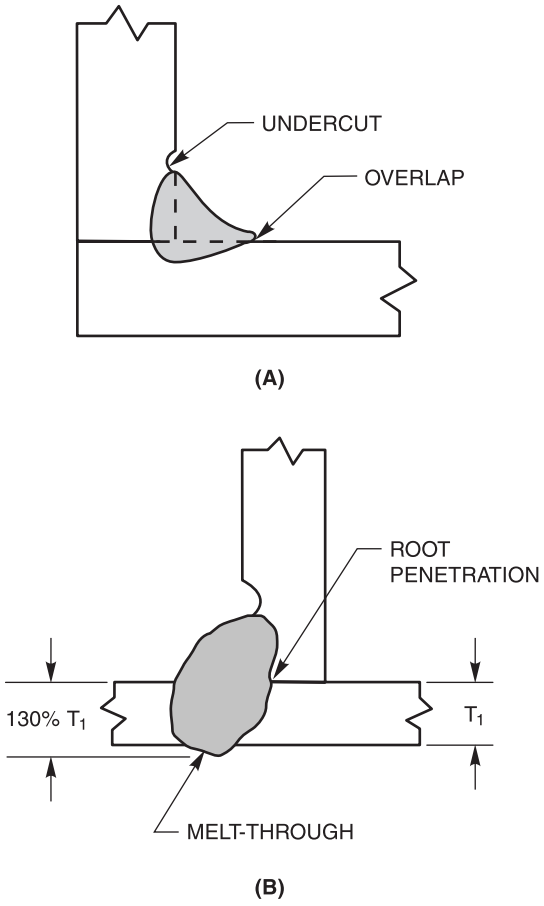



**Figure 4—Examples of Undercut, Melt-Through, Root Penetration, and Overlap**

**5.1.5 Inclusions.** Nonmetallic inclusions shall be considered a discontinuity the same as porosity, the dimensions of which shall be evaluated as per 5.1.4.

**5.1.6 Burn Through.** Holes caused by melting through the base metal shall not be permitted (see Figure 2).

**5.1.7 Meltback.** Meltback in lap fillet welds shall not exceed the stock thickness at top and shall decrease to zero at the root of the joint (see Figure 2). Complete fusion shall be obtained at the root of the joint.

**5.1.8 Melt-Through.** Melt-through shall not exceed 130%$T_1$ (see Figure 4).

**5.1.9 Notching.** Notching or gouging of the base metal at the ends or at the edge of the joint shall not be permitted (see Figure 3).

**5.1.10 Overlap**. The protrusion of weld metal beyond the weld toe is not allowed. This does not refer to the nonstandard use of the term "overlap" that refers to the continuation of a weld over the start/stop of a weld (see Figure 32 of AWS 3.0).

**5.1.11 Spatter.** The amount of spatter present shall not interfere with the fit or function of the part.

**5.1.12 Combination of Discontinuities.** The presence of more than one of the above discontinuities in any weld shall not be permitted if any one of the evaluated discontinuities (inclusions, undercut, porosity, or meltback) is at the maximum permissible limit.

**5.1.13 Metallographic Samples**. Metallographic samples shall be used to determine weld fusion to side walls of fillet weld in holes, slot welds and flared joints, and depth of fusion in arc spot, plug, slot welds and welds in holes or slots. Minimum side wall fusion shall be $0.1T_1$ and depth of fusion on the bottom plate shall be $0.2T_2$.

### 5.2 Dimensional Requirements

#### 5.2.1 Weld Length

**5.2.1.1** Unless specifically noted on the engineering drawings, the effective weld length shall not be less than 90% of the specified weld length.

**5.2.1.2** Any portion of a weld not meeting the individual quality requirements shall not be included in the effective weld length as defined in Clause 3.

**5.2.1.3** Welds shall be permitted to be longer than specified, provided that the part configuration maintains fit and function (does not interfere with part fit-up or mating).

**5.2.1.4** For non-specified weld lengths, the minimum acceptable weld length is determined by the available joint length that can be effectively welded, i.e., one needs to weld full length. In addition, this situation must be agreed to in writing by the customer and supplier.

#### 5.2.2 Weld Location

**5.2.2.1** All welds shall be located on or in the joint in a manner that ensures the parts are adequately joined to meet or exceed the minimum acceptance requirements of this specification.

**5.2.2.2** Any portion of the weld that is off the seam shall not be included in the effective weld length.

**5.2.2.3** Where a specified weld start and/or stop location is given, the start and stop points of the weld shall be within 6 mm of those shown on the drawing, as long as the part maintains fit and function.

### 5.3 Weld Size

#### 5.3.1 Fillet Welds

**5.3.1.1** Figures 5(A) and (B) identify the nomenclature which describes the cross section of a fillet welded T-joint. Figure 6 illustrates both convex and concave fillet welds in lap and T- joints.

**5.3.1.2** The length of the legs of a fillet weld on each side of the joint determines the fillet size. For purposes of determining the fillet leg size, only the fused portion of the leg (see Figure 7) shall be included and shall conform to the following dimensions:

(1) The minimum leg size shall be equal to 90% of the thickness of the thinner material being welded.

(2) When gaps are present, the leg where the gap appears must be increased by the amount of the gap (see Figure 1).

**5.3.1.3** The weld throat thickness shall conform to the following:

(1) The minimum theoretical throat thickness shall not be less than 60% of the thinner material being welded (see Figure 6).

(2) There shall be no maximum convexity or concavity requirement, provided that all other requirements of this specification are in compliance.

#### 5.3.2 Welds in Butt and Groove Joints

**5.3.2.1** The types of welds in butt joints are listed in 4.5.1.

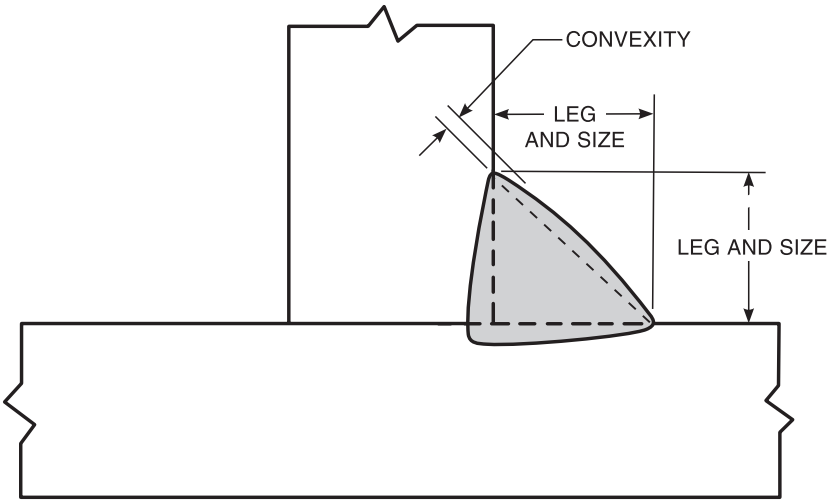
**5.3.2.2** The effective weld size shall be equal to the thickness of the thinner material being joined or that portion within the limits of the thickness of the thinnest sheet.

**5.3.2.3** No limit shall be set on the height of the weld reinforcement (face and root), if all other provisions of this Specification are in compliance (see Figure 8).

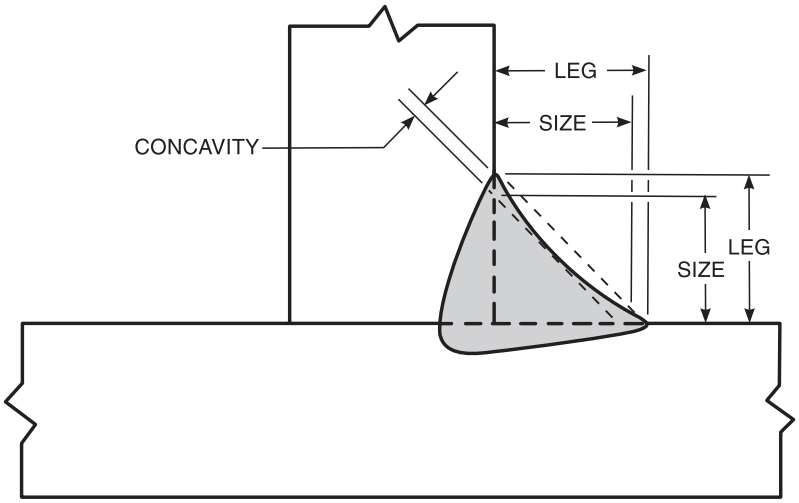
**5.3.2.4** The joint penetration shall extend beyond the joint preparation into the base metal (see Figure 9).

**5.3.2.5** Weld size and definitions for flare-bevel and flare-V-groove welds shall be used as shown in Figures 10 and 11.

**5.3.3 Arc Spot, Plug, Slot Welds, and Fillet Welds in Holes or Slots.** There are many types of arc spot, plug, slot welds and fillet welds in holes or slots that have different strength levels and quality requirements. Strength requirements of welds are not addressed in this standard and only geometric criteria are specified in the standard. See text and figures for examples of Arc Spot, Plug, and Slot Welds, and Fillet Welds in Holes and Slots.




(A) FILLET (CONVEX) WELDED T-JOINT




(B) FILLET (CONCAVE) WELDED T-JOINT

**Figure 5—Fillet Welded T-Joints**

**5.3.3.1 Depth of Fusion.** The minimum depth of fusion for Arc Spot Welds shall be $0.2T_2$ (bottom member) (see Figure 12). For Plug and Slot welds, there shall be fusion between the sidewalls of the top part and interface (see Figure 13). This should not be confused with fillet welded hole or slot welds.

**5.3.3.2 Depth of Fill.** The effective depth of filling shall be the thickness of the thinner material being joined [see Figures 13(A) and (B)].

**5.3.3.3 Weld Profile.** The weld profile shall conform to the following provisions:

(1) There is no maximum reinforcement as long as fit and function are maintained, and

(2) Any underfill requirement shall be specified on the drawings [see Figure 13(C)].

**5.3.3.4 Weld Dimensions.** The following minimum dimensions should be observed when welding arc spot, plug, slot welds, and fillet welds in slots:

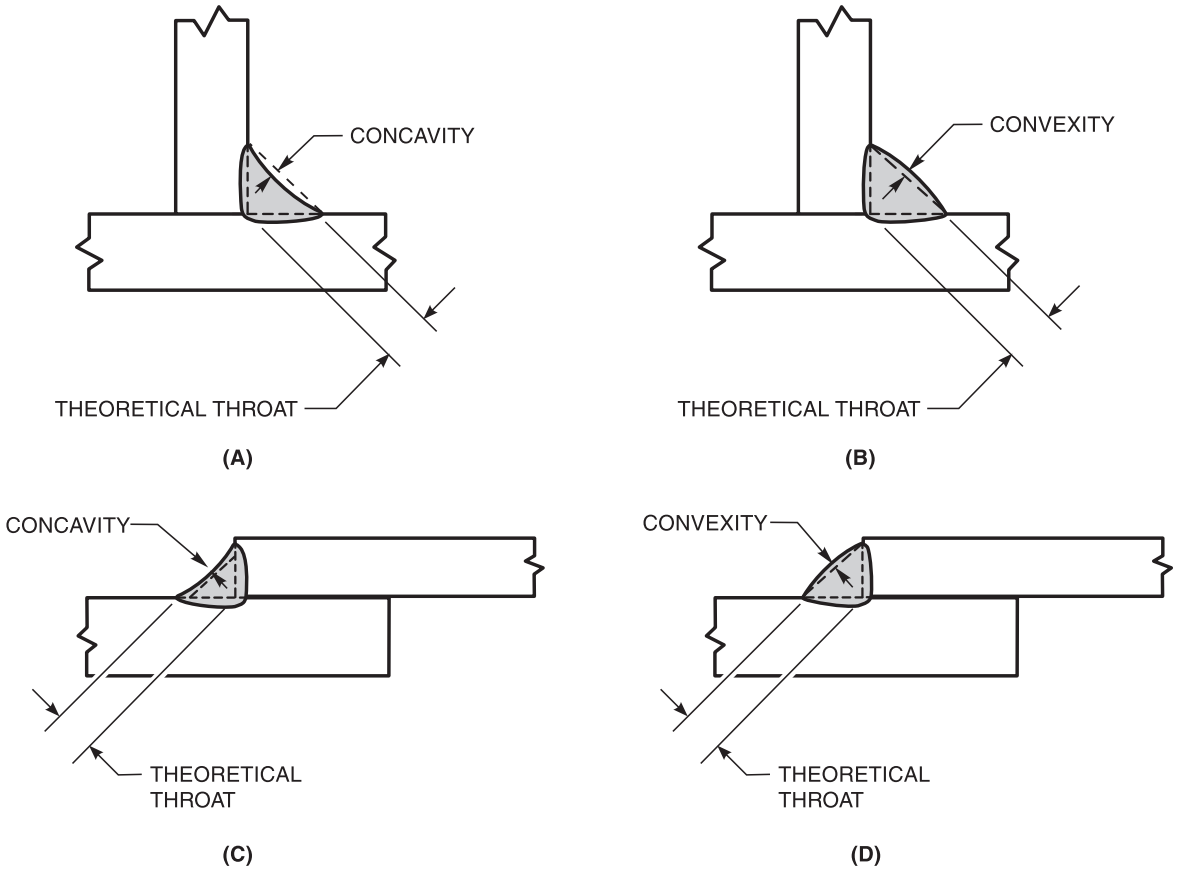



**Figure 6—Illustration of Fillet Welds—Concavity and Convexity**

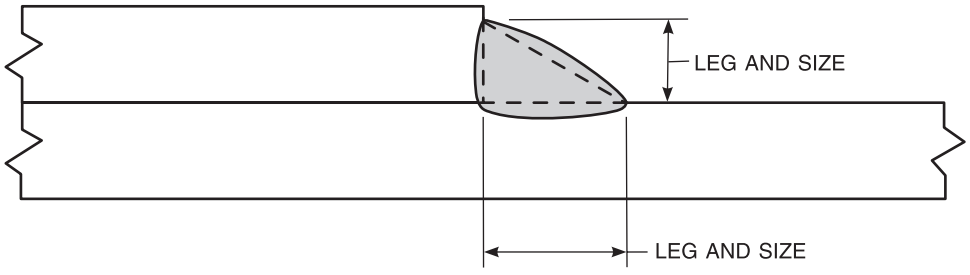



**Figure 7—Leg Length of a Lap Fillet Weld**

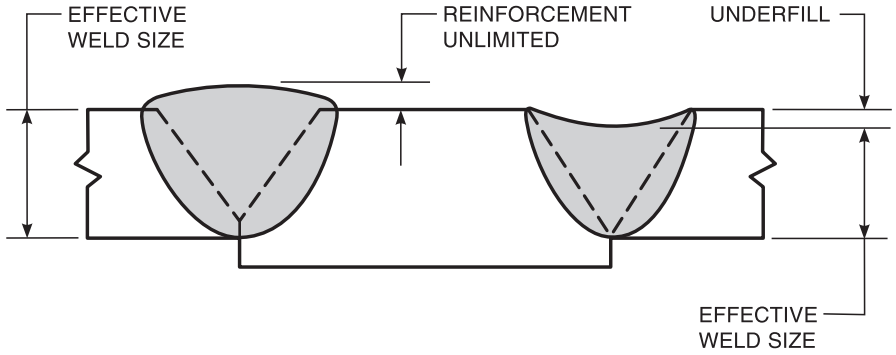



**Figure 8—Effective Weld Size**

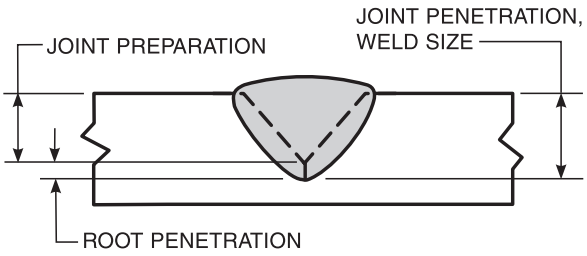
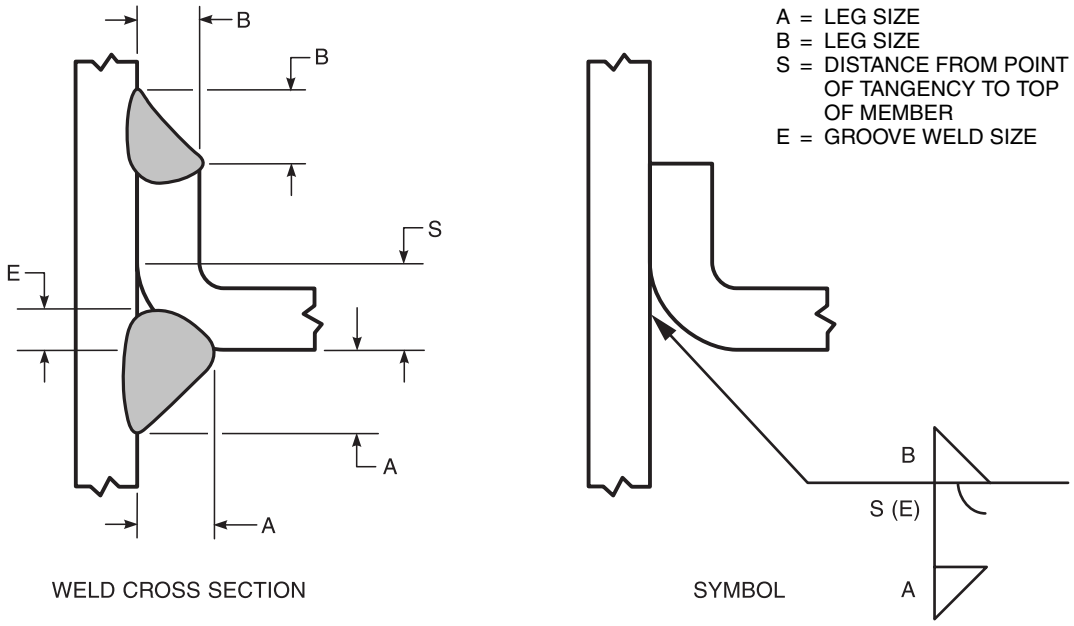
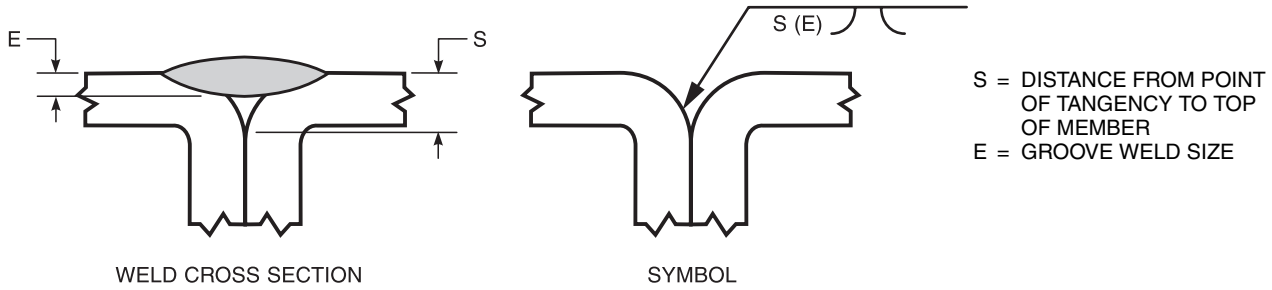



**Figure 9—Partial Joint Penetration Groove Weld**




*Source:* Adapted from AWS A2.4-98, *Standard Symbols for Welding, Brazing, and Nondestructive Examination*, Figure 20(B).

**Figure 10—Flare-Bevel-Groove Weld**




*Source:* Adapted from AWS A2.4-98, *Standard Symbols for Welding, Brazing, and Nondestructive Examination*, Figure 20(A).

**Figure 11—Flare-V-Groove Weld**

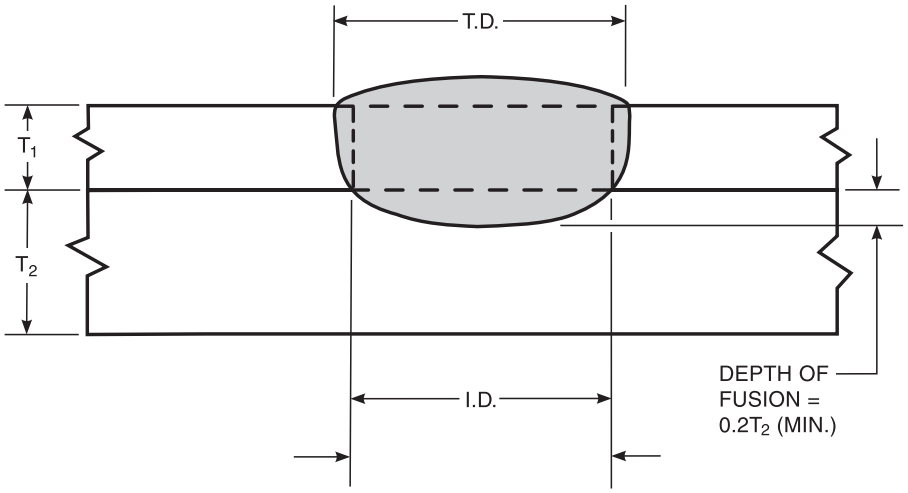



**Figure 12—Arc Spot Weld**

(1) *Arc spot welds.* The top diameter should be at least four times the thickness of the thinner material ($T_1$) being welded. The interface diameter (weld size) shall be at least four times the square root of the thinner material ($4\sqrt{T_1}$) being welded (see Figure 12).

(2) *Plug welds.* The top diameter should be at least 3 mm larger than the hole size. The interface diameter (weld size) shall be at least four times $\sqrt{T_1}$, where $T_1$ is the thickness of the thinner material being welded (see Figure 14).

(3) *Slot welds.* The length of the slot for a slot weld should not exceed ten times the thickness (10T) of the part containing it. The width of the slot shall be no less than the thickness of the part containing it plus 8 mm. The maximum width shall equal the minimum width plus 3 mm or 2-1/4 times the thickness of the member, whichever is greater. The depth of filling of slot or slot welds shall be equal to or greater than 90% of the thickness of the slotted material.

(4) *Fillet welds in a slot.* Single fillet welds on material thickness of 3 mm, or less, should have a slot width of at least 10 mm and a minimum slot length of 25 mm. Stock thickness of more than 3 mm for single fillet welds in slots should have a minimum slot width of 13 mm and

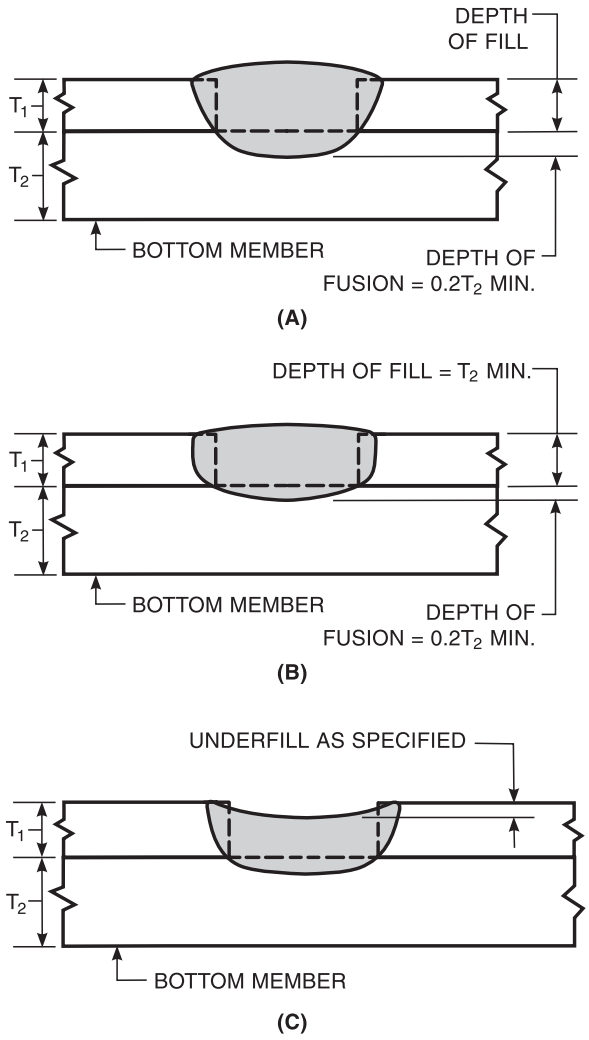



**Figure 13—Plug Weld Profiles—A, B, and C**

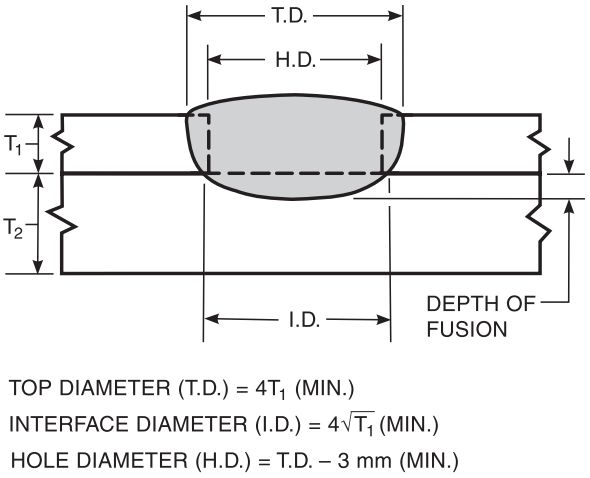
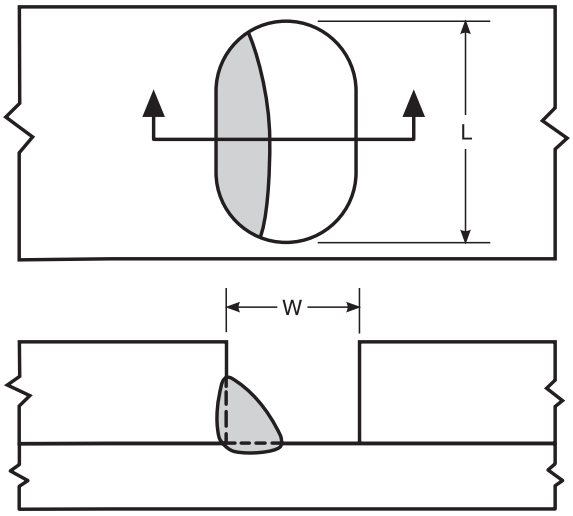



**Figure 14—Arc Plug Weld**

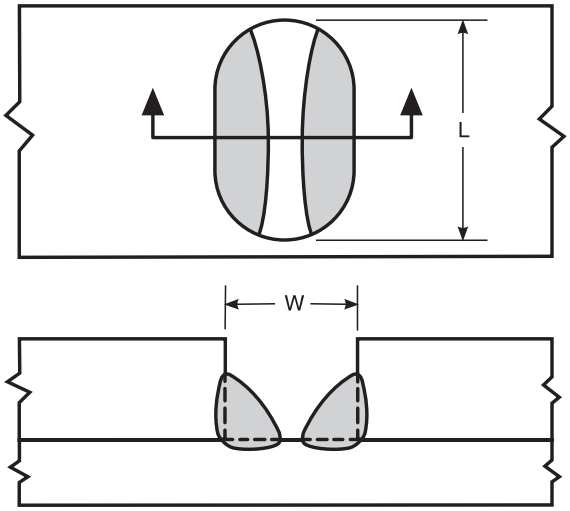
a minimum slot length of 32 mm (see Figure 15). A double fillet weld in a slot on material thickness of 3 mm or less should have a width of at least 13 mm and a minimum length of 25 mm on each of the two sides of the slot. A double fillet weld in a slot on stock thickness of more than 3 mm should have a width of at least 16 mm and a minimum length of 32 mm on each of the two sides of the slot (see Figure 16).

(5) *Fillet weld in a hole.* The minimum hole diameter for a fillet weld in a hole should be no less than the thickness of the part containing the hole, plus 8 mm (see Figure 17).



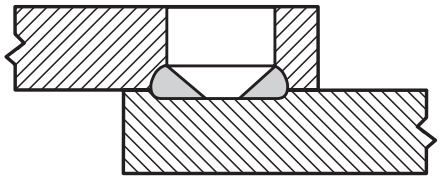

| Metal Thickness mm | Slot Width (W) mm | Slot Length (L) mm |
|---|---|---|
| ≤3 | 10 | 25 |
| >3 | 13 | 32 |

**Figure 15—Single Fillet Weld in a Slot**

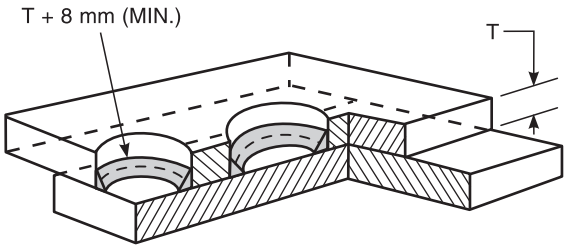



| Metal Thickness mm | Slot Width (W) mm | Slot Length (L) mm |
|---|---|---|
| ≤3 | 13 | 25 |
| >3 | 16 | 32 |

**Figure 16—Double Fillet Weld in a Slot**



(A)




(B)

**Figure 17—Fillet Weld in Holes**

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# Annex A (Informative)

# Guidelines for the Preparation of Technical Inquiries

This annex is not part of AWS D8.8M:2007, *Specification for Automotive Weld Quality—Arc Welding of Steel*, but is included for informational purposes only.

## A1. Introduction

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 interpretations are made by the committee that is responsible for the standard. Official communication concerning an interpretation is directed through the AWS staff member who works with that committee. The policy requires that all requests for an interpretation be submitted in writing. Such requests will be handled as expeditiously as possible, but due to the complexity of the work and the procedures that must be followed, some interpretations may require considerable time.

## A2. Procedure

All inquiries shall be directed to:

Managing Director
Technical Services Division
American Welding Society
550 N.W. LeJeune Road
Miami, FL 33126

All inquiries shall contain the name, address, and affiliation of the inquirer, and they shall provide enough information for the committee to understand the point of concern in the inquiry. When the point is not clearly defined, the inquiry will be returned for clarification. For efficient handling, all inquiries should be typewritten and in the format specified below.

**A2.1 Scope.** Each inquiry shall address one single provision of the standard unless the point of the inquiry involves two or more interrelated provisions. The provision(s) shall be identified in the scope of the inquiry along with the edition of the standard that contains the provision(s) the inquirer is addressing.

**A2.2 Purpose of the Inquiry.** The purpose of the inquiry shall be stated in this portion of the inquiry. The purpose can be to obtain an interpretation of a standard's requirement or to request the revision of a particular provision in the standard.

**A2.3 Content of the Inquiry.** The inquiry should be concise, yet complete, to enable the committee to understand the point of the inquiry. Sketches should be used whenever appropriate, and all paragraphs, figures, and tables (or annex) that bear on the inquiry shall be cited. If the point of the inquiry is to obtain a revision of the standard, the inquiry shall provide technical justification for that revision.

**A2.4 Proposed Reply.** The inquirer should, as a proposed reply, state an interpretation of the provision that is the point of the inquiry or provide the wording for a proposed revision, if this is what the inquirer seeks.

## A3. Interpretation of Provisions of the Standard

Interpretations of provisions of the standard are made by the relevant AWS technical committee. The secretary of the committee refers all inquiries to the chair of the particular subcommittee that has jurisdiction over the portion of the standard addressed by the inquiry. The subcommittee reviews the inquiry and the proposed reply to determine what the response to the inquiry should be. Following the subcommittee's development of the response, the inquiry and the response are presented to the entire committee for review and approval. Upon approval by the committee, the interpretation is an official

interpretation of the Society, and the secretary transmits the response to the inquirer and to the *Welding Journal* for publication.

## A4. Publication of Interpretations

All official interpretations will appear in the *Welding Journal* and will be posted on the AWS web site.

## A5. 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.

## A6. AWS Technical Committees

The activities of AWS technical committees regarding interpretations are limited strictly to the interpretation of provisions of standards prepared by the committees or to consideration of revisions to existing provisions on the basis of new data or technology. 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.

## List of AWS Documents on Automotive Welding

| | |
|---|---|
| D8.1M | *Specification for Automotive Weld Quality—Resistance Spot Welding of Steel* |
| D8.6 | *Specification for Automotive Resistance Spot Welding Electrodes* |
| D8.7 | *Recommended Practices for Automotive Weld Quality—Resistance Spot Welding* |
| D8.9M | *Recommended Practices for Test Methods for Evaluating the Resistance Spot Welding Behavior of Automotive Sheet Steel Materials* |
| D8.14M | *Specification for Automotive Weld Quality—Arc Welding of Aluminum* |

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