

MIL-E-18193B  
 22 April 1974  
 SUPERSEDING  
 MIL-E-18193A  
 23 July 1957  
 (See 6.3)

MILITARY SPECIFICATION

ELECTRODES, WELDING, CARBON STEEL AND ALLOY STEEL, BARE, COILED

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers bare electrode wire for welding and surfacing carbon and low-alloy steels by the semiautomatic or machine submerged-arc welding process, employing a granular flux.

1.2 Classification. Bare electrode wire shall be of the following types and sizes, as specified (see 6.2):

Type	Sizes (diameter) (inch)
MIL-A1 MIL-A2 MIL-A3	5/64, 3/32, 1/8, 5/32, 3/16, 7/32
MIL-B1 MIL-B2 MIL-B3	5/64, 3/32, 1/8, 5/32, 3/16, 1/4, 5/16, 3/8, 1/2
MIL-B4 MIL-B4-A MIL-B4-B MIL-B4-C MIL-B5 MIL-B6	3/32, 1/8, 5/32, 3/16, 1/4

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATION

MILITARY

MIL-W-10430 - Welding Rods and Electrodes: Preparation for Delivery of.

STANDARD

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

Z49.1-67 - Safety in Welding and Cutting.

(Application for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, N.Y. 10018.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

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## 3. REQUIREMENTS

3.1 Chemical composition. Chemical composition of electrodes shall be as specified in table I.

Table I - Chemical composition.

MIL-type <sup>1/</sup> (with suffix RC) <sup>2/</sup>	Carbon	Manganese	Molybdenum	Silicon <sup>3/</sup>	Sulfur (max)	Phosphorus (max)	Copper (max)
	Percent	Percent	Percent	Percent	Percent	Percent	Percent
MIL-A1	0.07-0.14	0.35-0.55	-----	0.03	0.035	0.030 <sup>3/</sup>	0.30
MIL-A2	.08- .14	.70-1.0	0.45-0.60	.05	.035	.025	.30
MIL-A3	.54- .65	.40- .70	-----	.05	.040	.040	.30
MIL-B1	.07- .15	.85-1.25	-----	.15- .35	.035	.025	.30
MIL-B2	.11- .15	.90-1.25	-----	.05	.035	.025	.30
MIL-B3	.10- .17	1.70-2.20	-----	.05	.035	.025	.30
MIL-B4	.10- .17	1.70-2.10	0.45-0.60	.05	.035	.025	.30
MIL-B4-A	.06- .11	.70-1.00	.45- .60	.05	.035	.025	.30
MIL-B4-B	.07- .13	.85-1.20	.45- .60	.05	.035	.025	.30
MIL-B4-C	.11- .17	1.30-1.60	.45- .60	.05	.035	.025	.30
MIL-B5	.06- .10	0.28-0.50	-----	.05	.035	.025	.30
MIL-B6	.55- .67	.90-1.25	-----	.25	.035	.025	.30

<sup>1/</sup> When the basic MIL-type electrode has a copper coating in accordance with 3.4.1, the maximum weight percent of copper in the electrode due to the coating and the residual copper content in the steel shall be 0.30 percent maximum.

<sup>2/</sup> Addition of the suffix RC to any basic MIL-type designation, e.g., type MIL-A1RC, indicates a special MIL-type of electrode which is not copper coated and for which the residual copper content in the steel is 0.15 percent maximum. Other requirements of this specification which apply to the basic MIL-type shall also apply to the special MIL-type counterpart with the restricted copper content (see 3.4.1, 3.4.2, and 6.2).

<sup>3/</sup> Maximum unless a range is specified.

3.2 Tolerances of electrode diameters.

3.2.1 All MIL-A types. Diameters of electrodes shall be as specified in 1.2. Tolerances for 3/32 inch and smaller diameters shall be plus or minus 0.002 inch; for 1/8-inch diameter, plus or minus 0.003 inch; and for 5/32 inch diameter and larger, plus or minus 0.004 inch.

3.2.2 All MIL-B types. Diameters of electrodes shall be as specified in 1.2. Tolerances for diameters of 5/64 to 3/8-inches, inclusive, shall be plus or minus 0.002 inch; for 1/2-inch diameter, plus or minus 0.003 inch.

3.3 Finish. Electrodes shall be smoothly finished, and free from injurious evidence of welds introduced during the process of fabrication. There shall be no injurious slivers, depressions, seams, laps, scratches, scale, lime, drawing compound, or other foreign matter, including rust.

3.4 Coating.

3.4.1 Basic MIL-type. Basic MIL-type electrodes may have either a clean, bright finish or a uniform continuous well-bonded smoothly drawn copper coating on a clean surface. Sizes 1/8-inch and larger shall have no other coating. Sizes 3/32-inch and smaller of types MIL-A1, MIL-A2, and MIL-A3 shall be lubricated with an oil additive, 0.015 percent by weight maximum, which shall not affect weld quality.

3.4.2 Special MIL-type with suffix RC. Special MIL-type electrodes, designated by the suffix RC (see footnote table I), shall not be copper coated but may have either a bright finish or a special protective coating provided the coating does not impair usability of the electrode or the quality and soundness of the weld metal deposits.

3.5 Form. Bare electrode wire shall be put-up in coils that are level and layer wound, except 3/8-inch and larger diameter wires furnished in 150-pound or greater coils shall be free of cross winding or waves. Electrode wire shall be free of sharp bends or kinks that would interfere with continuous welding operations, and shall uncoil freely without tangling.

3.5.1 Cast and pitch. Cast and pitch of the coiled wire shall be no greater than that specified in 4.4.3.

3.5.2 Coil size. The bare electrode wire shall be put-up in coils as specified in tables II and III. No preservative of any kind shall be applied to the coiled electrodes, except as specified in 3.4.

Table II - Coil dimensions, types MIL-A1, MIL-A2, and MIL-A3.

Electrode size	Weight Pounds	Width (max) Inches	Outside diameter (max) Inches	Inside diameter Inches	Ties <sup>1/</sup>		Liners <sup>4/</sup>
					2/	3/	
1/8-inch and smaller.	60 $\pm$ 1/2	4-5/8	16-1/2	11-7/8 $\begin{smallmatrix} +1/8 \\ -0 \end{smallmatrix}$	3 single	4	Required
5/32-inch and larger	60 $\pm$ 1	4-5/8	16-1/2	11-7/8 $\begin{smallmatrix} +1/8 \\ -0 \end{smallmatrix}$	3 single	4	Not required
All	200 $\pm$ 1	5	31-1/2	23-1/2 min	4 double	4	Not required

<sup>1/</sup> Ties shall be in accordance with footnote 2/ or 3/.

<sup>2/</sup> Equally spaced ties shall be of 5/64-inch minimum diameter medium or soft temper steel wire.

<sup>3/</sup> Equally spaced ties shall be two turns of soft galvanized or coppered steel binding wire either 16 gage or 18 gage or steel straps 3/8-inch minimum width and 0.015 inch minimum thickness.

<sup>4/</sup> Liners shall be a commercial grade of paperboard or double kraft lined fiberboard 0.08 inch thick minimum.

Table III - Coil dimensions, types MIL-B1, MIL-B2, MIL-B3, MIL-B4, MIL-B4-A, MIL-B4-B, MIL-B4-C, MIL-B5, and MIL-B6.

Electrode size	Weight Pounds	Width (max) Inches	Outside diameter (max) Inches	Inside diameter Inches	Ties <sup>1/</sup>		Liners <sup>4/</sup>
					2/	3/	
All	25 $\pm$ 2	2-1/4	16-1/2	12-1/8 $\pm$ 1/4	3 single	4	Required
All	65 $\pm$ 3	4	17	12-1/8 $\pm$ 1/4	3 single	4	Required
1/4-inch and smaller	150 $\begin{smallmatrix} +10 \\ -3 \end{smallmatrix}$	4	31-1/2	22-1/2 min	4 double	4	Required
	200 $\begin{smallmatrix} +25 \\ -10 \end{smallmatrix}$	4-1/4	31-1/2	22-1/2 min	4 double	4	Required
5/16-inch and larger	150 $\begin{smallmatrix} +10 \\ -20 \end{smallmatrix}$	4	34-1/2	22-1/2 min	4 double	4	Not required

<sup>1/</sup> Ties shall be in accordance with footnote 2/ or 3/.

<sup>2/</sup> Equally spaced ties shall be of 5/64-inch minimum diameter medium or soft temper steel wire.

<sup>3/</sup> Equally spaced ties shall be two turns of soft galvanized or coppered steel binding wire either 16 gage or 18 gage or steel straps 3/8-inch minimum width and 0.015 inch minimum thickness.

<sup>4/</sup> Liners shall be a commercial grade of paperboard or double kraft lined fiberboard 0.08 inch thick minimum.

3.6 Identification. Identification tags made of material suitable for resisting effacement or destruction and bearing the specification number, type, size and lot-control number shall be firmly attached at both ends of the coiled filler metal. Filler metal wound on coils with supports shall be identified with the above information placed directly on the coil with support in such a manner as not to be readily removable.

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## 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Sampling for quality conformance inspection.

4.2.1 Lot. For the purpose of sampling and inspection, a lot of electrodes is defined as the quantity of one type alloy produced as specified in either 4.2.1.1 or 4.2.1.2. The lot size shall be expressed in pounds of electrode.

4.2.1.1 Lot identification by heat of metal. Where manufacturing processes are such that wire is identified by a heat of metal, the lot, in addition to 4.2.1, shall be the quality produced from a single heat of metal.

4.2.1.2 Lot identification by wire chemical composition. Where manufacturing processes are such that wire is identified by chemical composition for each MIL-type, in addition to 4.2.1, a lot of electrodes shall be the quantity produced from one or more chemically tested mill coils from one or more heats of metal conforming to the requirements of table I for that type electrode. The following additional conditions shall apply:

- (a) Both ends of each mill coil shall be chemically analyzed.
- (b) Chemical analyses shall be certified by the laboratory and made available to the Government representative.
- (c) Mill coils conforming to established wire chemistry control for a specific MIL-type electrode shall be appropriately identified and segregated to avoid mix-ups.

Mill coils furnished by steel mills permitting spliced coil practice shall have no more than one splice per coil.

4.2.2 Sampling for examination of packaging and packing. A random sample of shipping containers filled with packages of coiled electrodes shall be selected in accordance with MIL-STD-105 at inspection level S-1 and acceptable quality level (AQL) = 2.5 percent defective to verify compliance with section 5. Upon satisfactory completion of examination of filled shipping containers, a representative sample of the filled packages shall be selected in accordance with MIL-STD-105 at inspection level S-1 and AQL = 2.5 percent defective to verify compliance with section 5. The packages selected shall be taken from shipping containers selected in the container examination sample.

4.2.3 Sampling for examination of electrodes. A random sample of coils shall be selected from each inspection lot for visual and dimensional examination at inspection level S-1, AQL = 2.5 percent defective in accordance with MIL-STD-105. The electrodes selected in this sample shall be taken from packages selected in the packaging examination sample.

4.2.4 Sampling for chemical analysis. One specimen shall be selected from the lot for the chemical analysis specified in 4.4.1.

4.2.5 Sampling for tests. A random sample of coils shall be selected from each inspection lot for the tests specified in 4.4.2 and 4.4.3 in accordance with MIL-STD-105 at inspection level S-1 and AQL = 2.5 percent defective.

4.3 Inspection.

4.3.1 Examination of packaging and packing. Each of the containers, both outer shipping container and unit packages, in a sample selected in accordance with 4.2.2 shall be examined for defects of construction, for unsatisfactory markings and for noncompliance with the requirements specified in section 5. If the number of rejected containers exceeds the acceptance number for the appropriate sampling plan of MIL-STD-105, the lot represented by the sample shall be rejected.

4.3.2 Visual and dimensional examination. Each sample coil selected in accordance with 4.2.3 shall be visually and dimensionally examined to verify compliance with this specification. Any coil in the sample containing one or more visual or dimensional defects shall be rejected. If the number of defective coils in any sample exceeds the acceptance number for that sample, the lot represented shall be rejected.

4.3.3 Quality conformance inspection. Each sample coil selected in accordance with 4.2.4 or 4.2.5, as applicable, shall be subjected to the chemical analysis specified in 4.4.1 and the cast and pitch test specified in 4.4.3; and, those sizes to which it is applicable (see 3.4.1), and to the oil additive determinations specified in 4.4.2. If any sample coil fails any test the lot represented by the sample shall be rejected.

#### 4.4 Test methods.

4.4.1 Chemical analysis. A chemical analysis for the elements specified in 3.1 shall be conducted on the specimen selected in accordance with 4.2.4.

4.4.2 Oil additive determination. An oil additive determination shall be made on sample coils of wire, selected in accordance with 4.2.5, 3/32-inch diameter and smaller. This shall consist of determination of the loss in weight of a sample length of wire approximately 100 grams in weight after being subjected to a standard degreasing treatment. Loss in weight thus determined shall not indicate a greater percentage of oil additive to have been present than that specified in 3.4.

4.4.3 Cast and pitch. Each sample coil, selected in accordance with 4.2.5, shall be checked by release of the six outside turns of wire. The cast is the free diameter of the circle assumed by the released coils, and the pitch is the spread in the direction of the axis of the coil between two successive turns of the wire when the coil is laid flat and is unrestrained. The cast shall be not less than the inside diameter of the coil nor more than 2-1/2 inches larger than the outside diameter of the unreleased coil. The pitch shall not exceed 1-1/2 inches.

### 5. PREPARATION FOR DELIVERY

5.1 Packaging. Packaging shall be level A or C, as specified (see 6.2).

5.1.1 Level A. Electrode wire, put-up in coils as specified in 3.5.2, shall be packaged in class 3d containers for coil weights 65 pounds and under, and in class 3e containers for coils exceeding 65 pounds as specified in MIL-W-10430, except that the ties specified in tables II and III shall apply. When applicable, electrode wire furnished on coils with supports (see 3.6), shall be packaged in class 3c containers as specified in MIL-W-10430.

5.1.2 Level C. Electrode wire, put-up as specified in 3.5.2, shall be packaged in a manner to afford protection against corrosion, deterioration and physical damage during shipment from the supply source to the first receiving activity for immediate use. The supplier's normal retail or wholesale packing methods may be utilized when such meet the requirements of this level.

5.2 Packing. Electrode wire packaged as specified (see 6.2), shall be packed level A, B or C, as specified (see 6.2) in accordance with MIL-W-10430.

5.3 Marking. In addition to any special marking required herein or by the contract or order (see 6.2), interior packages and exterior shipping containers shall be marked in accordance with MIL-W-10430.

#### 5.3.1 Special marking.

5.3.1.1 Interior packages and shipping containers. Identification on interior packages shall include MIL-type, size, specification number, manufacturer's or distributor's name, date of manufacturer (month/year), and manufacturer's or distributor's brand or type designation. In addition, unit packages shall be marked or labeled with the following precautionary information, as a minimum, and prominently displayed:

#### CAUTION

Welding may produce fumes and gases hazardous to health.  
 Avoid breathing these fumes and gases.  
 Use adequate ventilation.  
 See ANSI Standard Z49.1 "Safety in Welding and Cutting"  
 published by the American Welding Society.

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Significant toxic constituents, when present in the electrode in greater than trace amounts, shall be included in the precautionary information so that normal ventilation can be increased accordingly. These constituents include, but are not limited to, those itemized in section 8.5 through 8.11 of ANSI Z49.1-67.

## 6. NOTES

### 6.1 Intended use.

6.1.1 Types MIL-A1, MIL-A2, and MIL-A3. These electrodes are intended for use with fluxes conforming to MIL-F-18251 and with automatic or semiautomatic submerged-arc welding machines equipped with reels capable of receiving bare coiled electrodes specified in 3.5.2, table II. Application and properties obtainable with each type is dependent upon the current and voltage and the specific type fluxes employed.

6.1.1.1 Type MIL-A1 is intended for welding of carbon steels for as-welded or stress-relieved applications.

6.1.1.2 Type MIL-A2 is intended for welding of low alloy steels which may require further heat treatment.

6.1.1.3 Type MIL-A3 is intended for hard surfacing deposits on carbon steels.

6.1.2 Types MIL-B1, MIL-B2, and MIL-B3, MIL-B4, MIL-B5, and MIL-B6. These electrodes are intended for use with "B" type welding fluxes conforming to MIL-F-19922 and with automatic or semiautomatic submerged-arc welding machines equipped with reels capable of receiving bare coiled electrodes specified in 3.5.2, table III. Application and properties obtainable are dependent upon the current and voltage and the specific "B" type fluxes employed.

6.1.2.1 Type MIL-B1 is intended for high-speed butt and fillet welding of gage and light plate thicknesses of mild and low alloy high-strength steels. It is also used for heavier welds of structural quality.

6.1.2.2 Type MIL-B2 is intended for high-speed welding with multiple wire and power equipment.

6.1.2.3 Type MIL-B3 is intended for welding carbon, low-alloy, high strength steels for as-welded or stress relieved applications.

6.1.2.4 Type MIL-B4 is intended for welding alloy steels where high weld strengths are required or where further heat treatment of the weldment is specified. Deposits of this electrode work-harden in service up to 355 Brinell hardness number (Bhn).

6.1.2.4.1 Types MIL-B4-A, MIL-B4-B and MIL-B4-C are compositional modifications of type MIL-B4 with which a wide range of weld metal properties can be obtained. These electrodes are intended for welding high tensile strength carbon-silicon steels and other high strength low alloy steels where close control of weld strength, ductility and other mechanical properties is desired and where heat treatment of the weldment may be specified. Weld deposits are generally made by, but not restricted to, multi-pass procedures.

6.1.2.5 Type MIL-B5 is intended for making welds where maximum ductility or minimum alloy content in the weld is desired, and is especially suitable for heavy fillets and other welds subject to large shrinkage stresses.

6.1.2.6 Type MIL-B6 is intended for hard surfacing deposits on carbon steels.

6.1.2.7 Special MIL-type with suffix RC. Restricted copper electrodes shall be used when specified in 6.2 (see table I).

### 6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Type and size (diameter) required (see 1.2).
- (c) Coil size or standard stock number.
- (d) Whether the copper content shall be restricted (see table I).
- (e) Applicable levels of packaging and packing required (see 5.1 and 5.2).
- (f) Special marking required (see 5.3).

6.2.1 Electrode wire should be ordered by the pound.

6.3 THE MARGINS OF THIS SPECIFICATION ARE MARKED "\*" TO INDICATE WHERE CHANGES (ADDITIONS, MODIFICATIONS, CORRECTIONS, DELETIONS) FROM THE PREVIOUS ISSUE HAVE BEEN MADE. THIS WAS DONE AS A CONVENIENCE ONLY AND THE GOVERNMENT ASSUMES NO LIABILITY WHATSOEVER FOR ANY INACCURACIES IN THESE NOTATIONS. BIDDERS AND CONTRACTORS ARE CAUTIONED TO EVALUATE THE REQUIREMENTS OF THIS DOCUMENT BASED ON THE ENTIRE CONTENT IRRESPECTIVE OF THE MARGINAL NOTATIONS AND RELATIONSHIP TO THE LAST PREVIOUS ISSUE.

Custodians:

Army - WC  
Navy - SH  
Air Force - 84

Review activities:

Army - AT, ME, WC  
Navy - SH  
Air Force - 84

User activities:

Navy - AS, OS, YD

Preparing activity:

Navy - SH  
(Project 3439-0239)

## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

*(See Instructions - Reverse Side)*

1. DOCUMENT NUMBER	2. DOCUMENT TITLE		
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION <i>(Mark one)</i>	
b. ADDRESS <i>(Street, City, State, ZIP Code)</i>		<input type="checkbox"/> VENDOR	<input type="checkbox"/> USER
		<input type="checkbox"/> MANUFACTURER	<input type="checkbox"/> OTHER <i>(Specify):</i> _____
5. PROBLEM AREAS			
a. Paragraph Number and Wording:			
b. Recommended Wording:			
c. Reason/Rationale for Recommendation:			
6. REMARKS			
7a. NAME OF SUBMITTER <i>(Last, First, MI)</i> - Optional		b. WORK TELEPHONE NUMBER <i>(Include Area Code)</i> - Optional	
c. MAILING ADDRESS <i>(Street, City, State, ZIP Code)</i> - Optional		8. DATE OF SUBMISSION (YYMMDD)	