

INCH-POUND

MIL-W-47091A (MI)

30 June 1992

SUPERSEDING

MIL-W-47091 (MI)

24 May 1974

## MILITARY SPECIFICATION

### WELDING, ARC AND GAS; FOR FABRICATING GROUND EQUIPMENT FOR ROCKETS AND GUIDED MISSILES

This specification is approved for use by the U.S. Army Missile Command, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

#### 1. SCOPE

1.1 Scope. This specification covers electric arc and gas welding of metallic members in ground handling equipment for rockets and guided missiles.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, U.S. Army Missile Command, ATTN: AMSMI-RD-SE-TD-ST, Redstone Arsenal, AL 35898-5270 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC THJM

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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1.2 Classification. Welding covered by this specification shall be classified according to the base metal and shall be of the following types as specified (see 3.2).

- a. Type I Mild steel, high strength mild steel, or low alloy steel (see 6.2).
- b. Type II Aluminum base alloys
- c. Type III Magnesium base alloys
- d. Type IV Corrosion resistant or stainless steel

## 2. APPLICABLE DOCUMENTS

2.1 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.3).

## SOCIETY OF AUTOMOTIVE ENGINEERS, INC (SAE)

AMS 3412	-	Flux, Aluminum Brazing
AMS 4375H	-	Magnesium Alloy Sheet and Plate 3.0A1-1.0Zn (AZ31B-0) Annealed and Recrystallized
AMS 4376E	-	Magnesium Alloy Plate 3.0A1-1.0Zn (AZ31B-H26) Cold Rolled and Partially Annealed
AMS 4377F	-	Magnesium Alloy Sheet and Plate 1.0Zn (AZ31B-H24) Cold Rolled, Partially Annealed

(Application for copies should be addressed to the Society of Automotive Engineers, Inc. 400 Commonwealth Drive, Warrendale, PA 15096.)

## AMERICAN WELDING SOCIETY, INC. (AWS)

AWS WHB-1 CH6	-	Symbols for Welding and Inspection
AWS A3.0	-	Welding Terms and Definitions Including Terms for Brazing, Soldering Thermal Spraying and Thermal Cutting
AWS A5.1	-	Carbon Steel Electrodes for Shielded Metal Arch Welding, Specification for
AWS A5.2	-	Carbon and Low Alloy Steel Rods for Oxyfuel Gas Welding, Specification for

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AWS A5.5	-	Low Alloy Steel Covered Arc Welding Electrodes, Specification for
AWS 5.10	-	Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods, Specification for
AWS A5.19	-	Magnesium Alloy Welding Rods and Bare Electrodes, Specification for

(Application for copies should be addressed to the American Welding Society, Inc. 550 N.W. LeJeune Road, P.O. Box 351040, Miami, FL 33135)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational; services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

#### 3.1 Base metal preparation.

3.1.1 Cutting. The base metal may be cut by any of the accepted commercial practices such as shearing, torch cutting, or sawing in conformance with tolerance and edge conditions specified on the design drawing.

3.1.2 Edge preparation. Beveling, grooving, or other edge preparation shall be as specified on the design drawing in accordance with the symbols established in Chapter 6 of AWS WHB-1.

3.1.3 Weld surfaces. The base metal in the area to be welded shall be reasonably free from foreign materials such as dirt, grease, paint, and heavy scale in accordance with high grade commercial practice for this class of work. Slug and loose scale on torch-cut edges shall be removed by chipping, grinding, wire brushing, or equivalent means.

3.1.4 Low alloy steel parts. Low alloy steel parts shall be preheated to 204° to 316° Celsius (C) immediately prior to welding.

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3.1.5 Aluminum alloy parts. Aluminum alloy parts to be welded by the inert gas shielded arc method shall be cleaned to remove all oil, grease, or other foreign matter and then etched to provide a surface free from oxide before welding. A typical etching solution may be prepared as noted below. After etching, the parts shall be thoroughly rinsed and dried.

3.1.5.1 Etching solution (typical).

- a. Sulfuric acid, 10% (percent) by volume
- b. Hydrofluoric acid, 1% by volume
- c. Water, 89% by volume
- d. Sodium dichromate, 17 pounds per 100 gallons solution

3.2 Welding methods. The following welding methods shall be used for each type of welding. The welding shall be done by hand except as otherwise provided herein (see 1.2).

- a.. Type I (steel), metallic arc method, oxyacetylene, or inert gas shielded arc methods.
- b. Type II (aluminum alloy) oxyacetylene, oxyhydrogen or inert gas shielded arc methods.
- c. Type III (magnesium alloy) inert gas shielded arc method.
- d. Type IV (corrosion resistant steel) metallic arc or inert gas shielded arc methods.

3.2.1 Limitation on welding methods for steel. The inert gas shielded tungsten arc welding method or oxyacetylene welding method shall not be used for the welding of mild, high strength mild, or low alloy steel parts which are greater than 0.090 inches in thickness in the area to be welded.

3.2.2 Automatic welding. Automatic welding methods may be used, subject to the approval of the Government inspector, provided the strength of the deposited weld metal is at least equal to that of the materials specified herein and the quality of welding conforms to the requirements of this specification.

3.3 Welding materials.

3.3.1 Type I-steels.

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3.3.1.1 Electrodes for metallic arc welding.

3.3.1.1.1 Electrodes for mild steel. For welding mild steel, electrodes conforming to AWS A5.5 and having a tensile strength of not less than 60,000 pounds force per square inch (lbf/in<sup>2</sup>) as deposited shall be used. The electrodes shall be suitable for the intended use.

3.3.1.1.2 Electrodes for high strength mild steel and low alloy steel. For welding high strength mild steel and low alloy steel, electrodes conforming to AWS A5.5 and having a tensile strength of not less than 70,000 (lbf/in<sup>2</sup>) as deposited shall be used. The electrodes shall be suitable for the intended use.

3.3.1.2 Rods for oxyacetylene welding.

3.3.1.2.1 Rods for mild steel. For welding mild steel, rods conforming to R45 of AWS A5.2 shall be used.

3.3.1.2.2 Rods for high strength mild steel and low alloy steel. For welding high strength mild steel and low alloy steel, rods conforming to R65 of AWS A5.2 shall be used.

3.3.1.3 Rods for inert gas shielded arc method. For welding mild, high strength mild, or low alloy steels, rods conforming to R100 of AWS A5.2 shall be used.

3.3.2 Type II welding aluminum alloys.

3.3.2.1 ER1100 bare wire. For butt welds and welding outside corners of 1100 and 3003 aluminum alloys, ER1100 bare wire shall be used for all methods of welding as specified in AWS A5.10.

3.3.2.2 ER4043 bare wire. For welding aluminum alloys 5052, 6053, 6061, 443, and A356 (castings), and for welding all joints other than butt joints or outside corners in 1100 or 3003 aluminum alloys, ER4043 bare wire shall be used for all methods of welding as specified in AWS A5.10.

3.3.2.3 Gas welding flux. For oxyacetylene or oxyhydrogen welding of aluminum alloys, use aluminum gas welding flux specified in AMS 3412 or equivalent.

3.3.3 Type III welding magnesium alloys.

3.3.3.1 AZ31B and similar alloys. For welding magnesium alloys corresponding to or similar to those specified in AMS4375H, 4376E and 4377F, a

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magnesium alloy welding rod having the composition as specified in AWS A5.19 and Table I shall be used (see 6.2).

TABLE I. Composition of Magnesium Alloy Welding Rods.

Percent		
Materials	Not less than	Not greater than
Aluminum	2.5	3.5
Zinc	0.7	1.3
Manganese	0.20	
Silicon		0.05
Other elements		0.30
Magnesium	Remainder	

3.3.3.2 M-1 and similar alloys. For welding magnesium alloys corresponding to or similar to those specified in AMS4375H, 4376E and 4377F, a magnesium alloy welding rod having the composition as shown in table II shall be used (see 6.2).

TABLE II. M-1 Magnesium Rod Composition.

Percent		
Materials	Not less than	Not greater than
Manganese	1.2	
Silicon		0.30
Other elements		0.30
Magnesium	Remainder	

3.3.4 Type IV welding corrosion resistant steel.

3.3.4.1 Electrodes for metallic arc welding. For welding AISI types 347 and 321 or equivalent corrosion resistant or stainless steel by the metallic arc method, electrodes shall be AISI type 347 stainless steel or equivalent.

3.3.4.2 Rod for inert gas shielded arc welding. For welding AISI types 347 and 321 or equivalent corrosion resistant or stainless steel by the inert gas shielded arc method, the rod shall be AISI type 347 bare wire.

3.4 Location and direction of welds. The location of the welds and direction of welding shall be as specified on the applicable design drawing in accordance with the symbols established in Chapter 6 of AWS WHB-1.

3.5 Cleaning of welds.

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3.5.1 Welds in steel. Completed welds in mild steel, high strength mild steel, low alloy steel, or corrosion resistant steel shall be thoroughly cleaned by chipping and wire brushing to remove scale and flux prior to subsequent operations.

3.5.2 Gas welded aluminum parts. Gas welded aluminum alloy parts shall be defluxed by a suitable method immediately after welding. This may be accomplished by submerging the parts in 10% sulfuric acid solution for 20 to 30 minutes followed by a thorough rinse in clean running water.

3.6 Penetration. Penetration of fillet welds when cross sectioned and examined as specified herein shall equal 15 to 25% of the base metal thickness in material of not less than 0.25 inch thick. In material greater than 0.25 inch thick, penetration shall be not less than 0.0625 inch. Butt welded joints shall have 100% penetration unless partial penetration is permitted by symbol call out.

3.7 Workmanship. Workmanship shall be in accordance with high grade commercial practice covering this class of work. Weld beads shall be reasonably smooth and uniform. Evidence of excessive undercutting cold laps, porosity blow holes, cracks or slag inclusion shall be cause for rejection.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Lot. For purposes of acceptance, a lot of metallic parts welded under this specification shall consist of all the units of a single production order submitted for inspection at one time.

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4.3 Sampling. For purposes of inspection, sampling shall be performed in accordance with table III.

TABLE III. Sampling plan.

Lot Size	Sample Size
2 to 3	100%
4 to 25	3
26 to 50	5
51 to 90	6
91 to 150	7
151 to 280	10
281 to 500	11
501 to 1200	15
1201 to 3200	18
3201 to 10,000	22
10,001 and over	29
In all cases: Acceptance number is ZERO Rejection number is ONE	

4.4 Inspection. Inspection of the welded parts shall be by visual examination to determine compliance with the requirements of this specification. At the discretion of the Government Inspector, sample weldments representative of the production work of any welder may be required to permit evaluation of compliance with the requirements of this specification. Samples of fillet welds submitted for determining penetration shall be cross-sectioned, polished and etched by a method acceptable to the Government inspector. In addition, magnetic particle inspection shall be conducted on such welds and by such methods specified on the design drawing.

## 5. PREPARATION FOR DELIVERY

This section is not applicable to this specification.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)



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6.1 Intended use. Welding under this specification is intended for use in ground handling equipment for rockets and guided missiles and other applications where high grade commercial quality welding is required. As such, it does not come under the certification requirements of MIL-T-5021 and is not normally considered adequate for airborne structures or other applications where the highest degree of dependability with marginal design factors is of primary importance. Such certified welding is also separately covered in MIL-STD-2219.

6.2 Definition of steel grades. The three grades of steel mentioned herein are defined as follows:

- a. Mild steel, AISI 1010 to AISI 1030 or other low carbon steels.
- b. High strength mild steel, low carbon steel modified to increase tensile strength.
- c. Low Alloy steel, heat treatable structural alloys such as AISI 4130, AISI 8630, etc., and distinguished from the high alloy, stainless and other special purpose steels.

6.3 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of the specification
- b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).
- c. Types required (see 1.2 and 3.2).

6.4 Metriation. Metric equivalents in accordance with FED-STD-376 are acceptable for use in this specification.

6.5 Subject term (keyword) listing.

Aluminum alloys  
Electrodes and rods  
Magnesium alloys  
Weldments

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6.6 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodian:  
ARMY - MI

Preparing Activity:  
ARMY - MI

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