

ANSI/AWS D8.8-89
SAE HS J1196
An American National Standard

**Specification for
Automotive Frame
Weld Quality—
Arc Welding**



American Welding Society

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Specification for Automotive Frame Weld Quality—Arc Welding

Supersedes AWS D8.8-79

Prepared by
AWS/SAE Joint Committee on Automotive Welding

Under the Direction of
AWS Technical Activities Committee
and SAE Materials, Processes, and
Parts Divisions Council

Approved by
AWS Board of Directors
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Abstract

Defined in this specification are practical tolerances needed to achieve satisfactory weld quality when dealing with the production volumes associated with automotive structural parts. Gaps in the weld joints have a significant effect on structural performance and weld quality. Automatic and robotic arc welding require good part fitup in the weld joints for consistent weld quality. Therefore, metal stampings and press formed parts must be made to produce weld joint fits within the allowable gap of this specification.



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Foreword

(This Foreword is not a part of ANSI/AWS/SAE D8.8-89, *Specification for Automotive Frame Weld Quality—Arc Welding*, but is included for information purposes only.)

This *Specification for Automotive Frame Weld Quality—Arc Welding* was developed by the Subcommittee on Automotive Weld Quality—Arc Welding of the AWS/SAE Joint Committee on Automotive Welding.

Prior to 1979, this specification was developed by a subcommittee on Automotive Frame Weld Quality made up of members of the AWS/SAE Joint Committee on Automotive Welding. Arc welding of large passenger car frame structures with relatively thick metal parts and gas metal arc welding (GMAW) using CO₂ shielding gas are reflected in AWS D8.8-79/SAE HS J1196, *Specification for Automotive Frame Weld Quality—Arc Welding*.

Recent changes in automotive design caused by the desire to reduce fuel consumption has resulted in automotive structures being made of thinner metal parts.

More automatic and robot welding of these thinner metal parts with GMAW and argon rich shielding gases has resulted. Revision of the older AWS D8.8-79/SAE HS J1196 *Automotive Frame Welding Quality—Arc Welding* specification was done by the 1985-1986 Subcommittee on Automotive Arc Welding to reflect the arc welding features of the automotive industry in the mid-nineteen eighties.

The specification was undertaken to prepare minimum quality standards for arc welding of automotive frames and components associated with the frame. One objective of the subcommittee was to prepare a specification that would be useful for the smaller suppliers of automotive components, who generally have no quality standards of their own, in the establishment of standards for minimum arc welding quality in their plants.

This standard is the third published under the auspices of the AWS/SAE Joint Committee on Automotive Welding. The Society of Automotive Engineers lists this document as an SAE recommended practice, but does not include it in the SAE Handbook. However, it is referenced in the SAE Information Report J1147. This specification can be purchased at the same price from either the American Welding Society or the Society of Automotive Engineers.

Comments and inquiries concerning this specification are welcome. They should be addressed to Technical Director, American Welding Society, 550 N.W. LeJeune Road, P. O. Box 351040 Miami, Florida 33135.

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Specification for Automotive Frame Weld Quality—Arc Welding

1. Scope

The purpose of this specification is to provide the general minimum quality requirements necessary for automotive welding and to set limitations for the various types of discontinuities encountered.

2. General Provisions

2.1 Application

2.1.1 This specification is applicable to the design and manufacture of passenger car, truck, and similar vehicle structures when specified on engineering drawings.

2.1.2 Any requirements exceeding the limits of this specification shall be designated on the engineering drawings.

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

2.2 Welding Processes. This specification covers quality requirements for welds made by the shielded metal arc welding (SMAW), gas metal arc welding (GMAW), flux cored arc welding (FCAW), and gas tungsten arc welding (GTAW) processes.

2.3 Limitations

2.3.1 Material. This specification covers the welding of uncoated carbon steels, including uncoated readily weldable high-strength, low-alloy (HSLA) steels, that do not require preheat or postheat. These steels generally have a carbon equivalent (C.E.) not exceeding 0.40 percent maximum, as determined by the following formula:¹

$$\text{C.E.} = \%C + \frac{\%Mn}{6} + \frac{\%Ni}{20} + \frac{\%Cr}{10} + \frac{\%Cu}{40} - \frac{\%Mo}{50} - \frac{\%V}{10}$$

1. G. E. Linnert. *Welding metallurgy*, Vol. 2, 3 Ed. American Welding Society: Miami, 1967, p. 394.

2.3.2 Joint Fit

2.3.2.1 To ensure proper joint fit, all parts should be accurately located for welding.

2.3.2.2 The maximum allowable gap between adjacent members in the joint should be limited to the thickness of the thinner member or .060 in. (1.5 mm), whichever is the smaller dimension. Except in the case of heavier gauges above .125 in. (3 mm), the gap may not exceed .090 in. (2.3 mm).

2.3.3 Welding Equipment and Procedure. Responsible technical personnel shall determine that the welding equipment and procedures are capable of producing consistently sound welds.

2.3.4 Welding Consumables. The filler metal must conform to the requirements of the appropriate AWS filler metal specification. Classification designations must be specified by the responsible technical personnel.

2.4 Definitions

2.4.1 The welding terms used in this specification shall be interpreted in accordance with the definitions given in the latest edition of ANSI/AWS A3.0, *Standard Welding Terms and Definitions*, supplemented by 2.4.2.

2.4.2 The following terms and definitions are not defined in ANSI/AWS A3.0, but are defined as they relate to this specification:

2.4.2.1 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 1.

2.4.2.2 Gap. The distance between two base components of the joint to be welded. See Figure 2. Note that this distance can sometimes be referred to as the root opening.

2.4.2.3 Skip. An unwelded portion of a designated weld. See Figure 1.

2.4.2.4 Notching. Gouging of the parent metal at the ends or edge of the welded joint. See Figure 3.

2.5 Welding Symbols. Welding symbols on product drawings shall be those in the latest edition of ANSI/AWS A2.4, *Symbols for Welding and Nondestructive Testing*. Special conditions should be fully explained by added notes or details.

2.6 Safety Precautions. Use of the welding processes and consumables are safe, provided proper procedures are followed and precautions taken. If these procedures and precautions are followed, welding, cutting, and allied processes can be done safely with minimal health risk.

FUMES AND GASES can be dangerous to your health. Keep your head out of the fumes. Use enough ventilation, exhaust at the work, or both, to keep fumes and gases from your breathing zone and the general area.

ARC RAYS can injure the eyes.

INFRARED (HEAT) RADIATION can cause burns.

ELECTRIC SHOCK can kill. Do not touch live electrical parts. Read and understand the manufacturer's instructions and your employer's safety practices.

Before using the processes and consumables, acquaint yourself and those for whom you are responsible with the proper procedure and precautions. The primary source for these is contained in ANSI Z49.1, *Safety in Welding and Cutting*, available from the American Welding Society, P.O. Box 351040, Miami, FL 33135.

Another excellent source of safety and health information in easy to understand form is a series of fact sheets that have been collected and are available from the American Welding Society. The titles are listed below:

Fumes and Gases	Burn Protection
Radiation	Mechanical Hazards
Noise	Fire Prevention
Chromium and Nickel in Welding Fume	Tripping and Falling
Electrical Hazards	Falling Objects
Fire Prevention	Confined Spaces

2.7 Standard Units of Measurements. The values stated are from the U.S. Federal Register and are regarded as standard units. The metric (SI) equivalents are those of the U.S. Department of Commerce/National Institute of Standards and Technology. They may be approximate.

2.8 Types of Weld Joints and Applicable Welds

2.8.1 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

2.8.2 T-Joints. Applicable T-joint welds are as follows:

- (1) Fillet welds
- (2) Plug welds
- (3) Slot welds
- (4) Square-groove welds
- (5) Bevel-groove welds
- (6) J-groove welds
- (7) Flare-bevel-groove welds

2.8.3 Lap Joints. Applicable lap joint welds are as follows:

- (1) Fillet welds
- (2) Plug welds
- (3) Slot welds
- (4) Bevel-groove welds
- (5) J-groove welds
- (6) Flare-bevel-groove welds
- (7) Arc spot welds

2.9 Structural Classifications

2.9.1 Critical Locations. These are locations where failure would affect the structural integrity of the product when used in normal operation. These locations should be noted on the engineering drawing.

2.9.2 Federal Locations. These locations require compliance to the Federal Motor Vehicle Standards. These locations should be so designated on engineering drawings.

2.9.3 Normal or Ordinary Locations. These are locations where failure would not seriously affect normal operation of the product. These locations require no special designation.

3. Requirements

3.1 Weld Length

3.1.1 Unless specifically noted otherwise on engineering drawings, the allowance shown in the following table shall apply:

Specified Length		Short Allowance	
in.	mm	in.	mm
Up to 1	Up to 25	—	—
Over 1 to 6	Over 25 to 150	¼	6.0
Over 6 to 12	Over 150 to 300	½	13.0
Over 12	Over 300	½*	13.0*

*For welds over 12 in. (300 mm) in normal or ordinary locations, an additional 1/2 in. per ft. (42 mm per 1000 mm) of weld is permissible.

3.1.2 Welds may be longer than specified, provided that the part configuration remains functional.

3.2 Weld Location

3.2.1 All welds must be located on or in the joint in a manner to ensure fusion between the parts being joined.

3.2.2 Any portions of the weld either off seam or not properly fused shall be considered skips and shall not be included in the effective weld length.

3.2.3 Where a specified weld start location is given, the start and end points of the weld shall be within 1/4 in. (6 mm) of those shown on the drawing for welds under 6 in. (150 mm) and within 1/2 in. (13 mm) for welds over 6 in. (150 mm) and longer.

3.3 Weld Size

3.3.1 Fillet Welds

3.3.1.1 Figure 4 identifies the nomenclature which describes the cross section of a fillet welded T-joint. Figure 5 illustrates the elements of a lap fillet weld.

3.3.1.2 The length of the legs of a fillet weld on each side of the joint determines the fillet size and shall conform to the following dimensions:

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

(2) When gaps are present, the leg must be increased by the width of the gap. See Figure 5.

3.3.1.3 The weld throat thickness shall conform to the following:

(1) The minimum measured effective throat thickness shall be not less than sixty percent of the thinner material being welded.

(2) There shall be no maximum convexity or concavity requirement, provided that all other requirements of this specification are complied with and the part configuration remains functional and meets performance specifications. See Figure 6.

3.3.2 Welds in Butt Joints

3.3.2.1 The types of welds in butt joints are listed in 2.8.1.

3.3.2.2 The effective weld size shall be equal to or exceed ninety percent of the thickness of the thinner material being joined. See Figure 5.

3.3.2.3 No limit shall be set on the height of the weld reinforcement or convexity, if all other provisions of this specification are complied with and the part remains functional and meets the performance specification requirements. See Figures 7 and 8.

3.3.2.4 The joint penetration shall be to the root of the joint or joint preparation, except as 3.3.2.2 applies. See Figures 7 and 8.

3.3.2.5 Throat, weld size, and positioning definitions for flare-bevel and flare-v-groove welds are shown in Figures 9 and 10.

3.3.3 Arc Spot, Plug, and Slot Welds

3.3.3.1 Depth of Fusion. The minimum depth of fusion shall be twenty percent of the thickness of the bottom member. See Figure 11.

3.3.3.2 Depth of Fill. The effective depth of filling shall be the thickness of the thinner material being joined. See Figure 11.

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

(1) The maximum convexity shall not exceed 1/8 in. (3.0 mm), unless otherwise specified on the drawing. See Figure 12(A).

(2) Any concavity requirement should be specified on the drawings. See Figure 12(B).

3.3.3.4 Weld Diameters. The following minimum diameters shall be observed when welding arc spot welds and plug welds:

(1) Arc Spot Welds. The top diameter shall be at least twice the thickness of the thinner material being welded. The interface diameter (weld size) shall be at least 1.5 times the thickness of the thinner material being welded. See Figure 13(A).

(2) Plug Welds. The top diameter shall be at least 1/8 in. (3.0 mm) larger than the hole size. The interface diameter (weld size) shall be at least equal to the hole diameter. See Figure 13(B).

(3) Slot Welds. Single side slot welds should have a slot width of at least 3T and a minimum weld length of 1/2 in. (12 mm). See Figure 13(C). A double sided slot weld should have a slot width of at least 5T and a minimum weld length of 1/2 in. (12 mm) on each of the two sides of the slot. See Figure 13(D).

3.4 Weld Quality. Unless otherwise specified, the following discontinuities are not permissible in welds:

3.4.1 Undercut. Undercuts exceeding a depth of ten percent of the thickness of the thinner material involved, within 1/2 in. (13.0 mm) of each end of the weld, are not permissible. Undercuts exceeding an average depth of twenty percent of the thinner material thickness at any other location are not permissible.

3.4.2 Craters. Weld craters shall not be considered a part of the designated weld length unless they are filled and meet all the requirements of this standard.

3.4.3 Cracks. Cracks are not permissible.

3.4.4 Porosity. Individual pinholes, separated by at least their own diameter, and other scattered surface porosity will be tolerated. Total length of porosity (sum of diameters) shall not exceed 1/4 in. in any 1 in. (6.4 mm in any 25.4 mm) of weld. The maximum pinhole diameter shall not exceed 1/16 in. (1.6 mm).

3.4.5 Inclusions. Nonmetallic inclusions shall be considered and judged as being porous.

3.4.6 Holes. Holes caused by excessive melt-through during welding are unacceptable.

3.4.7 Burnback. Burnbacks (button hooks) in lap fillet welds must not exceed material thickness at top and must decrease to zero at the root of the joint (see Figure 1). Complete fusion must be obtained at the root of the joint.

3.4.8 Notching. Notching (gouging) of the base metal at the ends or at the edge of the joint is not acceptable. See Figure 3.

3.4.9 Combination of Discontinuities. The presence of more than one of the above discontinuities in any weld is not acceptable if any one of the discontinuities is at the maximum permissible limit.

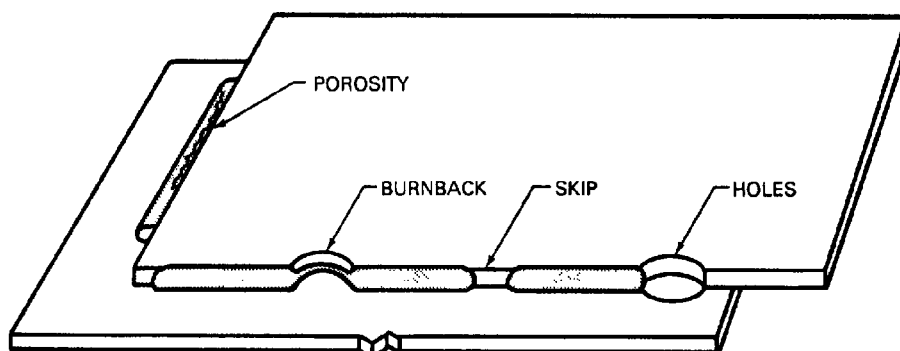


Figure 1—Schematic Examples of Discontinuities Found in Arc Welds

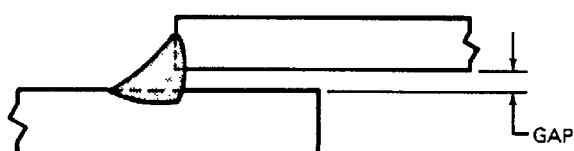


Figure 2—Fillet Weld—Gap

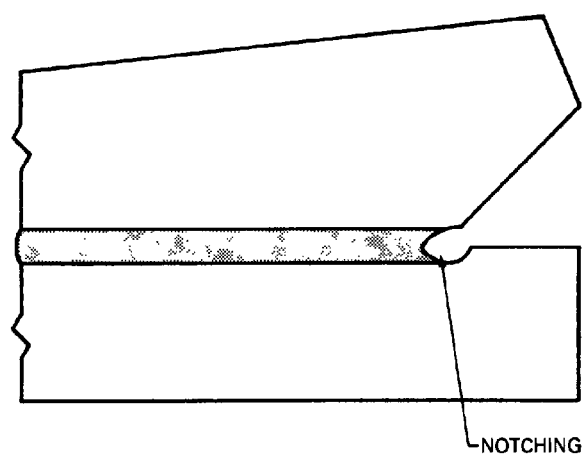
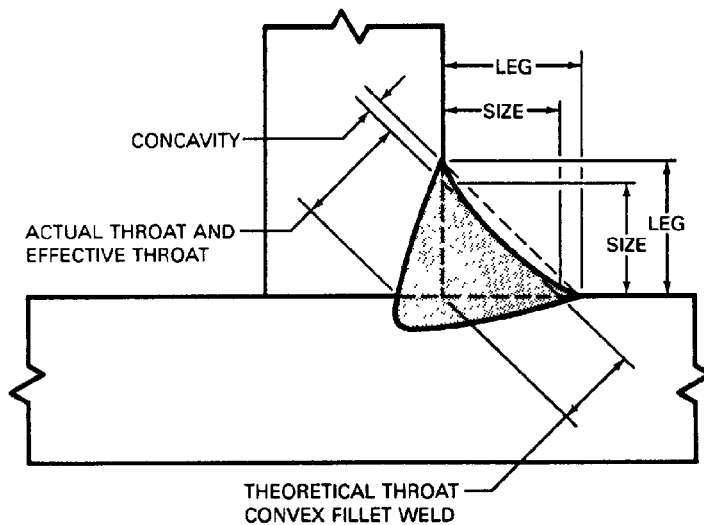
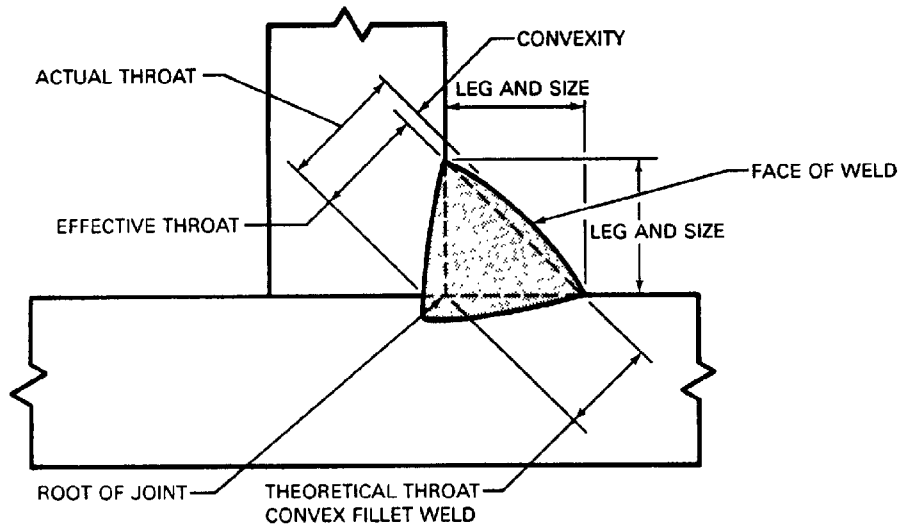


Figure 3—Example of Notching at End of Weld



NOTE: ADDITIONAL TERMS THAT REFERENCE THIS FIGURE: ACTUAL FILLET WELD THROAT, EFFECTIVE FILLET WELD THROAT, FILLET WELD LEG, FILLET WELD SIZE, AND THEORETICAL FILLET WELD THROAT.

Figure 4—Fillet Welded T-Joint

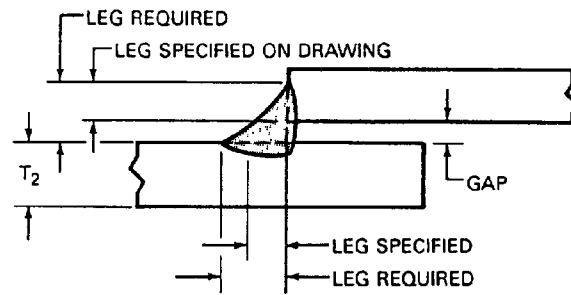


Figure 5—Fillet Weld

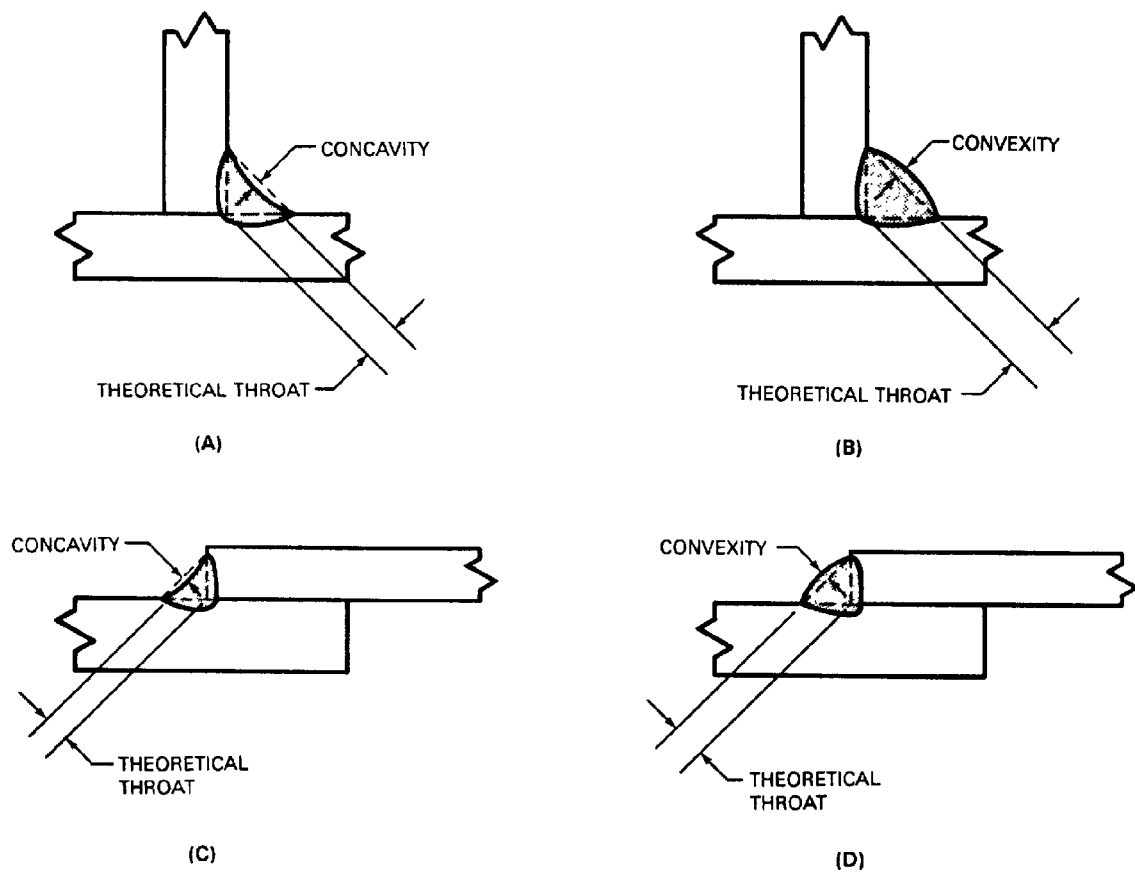


Figure 6—Illustration of Fillet Welds—Concavity and Convexity

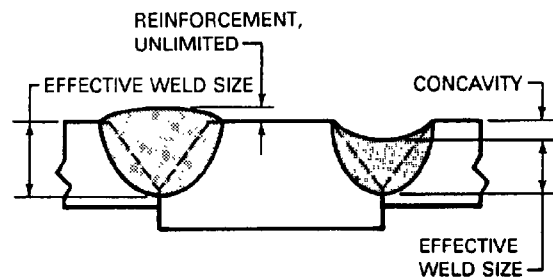


Figure 7—Effective Weld Size

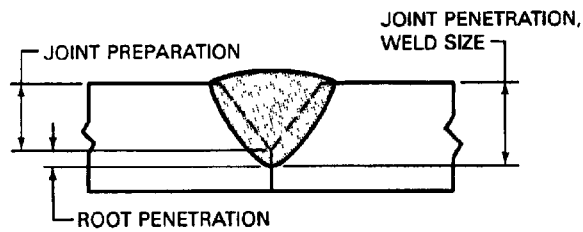


Figure 8—Partial Joint Penetration Groove Weld

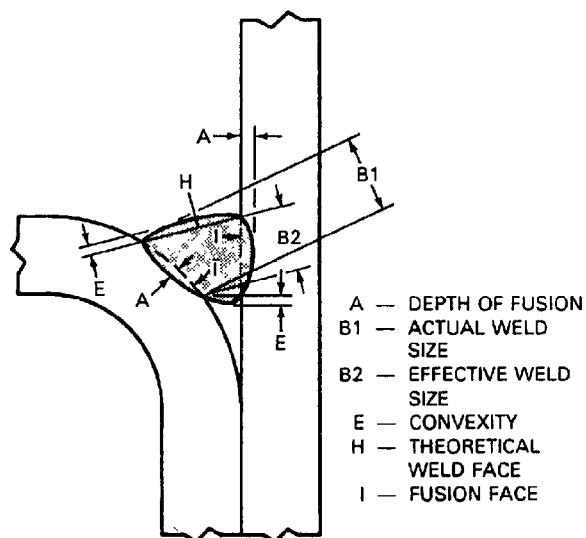


Figure 9—Flare-Bevel-Groove Weld

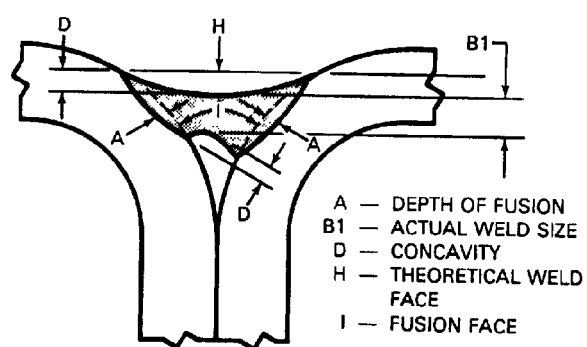


Figure 10—Flare-V-Groove Weld

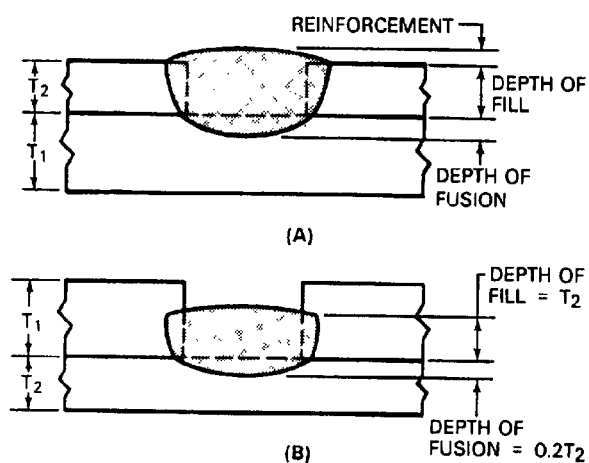


Figure 11—Arc Spot, Plug and Slot Welds

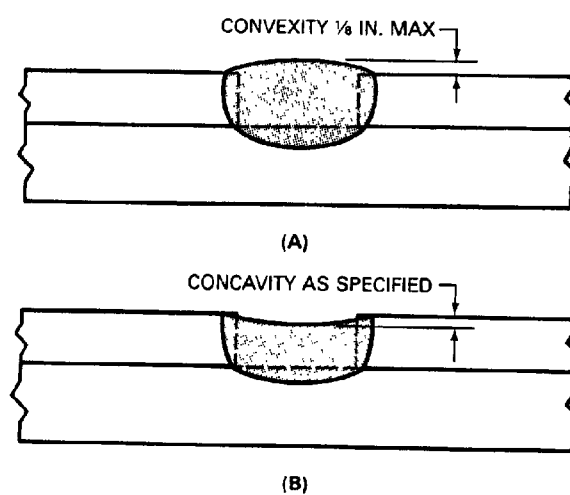
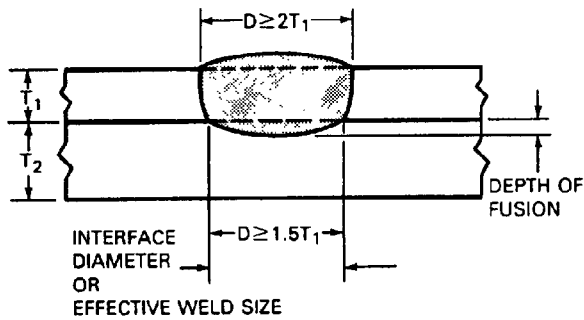
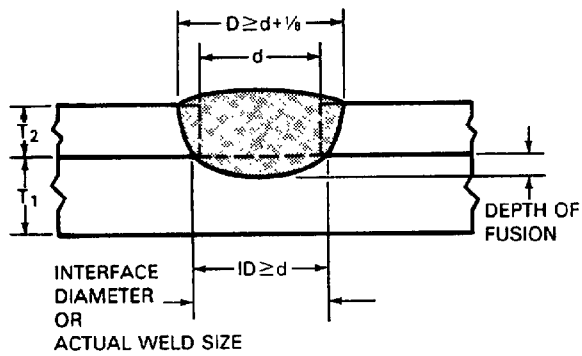
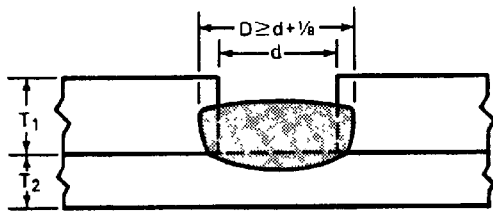


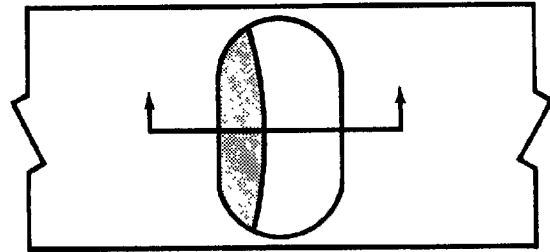
Figure 12—Arc Spot and Plug Welds



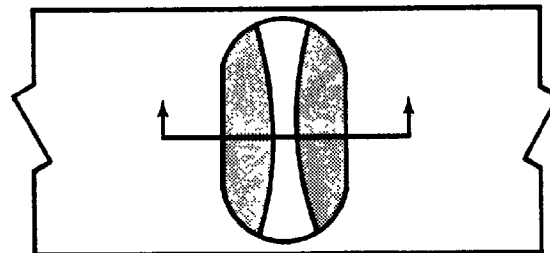
- (A) ARC SPOT WELD. (REQUIREMENT: THE TOP DIAMETER (D) MUST BE AT LEAST $2T_1$ or $2T_2$, WHICHEVER IS LESS; THE INTERFACE DIAMETER (ID) MUST BE AT LEAST $1.5T_1$ or $1.5T_2$, WHICHEVER IS LESS.)



- (B) PLUG WELD. (REQUIREMENT: THE TOP DIAMETER (D) MUST BE AT LEAST THE HOLE DIAMETER PLUS 3.0 mm ($1/8$ IN.); THE INTERFACE (ID) MUST BE AT LEAST EQUAL TO THE HOLE DIAMETER (d))



(C) SINGLE SIDE SLOT WELD



(D) DOUBLE SIDED SLOT WELDS

Figure 13—Schematic Diagram of Arc Spot, Plug and Slot Welds