

INCH-POUND

MIL-E-23765/4(SH)

15 September 1989

MILITARY SPECIFICATION

ELECTRODES - WELDING, BARE, SOLID;
AND FLUXES, SUBMERGED ARC WELDING,
CARBON AND LOW ALLOY STEELS

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers carbon and low alloy steel, solid and bare electrodes, and fluxes for submerged arc welding (SAW).

1.2 Classification. The classification system for the wire and flux is in accordance with AWS A5.17 and A5.23 except for the use of the prefix MIL-, for example, MIL-EL12 for wire and MIL-F6A2EL12 for flux.

1.2.1 Electrodes. The specified electrodes are MIL-EL8, EL12, EM12, EM12K, and EAL; and supplied in form 3b, 3c, 3d, 3e, and 4 in accordance with MIL-E-23765, and table I and 3.3 herein.

TABLE I. Form, size and weight.

| Form ^{1/} | Weight ^{2/} (pounds) |
|--------------------|----------------------------------|
| 3b | 25 or 35 |
| 3c | 25, 50, or 60 |
| 3d | 60 or 65 |
| 3e | 150 or 200 |
| 4 | 750 or less |

See footnotes at top of next page.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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- 1/ Electrodes shall be furnished in diameters 1/16, 5/64, 3/32, 1/8, 5/32, 3/16, 7/32 and 1/4 inch.
- 2/ Tolerance on net weight shall be plus or minus 10 percent.

1.2.2 Fluxes. Fluxes may be neutral or active, as specified (see 6.2).

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

- UU-S-48 - Sacks, Shipping, Paper.
- PPP-D-723 - Drums, Fiber.

MILITARY

- MIL-E-23765 - Electrodes and Rods - Welding, Bare, Solid and Alloyed Cored, General Specification for.
- MIL-S-24238 - Steel Plate, Carbon and Low Alloy.

STANDARDS

FEDERAL

- FED-STD-151 - Metals; Test Methods.

MILITARY

- MIL-STD-147 - Palletized Unit Loads.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following document(s) 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 6.2).

AMERICAN WELDING SOCIETY (AWS)

- A5.17 - Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding. (DoD adopted)
- A5.23 - Specification for Low Alloy Steel Electrodes and Fluxes for Submerged Arc Welding. (DoD adopted)

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 3951 - Standard Practice for Commercial Packaging. (DoD adopted)

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(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 Qualification. Electrodes and fluxes furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.3 and 6.4).

3.2 Coating.

3.2.1 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. Diameters 3/32 inch or smaller may be coated with other types of rust preventatives, provided such coatings do not impair usability of the electrodes or the quality or soundness of weld metal deposits.

3.2.2 Special MIL-type with suffix RC. Special MIL-type electrodes designated by the suffix RC shall not be copper coated but shall 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 weld metal deposits.

3.3 Chemical composition. The chemical composition of the electrodes shall be in accordance with AWS specification electrodes indicated with the same classification without the prefix MIL-.

3.3.1 Special MIL-type with suffix RC. Special MIL-type electrodes which are not copper coated shall have copper and phosphorus content of 0.10 percent and 0.012 percent maximum respectively (see 6.2).

3.4 Wall number. The neutral flux shall have a Wall neutrality number (N) of 35 or less. No testing shall be required for active fluxes to determine the neutrality number.

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3.5 Mechanical properties. Unless otherwise specified (see 6.2), the mechanical properties of the weld metal resulting from wire and flux combination shall be in accordance with AWS A5.17 or F7XX-EXXX-X of AWS A5.23.

3.6 Slag removal. The slag deposited during welding shall be readily removed from weld deposits with hand tools (these shall not be air or power operated).

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 test) 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 the 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 the 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 Classification of inspections. The inspection requirements specified herein are classified as follows:

- (a) Qualification inspection (see 4.3).
- (b) Quality conformance inspection (see 4.4).

4.3 Qualification tests. Qualification tests shall be in accordance with table II. The test sample of the electrodes or flux selected in accordance with MIL-E-23765 shall be used for these tests.

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TABLE II. Summary of tests required for qualification.

| MIL-types | Test | Procedure | Requirement |
|---------------------------------|---|--|---|
| All electrodes Form 3b or 3d | Cast and helix | MIL-E-23765 | MIL-E-23765 |
| | Chemical | MIL-E-23765 | For carbon steel electrodes AWS A5.17. For carbon molybdenum steel electrodes AWS A5.23. |
| | Radiography ^{1/} | AWS A5.17 and A5.23 ^{2/} MIL-E-23765 | MIL-E-23765 |
| | Tensile, bend, and impact ^{1/} | AWS A5.17 and A5.23 ^{2/} MIL-E-23765 | For carbon steel electrodes AWS A5.17. For carbon molybdenum steel electrodes AWS A5.23. |
| | Wall number ^{3/} | 4.3.3.2 herein | 3.4 herein |
| All fluxes | Radiography ^{1/} | AWS A5.17 and A5.23 ^{2/} MIL-E-23765 | MIL-E-23765 |
| | Tensile, bend, and impact ^{1/} | AWS A5.17 and A5.23 ^{2/} MIL-E-23765 | For carbon steel electrodes AWS A5.17. For carbon molybdenum steel electrodes AWS A5.23. |
| | Wall number ^{3/} | 4.3.3.2 herein | 3.4 herein |

^{1/} Radiographic and mechanical testing shall be in accordance with MIL-E-23765 for both carbon and carbon molybdenum steel electrodes. Tensile testing includes ultimate tensile strength, 0.2 percent offset yield strength, and percent elongation in 2 inches. Impact tests shall be carried out when required (see 6.2).

^{2/} Weld test assembly shall be in accordance with AWS A5.17 for carbon steel electrodes and AWS A5.23 for carbon molybdenum steel electrodes.

^{3/} Wall number shall be carried out for neutral flux.

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4.3.1 Carbon steel electrodes. The weld test assembly shall be made in accordance with AWS A5.17. Weldment shall be tested in the as-welded condition.

4.3.2 Carbon molybdenum steel electrodes (MIL-EA1). The weld test assembly shall be made in accordance with AWS A5.23. Weldment shall be tested in the as-welded condition.

4.3.3 Fluxes. Fluxes shall be used along with electrodes to make a weld test assembly in accordance with AWS A5.17 or AWS A5.23 as required. Weldments shall be tested in the as-welded condition.

4.3.3.1 Neutral fluxes. Prior to welding the test plates for flux qualification, N for neutral fluxes shall be determined in accordance with 4.3.3.2.

4.3.3.2 Determination of N. Determination of N shall be in accordance with the following:

- (a) Weld test pad (minimum size - 1 inch wide by 4 inches long by 5/8 inch high) shall be prepared on a steel test plate in accordance with MIL-S-24238 using the SAW process with the flux to be tested in combination with a 1/8-inch diameter electrode. Welding parameters shall be as follows:

| | | |
|-----------------------|---|--|
| Electrode stickout | - | 1 to 1-1/2 inches |
| Welding current | - | 500 \pm 10 amperes, direct current reverse polarity (dcrp) |
| Arc voltage | - | 28 \pm 1 volts |
| Travel speed | - | 15 \pm 1 inches per minute |
| Interpass temperature | - | 300 degrees Fahrenheit ($^{\circ}$ F) maximum |

- (b) A second weld test pad shall be made using the same parameters except that the arc voltage shall be increased to 36 \pm 1 volts.
- (c) The top surfaces of the weld pads shall be ground or machined to clean metal. Then, samples for analysis shall be removed by machining. No weld metal shall be removed within 1/2 inch of the base plate. The samples shall be chemically analyzed for silicon and manganese. Chemical analysis methods shall be in accordance with FED-STD-151. N shall be calculated by the following formula. The absolute values of the change in weight percentage of silicon and manganese levels shall be used.

$$N = 100 [|\Delta Si| + |\Delta Mn|]$$

4.4 Quality conformance inspection. Samples selected in accordance with MIL-E-23765 for electrodes and for fluxes shall be used for the tests specified in table III. Weld test assembly shall be made in accordance with AWS A5.17 for carbon steel electrodes and in accordance with AWS A5.23 for carbon molybdenum steel electrodes. The test shall be made in the as-welded condition (see 6.3).

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TABLE III. Summary of test required for quality conformance inspection.

| MIL-types | Test | Procedure | Requirement |
|---------------------------------------|---------------------------|--|---|
| All electrodes All forms and sizes | Cast and helix | MIL-E-23765 | MIL-E-23765 |
| | Chemical | MIL-E-23765 | For carbon steel electrodes AWS A5.17. For carbon molybdenum steel electrodes AWS A5.23. |
| | Radiography ^{1/} | AWS A5.17 and A5.23 ^{2/} MIL-E-23765 | MIL-E-23765 |
| | Tensile ^{1/} | AWS A5.17 and A5.23 ^{2/} MIL-E-23765 | For carbon steel electrodes AWS A5.17. For carbon molybdenum steel electrodes AWS A5.23. |
| All fluxes | Alloy identity | MIL-E-23765 | MIL-E-23765 |
| | Radiography ^{1/} | AWS A5.17 and A5.23 ^{2/} MIL-E-23765 | MIL-E-23765 |
| | Tensile ^{1/} | AWS A5.17 and A5.23 ^{2/} MIL-E-23765 | For carbon steel electrodes AWS A5.17. For carbon molybdenum steel electrodes AWS A5.23. |

^{1/} Radiographic and tensile testing shall be in accordance with MIL-E-23765. Tensile testing includes ultimate tensile strength, 0.2 percent offset yield strength, and percent elongation in 2 inches.

^{2/} Weld test assembly shall be in accordance with AWS A5.17 for carbon steel electrodes and AWS A5.23 for carbon molybdenum steel electrodes.

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4.5 Base metal. Unless otherwise specified (see 6.2), the base metal steel used for the weld test assemblies shall be in accordance with AWS A5.17 and A5.23.

4.6 Inspection of packaging. Sample packs, and the inspection of the preservation, packing and marking for shipment, stowage, and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.6.)

5.1 Packaging. Packaging of electrodes shall be as specified in MIL-E-23765.

5.2 Packing of flux. Flux packing shall be level A or commercial as specified (see 6.2).

5.2.1 Level A. Welding flux shall be packed in bags or drums as specified (see 6.2).

5.2.1.1 Drums. Drums shall conform to type II or III, grade A of PPP-D-723.

5.2.1.2 Bags. Bags shall be of a waterproof type and shall be in accordance with UU-S-48 (extensible heavy duty shipping sack kraft paper).

5.2.1.3 Palletization. When specified (see 6.2), bags and drums shall be palletized for shipment in accordance with MIL-STD-147.

5.2.2 Level C. Welding flux shall be packed in containers in accordance with ASTM D 3951.

5.3 Marking. Flux containers shall be marked as specified in MIL-E-23765.

6. NOTES

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

6.1 Intended use. This specification covers welding materials which, when deposited on the base metals specified in 4.5, will meet the mechanical properties specified herein in the as-welded condition.

6.1.1 MIL-EL8. MIL-EL8 electrode is intended for making welds where maximum ductility or minimum alloy content in the weld is desired, and is especially usable for heavy fillets and other welds subject to large shrinkage stresses.

6.1.2 MIL-EL12. MIL-EL12 electrode results in higher strength than MIL-EL8 and is intended for welding carbon steel.

6.1.3 MIL-EM12. MIL-EM12 electrode results in higher strength than MIL-EL12 and is intended for high speed welding of carbon steel.

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6.1.4 MIL-EM12K. MIL-EM12K has better deoxidation properties than MIL-EM12, and is used for high speed welding of carbon and low alloy steels.

6.1.5 MIL-EA1. MIL-EA1 electrode results in higher strength than MIL-EM12 and is intended for welding of low alloy steels.

6.1.6 Fluxes. Neutral fluxes covered in this specification are intended for multiple pass welding. Active fluxes are intended for single pass welds.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- (a) Title, number, and date of this specification.
- (b) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- (c) Whether flux to be used is neutral or active (see 1.2.2).
- (d) Necessary restriction on copper and phosphorus content of electrodes (see 3.3.1).
- (e) Mechanical properties of the weld metal from wire and flux combination (see 3.5).
- (f) When impact tests are to be carried out (see footnote 1 of table II).
- (g) Other base metal steel for use in tests, if required (see 4.5).
- (h) Level of flux packing required (see 5.2).
- (i) For flux level A packing, selection of bags or drums (see 5.2.1).
- (j) If required, whether flux bags or drums should be palletized for shipment (see 5.2.1.3).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

| <u>Reference Paragraph</u> | <u>DID Number</u> | <u>DID Title</u> | <u>Suggested Tailoring</u> |
|----------------------------|-------------------|---------------------------|----------------------------|
| 4.4 | DI-MISC-80678 | Certification/data report | --- |

The above DID's were those cleared as of the date of this specification. The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

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6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List No. 23765/4 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests must be made in accordance with "Provisions Governing Qualification SD-6" (see 6.4.1).

6.4.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

6.5 Cross-references.

6.5.1 Electrodes. The submerged arc electrodes covered by this specification are equivalent to the electrodes covered in MIL-E-18193 as follows:

| This specification | MIL-E-18193 |
|--------------------|-------------|
| MIL-EL8 | MIL-B5 |
| MIL-EL12 | MIL-A1 |
| MIL-EM12 | MIL-B2 |
| MIL-EM12K | MIL-B1 |
| MIL-EA1 | MIL-A2 |
| MIL-EA1 | MIL-B4-A |

6.5.2 Fluxes. The fluxes F1, F2, F3 and F4 in accordance with MIL-F-18251; and B20, B50 and B80 in accordance with MIL-F-19922 may be furnished to this specification if the weld metal from flux and wire combination conforms to the mechanical properties of this specification.

6.6 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.7 Subject term (key word) listing.

Active fluxes
Electrodes
Neutral fluxes
Wall number

Preparing activity:
Navy - SH
(Project 3439-N672)