

AUTOMOTIVE ARC WELDING SPECIFICATION

GM6122M

1 SCOPE.

1.1 The purpose of this specification is to provide acceptance criteria and geometric requirements for automotive arc welding for which GM is responsible for establishing or approving product design.

1.2 The application of the requirements of this specification is mandatory, unless a specific note on the engineering drawing establishes different weld criteria. Any exception from these requirements must be made in accordance with good engineering practice.

1.3 Welds are considered satisfactory when they carry the intended or expected service loads and satisfy functional performance requirements for a required period. Service loads on weldments in a vehicle are varied in both type and magnitude and cannot be addressed by this specification. Therefore, while weld quality criteria of this specification are consistent with service loading requirements, they have been established based on the use of process and product monitoring. Any attempted application of this document to other uses, such as post-crash weld quality assessment, may lead to an erroneous result or conclusion.

1.4 Welds are considered discrepant when they do not meet the criteria of this specification. Discrepant welds often retain some of their engineering properties and may still contribute to the integrity of the assembly.

1.5 The welding source is responsible for establishing practices and test methods to assure that the criteria of this specification are met.

1.6 This specification is applicable to arc welding related to passenger cars, trucks and their components when specified on the engineering drawing. This document is intended to be used as a supplement to engineering drawings and other documents for arc welding. When no arc welding specification is designated on the engineering drawing, this document shall apply for arc welds.

1.7 This specification does not apply for arc spot, plug and slot weld joint types. These joint configurations are covered by the specification GM4491M.

1.8 Any requirements exceeding the limits of this specification shall be designated on the engineering drawing.

1.9 Should any conflict occur between the limits specified herein and those specified on the engineering drawing, the engineering drawing has precedence.

1.10 This specification applies to all metals approved by GM for automotive products joined by arc welding.

1.11 This specification defines the geometric quality requirements for welds made with and without the addition of filler material for the following welding processes:

Gas Metal Arc Welding (GMAW)

Gas Tungsten Arc Welding (GTAW)

Flux Cored Arc Welding (FCAW)

Shielded Metal Arc Welding (SMAW)

Plasma Arc Welding (PAW)

2 REFERENCED STANDARDS.

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ANSI/AWS 2.4

3 GENERAL PROVISIONS.

3.1 Filler metal, when required, shall be designated on the weld symbol or by note on the engineering drawing or other appropriate documents. The designated filler metal must conform to the latest requirements of the appropriate AWS filler metal classification (AWS A5.1, A5.5, A5.8....etc.). Any change in specification or classification of filler metal requires requalification for welding procedure prior to its implementation.

3.2 Responsible technical personnel shall determine that welding equipment and procedures are capable of consistently producing good welds.

3.3 Welding symbols on engineering drawings shall be those in the latest edition of ANSI/AWS 2.4, Standard Symbols for Welding and Non Destructive Examination. The use of auxiliary symbols to clarify location is accepted. Special conditions should be fully explained by added notes or details.

4 STRUCTURAL CLASSIFICATIONS.

4.1 STANDARD WELD. An arc weld for which reasonably anticipated variation is unlikely to affect a product's safety, compliance with government regulations, or fit and function. All welds are drawn as standard welds unless specifically identified by the following weld symbols.

4.2 FIT/FUNCTION WELD. An arc weld for which reasonably anticipated variation is likely to significantly affect customer satisfaction with the product (other than safety/compliance), such as fits, function, performance, durability, mounting, or appearance. Fit/function welds will be identified with a $\diamond$ symbol.

4.3 SAFETY/COMPLIANCE WELD. An arc weld for which reasonably anticipated variation could significantly affect the product safety or its compliance with government regulations such as flammability, occupant protection, steering control, braking. Safety/compliance welds will be identified with a $\odot$ symbol.

5 DEFINITIONS.

5.1 Terms used frequently in this specification are explained in the attached glossary.

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6 TYPES OF WELD JOINTS.

6.1 The weld joints that are covered by this specification are shown in Figure 1.

7 GENERAL WELD REQUIREMENTS.

7.1 The maximum allowable gap between adjacent members in the joint shall be limited to the thickness of the thinner member or 1.5 mm, whichever is the smaller dimension. However, in the case of heavier gauges above 3 mm, the gap must not exceed 2.3 mm.

7.2 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.

7.3 Welds may be longer than specified provided that there is specific structural engineering approval to assure that the part configuration remains functional and all other requirements of this specification are met.

7.4 Short allowances shall be defined to be the total amount of negative weld length tolerance at the joint interface. These short allowances are given in Table 1 below:

TABLE 1 - ARC WELD SHORT ALLOWANCES

Specified Length (mm)	Short Allowance (mm)
0-15	0.0
Over 15-25	3.0
Over 25-150	6.0
Over 150-300	13.0
Over 300	13.0*

*NOTE: For welds over 300 mm an additional 42 mm/1000 mm of weld is permissible.

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

7.6 Welds will not start from or end at any sheet edge. For welds near the end of weldments, the start or end of the weld shall be within 3 to 6 mm from any sheet edge. (See Figure 2).

7.7 Welds shall be located within 6 mm of the specified weld start location shown on the engineering drawing.

7.8 Fusion shall be required for the effective length of the weld which will be defined as the specified length minus the short allowance.

8 FILLET WELDS.

8.1 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:

8.1.1 Minimum fillet weld size shall be 90% of the thickness of the thinner material being welded.

8.1.2 Maximum fillet weld size is not defined so long as the part meets its functional and performance specifications.

8.1.3 When root openings (gaps) are present, the weld size must be increased by the width of the root opening (gap), as shown in Figure 5.

8.2 The theoretical throat shall be not less than 60% of the thinner material being welded as shown in Figure 5.

8.3 There are no convexity limitations provided the part remains functional and meets performance specifications.

9 WELDS IN BUTT JOINTS.

9.1 Joint penetration shall be 100% unless otherwise specified. (See Figure 6).

9.2 No limit shall be set on the height of the weld reinforcement or convexity provided the part remains functional and meets the performance specification requirements.

9.3 Throat, weld size, and positioning requirements for flare-bevel and flare-V-groove welds are shown in Figure 7 (a), (b), (c) and (d).

10 GEOMETRIC DISCREPANCIES.

10.1 Undercut (see Figure 8) exceeding a depth of 10% of the thickness of the affected member, within 13 mm of each end of the weld, is not permissible. Undercut exceeding a depth of 20% at any other location is not permissible.

10.2 Weld craters shall not be considered a part of the designated weld length unless they are filled. All craters shall meet the requirements of this standard.

10.3 Burn-through producing a hole in the weld is not permissible.

10.4 Cracks are not permissible (see Figure 9).

10.5 Meltback is not permissible (see Figure 10).

10.6 Notching is not permissible (see Figure 10).

10.7 Maximum porosity diameter shall not exceed 1.6 mm or $0.5 \times T$ whichever is smaller, where T is the thickness of the thinnest member. The total length of porosity (sum of diameters) shall not exceed 6.4 mm in any 25 mm of weld. Two or more pores which are separated by less than the diameter of the smaller pore(s) is not permissible. Scattered porosity which is within the above limitations is acceptable. Sharp angular porosity is not permissible (see Figure 11).

10.8 Nonmetallic inclusions shall be considered and judged as porosity.

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10.9 Melt through shall not effect the function or fit-up of the part (see Figure 12).

11 DISPOSITION OF NONCONFORMING WELDED PRODUCT.

11.1 Products or components with weld found to be nonconforming to the requirements of the specification must be discarded or repaired using engineering approved procedures.

12 INITIAL SOURCE APPROVAL. No shipment shall be made by any supplier until representative initial production samples have been approved by engineering as meeting the requirements of this specification.

12.1 Completed copies of the GM Material Safety Data Sheet and Critical Material Register (available from the engineering department or laboratory), or equivalent, must be submitted with any new submissions or where a composition change has occurred.

13 INSPECTION AND REJECTION. All shipments of material or parts under contract or purchase order manufactured to this specification shall be equivalent in every respect to the initial samples approved by engineering. There shall be

no changes in either formulation or manufacturing processes permitted without prior notification and approval by engineering. Lack of notification by the supplier constitutes grounds for rejection of any shipment. While samples may be taken from incoming shipments and checked for conformance to this specification, the supplier shall accept the responsibility for incoming shipments meeting this specification without dependence upon purchaser's inspection.

14 APPROVED SOURCES. Engineering qualification of an approved source is required for this specification. Only sources listed in the GM Corporate Materials File under this specification number have been qualified by engineering as meeting the requirements of this specification. Sources are available through the on-line MATSPC System.

15 GENERAL INFORMATION. This standard was originated in May 1947 on an engineering drawing form. The latest revisions include:

Rev	Date	Description	Div
B	4/92	Complete Revision	CPC
C	2/94	Editorial	

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APPENDIX A

GLOSSARY

A1 TERMS AND DEFINITIONS.

ACTUAL THROAT. The shortest distance between the weld root and the face of the fillet weld (see Figure 4).

ARC WELDING. A group of welding processes that produces coalescence of metals by heating them with an arc, with or without the application of pressure, and with or without the use of filler metal.

BURN THROUGH. A non standard term for excessive melt through producing a hole.

BUTT JOINT. A joint between two members aligned approximately in the same plane (see Figure 1(a)).

CHAIN INTERMITTENT WELD. An intermittent weld on both sides of a joint in which the weld increments on one side are approximately opposite those on the other side (see Figure 13).

COALESCENCE. The growing together or growth into one body of the materials being welded.

COLD LAP. Non standard term for overlap. See Overlap.

CONCAVITY. The maximum distance from the face of a concave fillet weld perpendicular to a line joining the weld toes.

CONTINUOUS WELD. A weld that extends continuously from one end of a joint to the other. Where the joint is essentially circular, it extends completely around the joint.

CRACK. A fracture type discontinuity characterized by a sharp tip and high ratio of length and width to opening displacement (see Figure 9).

CRATER. A depression at the termination of a weld bead.

DEPTH OF FUSION. The distance that fusion extends into the base metal or previous pass from the surface melted during welding (see Figure 14).

DISCONTINUITY. An interruption of the typical structure of a weldment, such as a lack of homogeneity in the mechanical, metallurgical, or physical characteristics of the material or the weldment. A discontinuity is not necessarily a defect.

EDGE JOINT. A joint between the edges of two or more parallel or nearly parallel members.

EFFECTIVE THROAT. The minimum distance minus any convexity between the weld root and the face of a fillet weld (see Figure 4A).

FAYING SURFACE. That mating surface of a member that is in contact with or in close proximity to another member to which it is to be joined.

FILLET WELD. A weld of approximately triangular cross section joining two surfaces approximately at right angles to each other in a lap joint, T-joint, or corner joint.

FILLET WELD LEG. The distance from the joint root to the toe of the fillet weld (see Figures 4 and 5).

FILLET WELD SIZE. For equal leg fillet welds, the leg lengths of the largest isosceles right triangle which can be inscribed within the fillet weld cross section. For unequal leg fillet welds, the leg lengths of the largest right triangle that can be inscribed within the fillet cross section (see Figures 4 and 5).

FLUX CORED ARC WELDING (FCAW). An arc welding process that produces coalescence of metals by heating them with an arc between continuous filler metal electrode and the work. Shielding is provided by a flux contained within the tubular electrode. Additional shielding may or may not be obtained from an externally supplied gas or gas mixture.

FUSION. The melting together of filler metal and base metal (substrate), or of base metal only which results in coalescence.

FUSION FACE. A surface of the base metal that will be melted during welding (see Figure 14).

FUSION WELDING. Any welding process that uses fusion of the base metal to make the weld.

FUSION ZONE. The area of base metal melted as determined on the cross section of a weld (see Figure 14).

GAS METAL ARC WELDING (GMAW). An arc welding process that produces coalescence of metals by heating them with an arc between a continuous filler metal electrode and the workpieces. Shielding is obtained entirely from an externally supplied gas.

GAS TUNGSTEN ARC WELDING (GTAW). An arc welding process that produces coalescence of metals by heating them with an arc between a tungsten electrode (nonconsumable) and the workpieces. Shielding is obtained from a gas. Pressure may or may not be used.

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INTERMITTENT WELD. A weld in which the continuity is broken by recurring unwelded spaces (see Figure 3 and 13).

JOINT. The junction of members or the edges of members which are to be joined or have been joined.

JOINT CLEARANCE. The distance between the faying surfaces of a joint.

JOINT PENETRATION. The depth a weld extends from its face into a joint, exclusive of reinforcement (see Figure 15).

JOINT ROOT. That portion of a joint to be welded where the members approach closest to each other. In cross section, the joint root may be either a point, a line, or an area (see Figure 13).

LAP JOINT. A joint between two overlapping members in parallel planes (see Figure 1 (d)).

MELT BACK. 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 10).

MELT-THROUGH. Visible root reinforcement produced in a joint welded from one side (see Figure 12).

MIG WELDING. A non standard term for Gas Metal Arc Welding and Flux Cored Arc Welding.

NOTCHING. Gouging of the parent metal at the ends or edge of the welded joint (see Figure 10).

OVERLAP. The protrusion of weld metal beyond the weld toe or weld root.

PENETRATION. A non standard term for Joint Penetration and Root Penetration.

PLASMA ARC WELDING (PAW). An arc welding process that produces coalescence of metals by heating them with a constricted arc between an electrode and the workpiece (transferred arc) or the electrode and the constricting nozzle (nontransferred arc). Shielding is obtained from the hot, ionized gas issuing from the torch which may be supplemented by an auxiliary source of shielding gas. Shielding gas may be an inert gas or a mixture of gases. Pressure may or may not be supplied.

POROSITY. Cavity type discontinuities formed by gas entrapment during solidification (see Figure 11).

ROOT. A nonstandard term for Joint Root and Weld Root.

ROOT GAP. A nonstandard term for Root Opening.

ROOT OPENING. A separation at the joint root between the workpieces (see Figure 4).

ROOT PENETRATION. The dept that a weld extends into the joint root (see Figure 15).

SHIELDED METAL ARC WELDING (SMAW). An arc welding process that produces coalescence of metals by heating them with an arc between a covered metal electrode and the work pieces. Shielding is obtained from decomposition of the electrode covering. Pressure is not used, and filler metal is obtained from the electrode.

SKIP WELD. A nonstandard term for Intermittent Weld.

SLAG INCLUSION. Nonmetallic solid material entrapped in weld metal or between weld metal and base metal.

SPATTER. The metal particles expelled during arc welding that do not form a part of the weld.

STAGGERED INTERMITTENT WELD. An intermittent weld on both sides of a joint in which the weld increments on one side are alternated with respect to those on the other side (see Figure 13).

STITCH WELD. A nonstandard term for Intermittent Weld.

THEORETICAL THROAT. The distance from the beginning of the joint root perpendicular to the hypotenuse of the largest right triangle that can be inscribed within the cross section of a fillet weld. This dimension is based on the assumption that the root opening is equal to zero (see Figure 5).

THROAT. See actual throat, effective throat.

UNDERCUT. A groove melted into the base metal adjacent to the weld toe or weld root and left unfilled by weld metal (see Figure 8).

UNDERFILL. A depression on the weld face or root surface extending below the adjacent surface of the base metal (see Figure 16).

WELD PENETRATION. A nonstandard term for Joint penetration and Root penetration.

WELD TOE. The junction of the weld face and the base metal.

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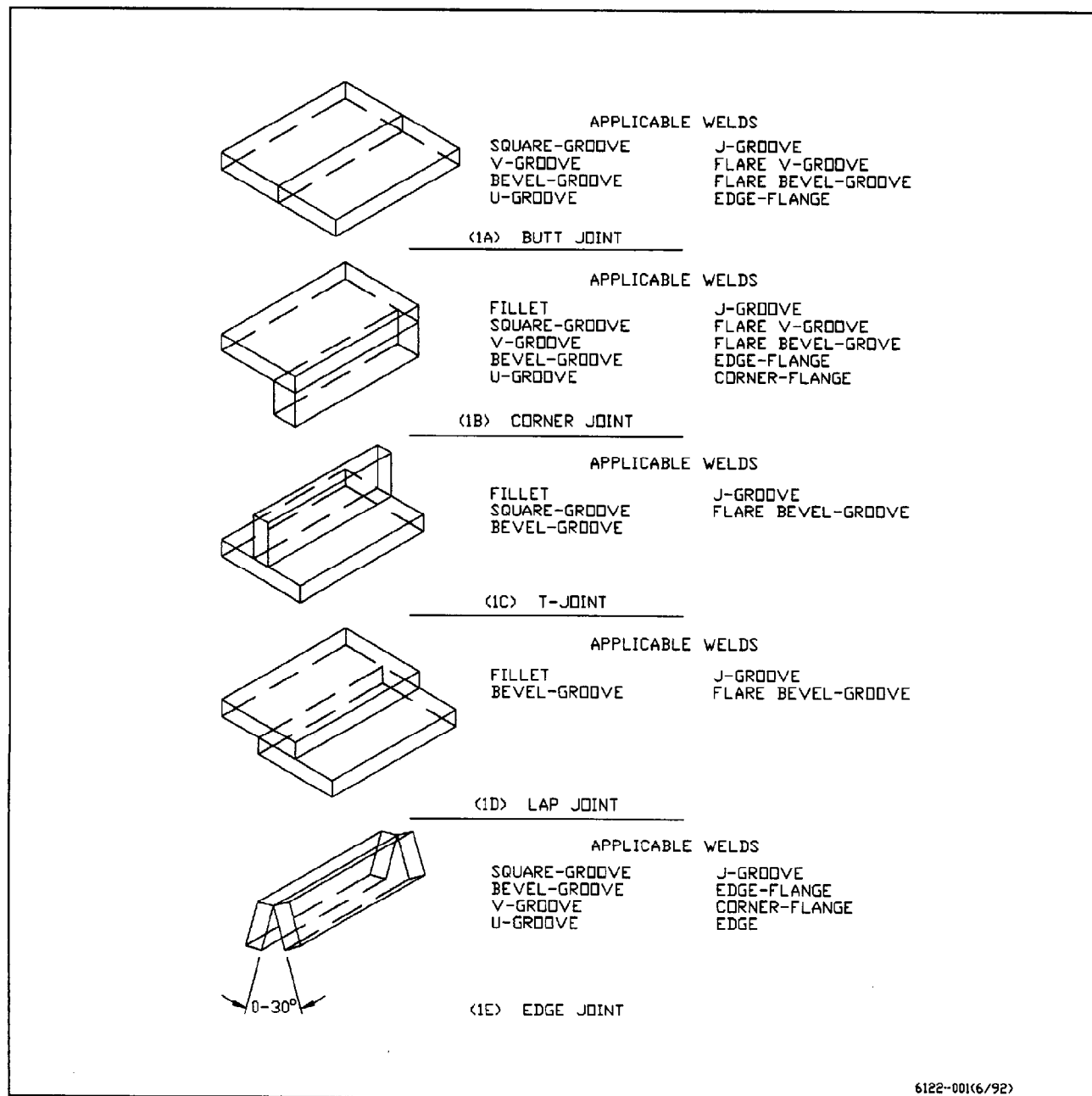
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FIGURE 1 - TYPES OF WELD JOINTS