

INCH-POUND

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SUPERSEDING
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DETAIL SPECIFICATION
ELECTRODES, WELDING, COVERED: AUSTENITIC STEEL
(19-9 MODIFIED) FOR ARMOR APPLICATIONS

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

1. SCOPE

1.1 Scope. This specification covers austenitic steel arc welding electrodes for use on steels of high hardenability (see 6.1).

1.2 Classification. The electrodes should be furnished in the types, classes, and sizes shown in tables IA and IB as specified (see 6.2).

TABLE IA. Types of electrodes.

Type <u>1</u> /, <u>2</u> /, <u>3</u> /	Description	
MIL-307L-15	Lime	covering DC, Electrode Positive
MIL-307L-16	Lime	covering AC-DC
MIL-307T-15	Titania	covering DC, Electrode Positive
MIL-307T-16	Titania	covering AC-DC
MIL-308MoL-15	Lime	covering DC, Electrode Positive
MIL-308MoL-16	Lime	covering AC-DC
MIL-308MoT-15	Titania	covering DC, Electrode Positive
MIL-308MoT-16	Titania	covering AC-DC

1/ Electrodes designated-16 (qualified for use on both AC and DC) should be considered as meeting all the requirements for electrodes designated-15 (DC only) of the same composition and covering. For DC welding applications-15 and -16 electrodes of the same composition and covering are interchangeable.

2/ "L" types have lime coverings which contain less than 9 percent TiO₂ and consist chiefly of alkaline-earth elements and their components.

3/ "T" types have titania coverings which contain more than 20 percent TiO₂.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, U.S. Army Research Laboratory, Weapons and Materials Research Directorate, ATTN: AMSRL-WM-M, Aberdeen Proving Ground, MD 21005-5069 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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TABLE IB. Classes and sizes with welding positions.

Class	Diameter: in.(mm)	Length: in.(mm)	Welding positions
1	1/8, 5/32 (3.2, 4.0)	14 (356)	All (overhead, vertical, horizontal and flat)
2	3/16 (4.8)	14 or 18 (356 or 457)	Horizontal fillets and flat
2	7/32, 1/4 (5.56, 6.4)	18 (457)	Horizontal fillets and flat
3	5/16, 3/8 (8.0, 9.5)	18 or 24 (457 or 610)	Flat

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 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

DEPARTMENT OF DEFENSE

MIL-A-12560	Armor Plate, Steel, Wrought, Homogeneous (For Use In Combat-Vehicles and For Ammunition Testing).
MIL-E-22200/1	Electrodes, Welding, Mineral Covered, Iron-Powder, Low Hydrogen Medium and High Tensile Steel, as Welded or Stress-Relieved Weld Application

HANDBOOKS

DEPARTMENT OF DEFENSE

MIL-HDBK-1264	Radiographic Inspection for Soundness of Welds in Steel by Comparison to Graded ASTM E390 Reference Radiographs.
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(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automated Printing Service (DAPS), Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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2.3 Non-Government publications. The following documents form a part of this specification 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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A517/A517M Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered (DoD adopted)

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

AMERICAN WELDING SOCIETY (AWS)

AWS A3.0 Standard Welding Terms and Definitions (DoD adopted)

(Application for copies should be addressed to the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.)

2.4 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 First article. The electrodes furnished under this specification shall be a product(s) which has been inspected and has passed the first article inspection specified herein or has been accepted on waiver or first article inspection requirements. The contractor shall furnish a sample unit(s) for first article inspection and approval when specified (see 4.4 and 6.2).

3.2 Definitions. For the purpose of this specification the welding terms and definitions contained in AWS A3.0 shall apply.

3.3 Core wire. The core wire shall be free from injurious defects such as segregations and non-metallic inclusions and shall conform to the compositional requirements specified in 3.5.1.

3.4 Covering of electrodes.

3.4.1 Concentricity. The covering on all sizes of electrodes shall be concentric to the extent that the maximum core-plus-one covering dimension shall not exceed the minimum core-plus-one covering dimension by more than the following percentages of the mean dimension (see 4.6.2):

<u>Electrode size, in. (mm)</u>	<u>Percentage of mean dimension</u>
3/32 (2.4) and smaller	7
1/8 (3.2) and larger	5

3.4.2 Uniformity. The coverings shall be such as to be consumed uniformly.

3.4.3 Dielectric strength. The coverings of electrodes at room temperature and in the dry condition, as removed from freshly opened containers, shall have a dielectric strength sufficient to insulate effectively against a difference of potential of 110 volts AC, 60 cycles.

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3.4.4 Flaking of covering. Electrode coverings, when tested in accordance with 4.6.7, shall not flake. Flaking shall be understood to mean a "popping off" or "dropping off" of one or more pieces of the covering ahead of the welding arc so as to expose at least 50 percent of the circumference of the core wire. However, such exposure at the arc end at the time of striking the arc shall not be considered flaking provided that the core wire is not thereby exposed more than 1/8 in. (3.2 mm) beyond that specified for the arc end in table II.

3.4.5 Fumes. Fumes from the burning coverings of electrodes shall not be injurious to personnel when adequate ventilation is provided.

3.4.6 Slag removal. Slag deposited by the coverings shall be readily removable from the cooled weld deposits with the use of hand tools (not air or power operated tools).

3.4.7 Extent of coverings.

3.4.7.1 Arc ends. The arc ends of the electrodes shall be sufficiently bare to permit easy striking of the arc. The length of the bare portion of the arc end (measured from the end to the point where the full cross section of the covering is obtained) shall not exceed the limits shown in table II. Electrodes with chipped coverings near the arc end, which expose the core wire for more than 1/8 in. (3.2 mm) beyond the specified distance, may be acceptable provided that no chip uncovers more than 50 percent of the circumference of the core.

3.4.7.2 Grip ends. The grip ends shall be bare within the limits shown in table II and on figure 1.

3.4.8 Electrode identification.

3.4.8.1 Labeling. The type designation or classification number shall be stamped or imprinted on the covering of each electrode on at least two locations. One imprinted type designation shall appear as closely as practicable to the bare grip end; the location of the second shall be determined by the manufacturer.

TABLE II. Lengths of bare and tapered portions.

Diameter, in. (mm)	Grip End		Arc End
	Minimum bare portion, in. (mm) (A)	Maximum distance to full diameter of covering, in. (mm) (B)	Maximum distance to full diameter of covering, in. (mm) (C)
1/8, 5/32, 3/16 (3.2, 4.0, 4.8)	3/4 (19)	1-1/2 (38)	1/8 (3.2)
7/32, 1/4, 5/16, 3/8 (5.6, 6.4, 8.0, 9.5)	1 (25.4)	1-3/4 (44)	3/16 (4.8)

Note: See figure 1 for the significance of (A), (B), and (C).

3.4.8.2 Size and legibility. The imprinted designations shall be composed of block characters of equal size, the height of which shall be approximately 50 to 100 percent of the overall electrode diameter (core wire plus covering) but need not exceed a height of 5/32 in. (4 mm). The imprinted designations shall read from left to right from the grip end as shown on figure 1. The color of the

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print shall stand out in contrast to the color of the electrode covering and printed designations shall be readable under normal lighting conditions.

3.4.8.3 Designations. Printed type designations shall remain readily discernible on electrodes baked at temperatures up to 850°F (454°C) and on unused portions of partially consumed electrodes or discarded stubs, and shall resist effacement by contact incidental to normal handling, shipping and storing.

3.5 Chemical composition.

3.5.1 Weld metal. The chemical composition of the deposited weld metal shall conform to the requirements shown in table III (see 4.6.3).

TABLE III. Chemical composition of deposited weld metal (percent).

Type	Carbon	Manganese	Silicon	Chromium	Nickel	Molybdenum	Sulfur	Phosphorus
MIL-307	0.07- 0.17	3.30- 4.75	0.80 max.	18.00- 21.50	9.00- 10.70	0.50- 1.50	0.03 max.	0.04 max.
MIL-308	0.07- 0.17	1.25- 2.25	0.80 max.	18.00- 21.50	9.00- 10.70	1.85- 2.25	0.03 max.	0.04 max.

3.6 Core wire tolerances.

3.6.1 Length. The length of any electrode shall not vary by more than 1/8 in. (3.18 mm) from the length specified in the contract.

3.6.2 Diameter. The diameter of the core wire shall not vary from the nominal diameter by more than 0.003 in. (0.08 mm).

3.7 Mechanical properties. Mechanical properties for the weld metal shall be in accordance with table IV.

TABLE IV. Mechanical properties.

Diameter: in. (mm)	Ultimate tensile strength: psi (kPa), minimum	Elongation in 2 in. (50.8 mm) (transverse specimen), percent, minimum
5/32, 3/16, 7/32, 1/4 (4.0, 4.8, 5.6, 6.4)	85,000 (586,000)	7
5/16, 3/8 (8.0, 9.5)	85,000 (586,000)	10

3.8 Deposit patterns. Electrodes shall be capable of depositing all types of welds in the positions specified in table IB.

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3.9 Fillet welds.

3.9.1 Soundness. Electrodes shall be capable of depositing single-pass fillets in the positions specified in table IB. Each fillet shall have penetrated to or beyond the junction plate edges and shall be free of slag inclusions and excessive porosity. Fillet welds shall conform to grade II of MIL-HDBK-1264.

3.9.2 Convexity. The convexity of each fillet shall not exceed that shown on figure 2.

3.9.3 Undercut and overlap. Fillet welds shall be free from undercut and overlap.

3.10 Groove welds. As shown by radiographic examination, deposited weld metal in weldments produced in accordance with 4.6.4 shall conform to grade II of MIL-HDBK-1264, except that deposited weld metal in weldments produced in accordance with 4.6.4.5.2 shall conform to grade I of MIL-HDBK-1264. In all weldments, defects within 1 in. (25.4 mm) of ends may be disregarded.

3.11 Root pass soundness. Electrodes shall be capable of meeting the requirements of the root pass crack test specified in 4.6.6.

3.12 Workmanship. Electrodes shall be manufactured in accordance with high-grade commercial practice. The electrodes shall be of uniform quality, clean, sound and smooth. The material shall be free from scabs, scale, cracks, blisters, pock marks, bruises or other surface defects. The electrodes shall be free from any substances or characteristics which would adversely affect the operation of the electrodes or cause unsound weld metal.

4. VERIFICATION

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.

4.2 Lot. A lot shall consist of all electrodes of the same heat or core wire chemical analysis, type, and size, covered with the coating material from the same batch, and submitted at one time for acceptance.

4.3 Classification of inspection. The examination and testing of electrodes shall be classified as follows:

- a. First article inspection (see 4.4).
- b. Quality conformance inspection (see 4.5).

4.4 First article inspection. First article inspection shall consist of tests for all of the requirements of this specification. In testing electrodes, the welder shall not use any unusual technique of manipulating the electrode, any technique not commonly taught to, and proficiently used by, the average welder who has been trained and qualified to use electrodes of the types covered by this specification. The responsibility for performing first article inspection shall be as specified by the procuring activity (see 6.2). If multiple lots are offered in a given shipment for which first article inspection has been specified by the purchaser, only one lot shall be subject to the first article inspection. The remaining lots shall be subject to quality conformance inspection only.

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4.4.1 First article samples. First article test samples shall be obtained from the material to be furnished for each type. Samples shall be selected at random from electrodes which have been manufactured using the same production processes, procedures, and equipment which will be used in filling the contract. The samples shall be selected from either filled unit containers or from the production line immediately before packaging. If selected from the production line, the total sample shall be selected throughout the run so all parts of the run are represented.

4.4.1.1 Sampling for visual, dimensional, and concentricity requirements. The number of random samples selected to verify compliance with visual, dimension, and concentricity requirements, from each lot of electrodes shall be defined by the procuring activity (see 6.2).

4.4.1.2 Sampling for tests for all other requirements. For all other tests, select a random sample from each lot of electrodes as defined by the procuring activity (see 6.2).

4.4.2 Completion of first article inspection. Upon completion of the first article inspection, all the applicable inspection reports and when applicable, recommendations and comments pertinent for use in monitoring production shall be forwarded to the cognizant Government activity. The first article test report shall consist of the following:

- a. Concentricity of the electrode coverings (see 3.4.1).
- b. The type classification for which approval is sought (see 1.2).
- c. The principal compounds and nominal percentages thereof in the coverings.
- d. The range of chemical composition of the deposited weld metal (see 3.5.1).
- e. Results of all tests, referring specifically to the appropriate paragraph numbers of the specification. If a particular requirement is not applicable, the report shall so state it.
- f. A complete description of the inspection testing equipment and procedures.
- g. Copies of inspection log sheets.

4.5 Quality conformance inspection. Quality conformance inspection consists of tests for the following requirements only. The applicable methods of test are specified in the respective subparagraphs of 4.6.

- a. Dimensions and tolerances (see 3.4.1, 3.4.8.1, 3.4.8.2, 3.6.1 and 3.6.2).
- b. Concentricity of covering (see 3.4.1).
- c. Chemical composition of deposited weld metal (see 3.5.1).
- d. Workmanship (see 3.12).

4.5.1 Sampling for examination and test of electrodes. Sample electrodes shall be selected either from filled unit packages or from the production line after the baking operation. The unit packages required for this examination shall be selected from the sample of packages used for 4.4.1.1 and 4.4.1.2. If sample electrodes are selected from filled unit packages, the total sample shall be defined by the procuring activity (see 6.2). Lot size shall be expressed in pounds. A minimum number of unit packages shall be selected from the production line, the total sample shall be equivalent to the above and the electrodes shall be selected throughout the production period so that all parts of the lot are represented. The electrodes selected shall be identified as to type, lot, size and other available information such as contract or order number being filled.

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4.5.2 Visual and dimensional examination (except concentricity). Each of the sample electrodes selected in accordance with 4.5.1 shall be examined to verify conformance with all requirements which do not involve tests.

4.5.3 Concentricity. Each of the electrodes selected in accordance with 4.5.1 shall be tested as specified in 4.6.2.

4.5.4 Sampling for other tests. Take one or more packages of electrodes at random from unit packages selected for each lot in accordance with 4.5.1 or take random samples of electrodes from the production line equivalent to the above so that all parts of the lot are represented. The sample of electrodes shall be used for the tests specified in 4.6.3, 4.6.4, 4.6.5, 4.6.6, and 4.6.7 as applicable.

4.6 Test methods.

4.6.1 Dimensions and tolerances. Make determinations of the requirements for dimensions and tolerances specified in 3.4.1, 3.4.8.1, 3.4.8.2, 3.6.1 and 3.6.2 in the course of making measurements for concentricity in accordance with 4.6.2.

4.6.2 Concentricity. Make determinations of concentricity by either of the methods described in 4.6.2.1, 4.6.2.2, 4.6.2.3, or 4.6.2.4 on several electrodes of each size, selected from the samples submitted.

4.6.2.1 Method I. At a point near one end of the covered length of the electrode, remove a portion of the covering material completely to the bare core wire in the form of a band 1/2 in. (12.7 mm) wide taking care to insure that no metal is removed from the core wire. Measure the diameter of the core wire plus the thickness of the covering on one side of the electrode, using a micrometer and a supplemental metal strip approximately 1 in. (25.4 mm) long by any convenient thickness, 0.125 or 0.250 in. (3.2 or 6.4 mm). Alternatively, a specially adapted micrometer having a T-shaped anvil may be used. The metal strip shall bridge the gap left by the removal of the ring of covering material, and the total measurement shall be noted. (It is immaterial whether or not the thickness of the metal strip is included in the measurement.) Make several measurements on several different diameters around the area from which the covering was removed, taking note of the minimum and maximum measurements. Make a second and third series of similar measurements at approximately the mid-length and the other end of the covered portion, respectively. Use the maximum and minimum dimensions at any one section that show the greatest difference to determine the acceptability of the electrodes in accordance with 3.4.1.

4.6.2.2 Method II (alternate method). Expose the core wire by removing a small amount of covering from a spot on one side near one end of the covered length, taking care that no metal is removed from the core wire. Measure the diameter of the core wire plus the thickness of the covering on the side opposite the bared spot, with a micrometer. Then remove the covering from a spot on the opposite side of the core wire at a point immediately adjacent to that where the first and a second, similar, measurement were made. Make two additional pairs of similar measurements approximately 60° and 120°, respectively, from the diameter on which the first pair of measurements was made. Use the pair of measurements (two adjacent measurements) that show the greatest variation to determine the acceptability of the electrodes in accordance with 3.4.1.

4.6.2.3 Method III (alternate method). At a point near the arc end of the covered length of the electrode, a portion of the covering material in the form of two bands (each approximately 1/8 inch wide and approximately 1 inch apart from each other), shall be completely removed to the bare core wire, making sure that no metal is removed from the core wire. Using a V block support at each band and an optical measuring scope with a measuring guide focused on the outer edge of the covering, the electrode is rotated 360 degrees (1 turn). The minimum and maximum measurements shall be recorded. The core wire diameter is measured using a micrometer. The above procedure shall be repeated at the middle and grip ends of the electrode. The dimensions obtained shall be used to determine compliance with 3.4.1.

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4.6.2.4 Method IV (alternate method). At a point near the arc end of the covered length of the electrode, a portion of the covering material in the form of a band approximately 1/2 inch (12.7 mm) wide, shall be completely removed to the bare core wire, making sure no metal is removed from the core wire. Using two V block supports between 1 and 2 inches (25.4 and 50.8 mm) apart and any measuring instrument (such as a dial indicator gage or optical measuring scope) which rides or focuses on the bared edge of the core wire, the electrode is rotated 360 degrees (1 turn). The minimum and maximum measurements shall be recorded. The core wire diameter is measured using a micrometer. The above procedure shall be repeated at the middle and grip ends of the electrode. The dimensions obtained shall be used to determine compliance with 3.4.1.

4.6.3 Chemical analysis of deposited weld metal.

4.6.3.1 Preparation of the sample for analysis. Prepare 2-oz (56.7 gram) samples machined from pads of weld metal measuring 1-1/2 by 1-1/2 by 1/2 in. (38 by 38 by 12.7 mm) minimum height for deposits from electrodes of 3/16 in. (4.8 mm) or smaller diameter; or measuring 2 by 2 by 1/2 in. minimum height (50.8 by 50.8 by 12.7 mm minimum height) for deposits from electrodes 7/32 in. (5.6 mm) or larger diameter. Make the samples from pads of weld metal deposited on steel conforming to MIL-A-12560, or the equivalent, as approved by the procuring activity. First machine off the top surface of the pad. Then machine the sample for chemical analysis from the section immediately below the top surface, in such a manner that no metal will be removed within 1/4 in. (6.4 mm) of the base metal.

4.6.3.2 Preparation of the pad. Deposit each pass so that the width of the pass is 1-1/2 to 2-1/2 times the diameter of the core wire of the electrode being deposited. After depositing each pass, immerse the pad in cool water for one minute. Deposit the weld metal using as short an arc as practicable, under the following electrical conditions:

Electrode size, in. (mm)	Arc amperes <u>1/</u>	Arc voltage, maximum
1/8 (3.2)	100	25
5/32 (4.0)	130	26
3/16 (4.8)	170	27
7/32 (5.6)	200	27
1/4 (6.4)	230	28
5/16 (8.0)	300	29
3/8 (9.5)	400	30

1/ Maximum permissible variation: Plus or minus 10 amperes.

4.6.4 Groove welds.

4.6.4.1 Welded joint designs. Make groove weld test joints in accordance with the designs shown on figure 3.

4.6.4.2 Groove preparation. Prepare all grooves to the finished dimensions by machining or by machine gas-cutting, supplemented as necessary by grinding or chipping.

4.6.4.3 Vertical position welds. Make test welds for the vertical welding position by progressing in an upward direction.

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4.6.4.4 Welding procedures and conditions.4.6.4.4.1 Layering of welds. Deposit welds in layers as shown on figure 3.

4.6.4.4.1.1 For checking physical properties of welds. Deposit the welds with the number of layers specified below, and in such a manner that the final layer is a reinforcement of standard proportions.

Electrode size: in. (mm)	Number of layers
5/32 (4.0)	9 or 10
3/16 (4.8)	9 or 10
7/32 (5.6)	8 or 9
1/4 (6.4)	8 or 9
5/16 (8.0)	8 or 9 *
3/8 (9.5)	7 or 8 *

* See 4.6.4.5.2

4.6.4.4.2 Width of pass. Deposit the weld, except for the two root layers, using the 2-1/2 diameter (split weave) build-up sequence shown on figure 3.

4.6.4.4.3 Crater cracks. If cracks in any root pass extend beyond to craters into the deposited metal or if there are cracks longer than 1/2 in. (12.7 mm) in any succeeding pass or weld metal, discontinue tests of the electrode involved. Report any cracking encountered in an electrode.

4.6.4.4.4 Plate temperature. Do not start the initial root pass on any groove weld until the temperature of the test plate is between 60°F and 86°F (16°C and 30°C). When starting the deposition of additional passes, the plate temperature in the immediate vicinity of the weld shall not exceed 225°F (107°C).

4.6.4.5 Preparation of test joints.

4.6.4.5.1 For 5/32 in. (4.0 mm) electrodes. Weld one joint on rolled, homogeneous armor plate in the vertical position for checking physical properties. The procuring activity shall specify the necessary details (see 6.2).

4.6.4.5.2 For 3/16, 7/32, 1/4, 5/16, and 3/8 in. (4.8, 5.6, 6.4, 8.0, and 9.5 mm) electrodes. Weld one joint in the flat position on rolled, homogeneous armor plate, for checking physical properties, as specified by the procuring activity. In addition, prepare welds for tests of 5/16 and 3/8 in. (8.0 and 9.5 mm) electrodes by depositing the three layers immediately above the root layer with 3/16 in. (4.76 mm) electrodes, then complete the weld with 5/16 or 3/8 in. (8.0 or 9.5 mm) electrodes. Use electrodes of 5/32 in. (4.0 mm) diameter for depositing root passes and also for passes A and B as shown on figure 3 for each size of electrode being tested.

4.6.4.6 Post welding treatment of welds.

4.6.4.6.1 Peening. Peening of welds shall not be permitted.

4.6.4.6.2 Chipping of crater cracks. Chipping of crater cracks shall be permitted only in the root passes.

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4.6.4.7 Preparation of specimens from joints. Weld test specimens for tension testing shall be machined in accordance with figure 3. Two transverse tensile specimens shall be tested.

4.6.4.8 Testing of specimens and joints.

4.6.4.8.1 Specimens. Test the specimens to determine tensile strength and elongation.

4.6.4.8.2 Joints. Radiograph the welded test joint after removal of the reinforcement and backing strip before machining the test specimen from them.

4.6.5 Fillet welds.

4.6.5.1 Welded joint designs. Make fillet weld joints as shown in figures 4A and 4B.

4.6.5.2 Welding procedure. Make one joint each for 1/8 and 5/32 in. (3.2 and 3.97 mm) electrodes in both vertical and overhead positions. Make one joint each for 1/8, 5/32, 3/16, 7/32, and 1/4 in. (3.2, 4.0, 4.8, 5.6, and 6.4 mm) electrodes in the horizontal position. The plate material shall conform to MIL-A-12560 or the equivalent. When performing the vertical welding tests, deposit the weld by progressing in an upward direction.

4.6.5.3 Specimen examination. Examine the fillet welds for surface holes, surface smoothness, undercutting, overlapping, excessive convexity, and cracking. Observe the penetration of the weld to the root of the fillet after breaking specimen 4A as illustrated. Determine the convexity on a polished and etched section of specimen 4B. Examine both specimens visually for porosity, cracking, and slag entrapment.

4.6.6 Root pass cracking test.

4.6.6.1 Purpose. To evaluate the susceptibility of weld metal to longitudinal cracking.

4.6.6.2 Welding conditions. The required welding conditions for the root pass cracking test shall be as stated in table V and as shown on figure 5.

TABLE V. Root pass crack susceptibility requirements.

Electrode diameter: in. (mm)	Current, amp, \pm 5%	Arc-Voltage (max.)	Root gap in. (mm)	Root bead thickness in. (mm)	Plate temperature: $^{\circ}$ F ($^{\circ}$ C)	Length of electrode consumed, min. in. (mm) *
5/32 (4.0)	145	26	3/16 (4.8)	0.160-0.200 (4.6-5.1)	60-80 (15.6-26.7)	10.5 (267)
3/16 (4.8)	185	27	1/4 (6.4)	0.185-0.240 (4.7-6.1)	60-80 (15.6-26.7)	12.25 (311)
1/4 (6.4)	255	28	5/16 (8.0)	0.250-0.330 (6.4-8.4)	60-80 (15.6-26.7)	14 (356)
5/16 (8.0)	315	29	3/8 (9.5)	0.280-0.360 (7.1-9.15)	60-80 (15.6-26.7)	14 (356)

* Total length of electrode consumed in making a weld.

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4.6.6.3 Test material. The material used for this test shall be steel plate meeting the requirements of class 1 of MIL-A-12560 or of the grade F of ASTM A517/A517M.

4.6.6.4 Welding position. Perform welding in the flat position with the plate in a horizontal plane.

4.6.6.5 Welding procedure. At the termination of the root pass, snap out the arc (while in forward motion) without filling the crater. Leave the crater in the as formed condition except for removing the slag.

4.6.6.6 Electrode evaluation procedure.

- a. Remove the slag carefully from the top and the bottom of the weld.
- b. After removing the slag and allowing the plate to cool to approximately 100°F (38°C), examine the weld by a dye penetrant method.
- c. Reject the electrode if:
 - Longitudinal weld bead cracking exceeds 20 percent of the total weld length on the back side of the weld.
 - Transverse cracking occurs.
 - Fusion zone cracking occurs in either the front or the back of the weld.

4.6.7 Flaking of covering. Determine the flaking tendency of electrode coverings by a welding test using the currents specified in 4.6.3.2, as prescribed in 4.6.7.1 through 4.6.7.4.

4.6.7.1 Sampling. Select a sample of no fewer than five electrodes from each size of electrode to be tested.

4.6.7.2 Preparation for testing. Groove the covering completely around the electrode at the midpoint of its length for each of the electrode samples selected for test.

4.6.7.3 Deposit with full length. Use each test electrode in the usual manner, with the appropriate, prescribed welding current (4.6.3.2), depositing a bead weld on a steel plate surface until the electrode is consumed to the groove in the covering. Then stop welding. Remove the half-length stub immediately from the electrode holder and place the stub on a flat steel plate to cool.

4.6.7.4 Deposit with half length. When the half length stub has cooled sufficiently to be held comfortably in the bare hand, insert it in the electrode holder and resume welding until the half stub has been consumed to a stub not more than 2 inches (50.8 mm) in length. If any flaking of the electrode covering occurs during welding with the half stub, reject the particular electrode size involved of the brand under test.

4.7 Preparation for delivery. Prior to shipment, examination shall be made to determine compliance with section 5.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military

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Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

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 is military unique because it covers austenitic welding electrodes for the welding of steels of high hardenability such as those used for armor applications. Chromium-nickel electrodes for the welding of corrosion and heat resisting steels are covered by MIL-E-22200/2. The MIL-307 and MIL-308 types of electrodes are commonly designated as 19-9 Mn and 19-9 Mo, respectively.

6.1.1 Unit containers. Unit containers should bear a printed label in a conspicuous location, on or near the manufacturer's label and on any special instructions which may be enclosed. As a minimum the warning label should contain the following:

CAUTION: Welding may produce fumes and gases hazardous to health. Avoid breathing these fumes and gases. Use adequate ventilation. See AWS Z49.1, Safety in Welding and Cutting.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Type, class, and size of the required electrodes (see 1.2).
- c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
- d. When first article is required (see 3.1).
- e. Responsibility for performance of first article inspection (see 4.4).
- f. Number of samples to be inspected to verify compliance with visual, dimension, and concentricity requirements (see 4.4.1.1).
- g. Number of samples to be inspected for all other tests for all other requirements (see 4.4.1.2).
- h. Number of samples to be inspected when the total sample is selected from filled unit packages (see 4.5.1).
- i. Specify details for checking physical properties of test joints (see 4.6.4.5.1).
- j. Packaging requirements (see 5.1).

6.3 Moisture control in austenitic electrodes. Excessive moisture in austenitic electrode coverings has been shown to contribute to weld metal porosity and cracking.

6.3.1 Storage of new electrodes. It has been determined that electrodes stored as follows should not absorb excessive amounts of moisture:

- a. Within the temperature range from 212°F to 260°F (100°C to 127°C).
- b. Within the temperature range from 68°F to 86°F (20°C to 30°C) and a maximum relative humidity of 50 percent.

6.3.2 Reconditioning of exposed electrodes. Austenitic electrodes that have absorbed excessive amounts of moisture in the coverings can be reconditioned by placing them in a well-ventilated oven at not more than 150°F (66°C), heating to between 500°F to 600°F (260°C to 316°C) for at least one hour. Such reconditioned electrodes should be stored in accordance with 6.3.1. This reconditioning method does not apply to electrodes that have been in physical contact with water. Such electrodes should not be used without further investigation.

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6.4 Subject term (key word) listing.

Concentricity
Core wire
Dielectric strength
Fillet
Slag

CONCLUDING MATERIAL

Custodians:
Army - MR
Navy - SH
Air Force - 11

Preparing activity:
Army - MR
(Project 3439-0959)

Review activities:
Army - AL
Navy - AS, NP
Air Force - 03, 84, 99
DLA - GS

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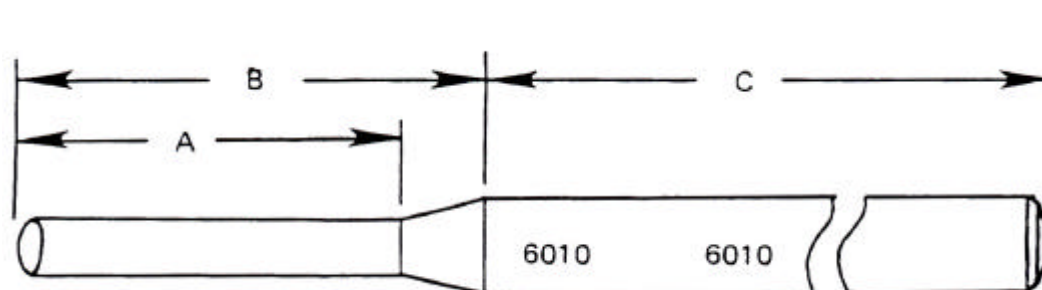
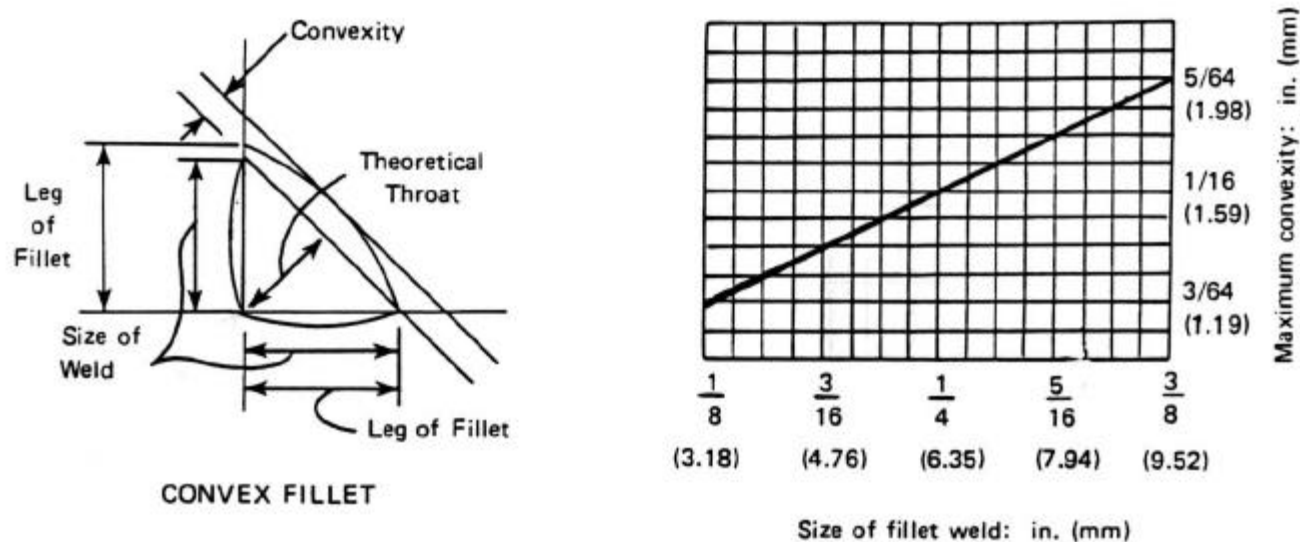


FIGURE 1. Marking of electrodes.

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Dimensions of fillet welds

NOTES:

1. Size of fillet weld = length of leg of largest inscribed isosceles right triangle.
2. Length of horizontal leg of fillet weld shall not vary more than $\frac{1}{16}$ in. (1.59 mm) from length of vertical leg.
3. Fillet weld size, convexity, and leg lengths of fillet welds shall be determined by actual measurement (to nearest $\frac{1}{64}$ in. or 0.397 mm) on a section laid out with scribed lines as shown.

FIGURE 2. Sizes, dimensions, and design of fillet welds.

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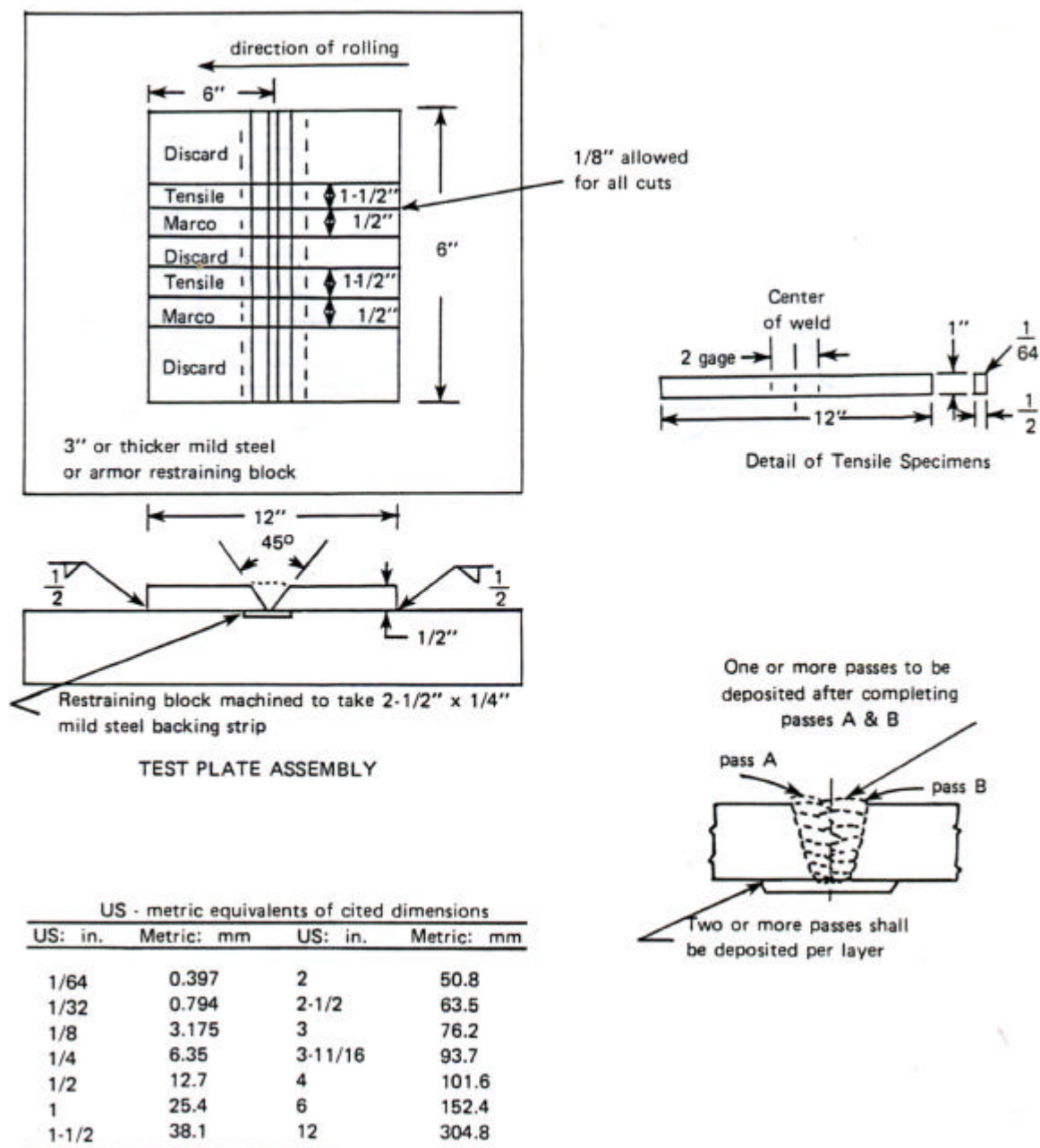
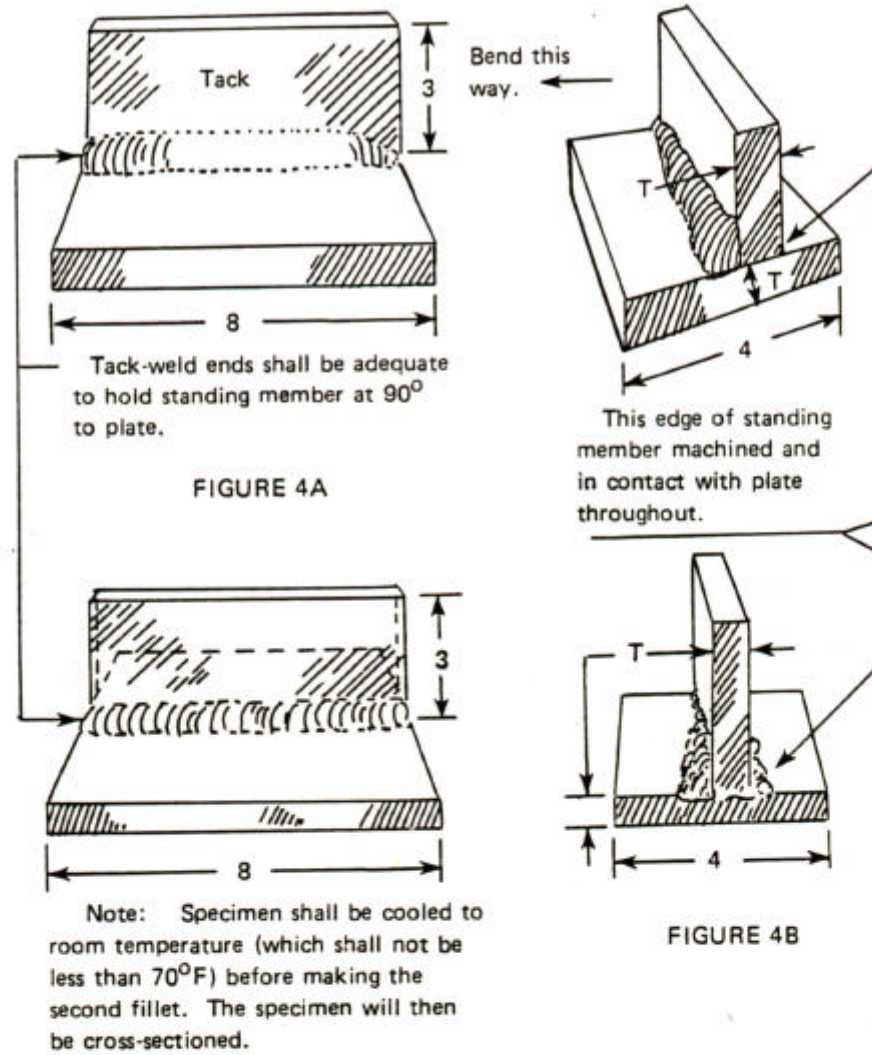


FIGURE 3. Test set-up for determining physical properties.

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Dimensions of electrode, thickness, and fillet weld

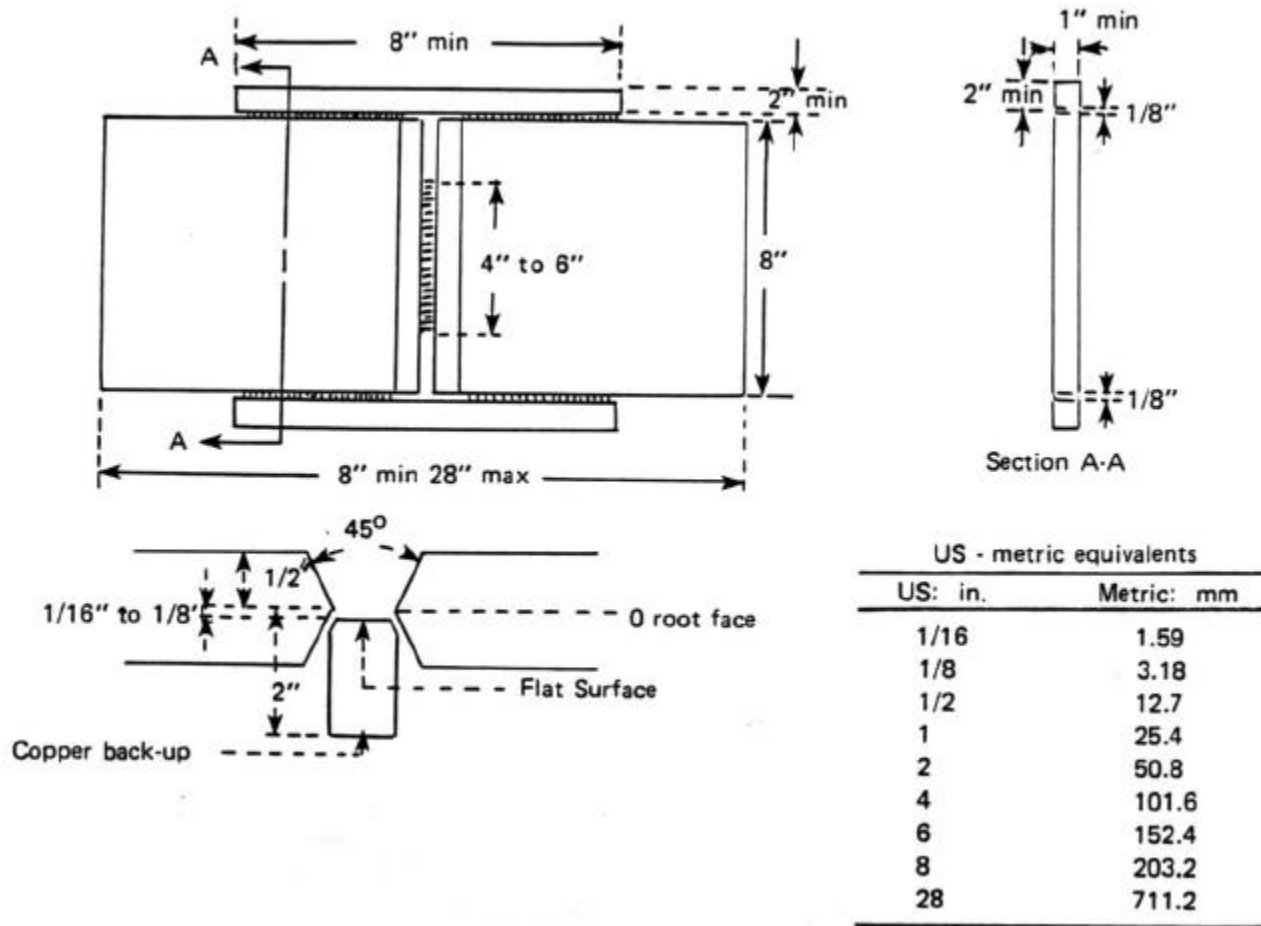
Electrode size: in. (mm)	Thickness (T) in. (mm)	Fillet weld size in. (mm)
1/8 (3.18)	3/8 (9.52)	3/16 to 1/4 (4.76 to 6.35)
5/32 (3.97)	3/8 (9.52)	1/4 to 5/16 (3.18 to 7.94)
3/16 (4.76)	1/2 (12.7)	5/16 to 3/8 (7.94 to 9.52)
1/4 (6.35)	1/2 (12.7)	3/8 (9.52)

US - metric equivalents of cited values

US	Metric
3 in.	76.2 mm
4 in.	101.6 mm
8 in.	203.2 mm
70°F	21°C

FIGURE 4. Usability test specimen for electrodes

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Test plate

NOTES:

1. Material shall be 1 in. (25.4 mm) homogeneous steel armor plate.
2. Locate copper back-up 1/16 to 1/8 in. (1.6 to 3.2 mm) below vortex of joint.
3. Guide electrode manually.
4. Use AC or DC power source for designation-16 electrodes. Use DC power source only for designation-15 electrodes.
5. Deposit welds for joining the restraining bar using electrodes conforming to MIL-DTL-13080 or MIL-E-22200/1.

Back-up bar

Back-up bar size: in. (mm)	Electrode size in. (mm)	Flat surface width: in. (mm)	Bevel angle	Material
7 x 2 x 1/2, min. (177.8 x 50.8 x 12.7, min.)	5/32 or 3/16 (4.0 or 4.8)	3/8 (9.5)	40°	Wrought copper
7 x 2 x 5/8, min. (177.8 x 50.8 x 15.9, min.)	1/4 or 5/16 (6.4 or 8.0)	1/2 (12.7)	40°	Wrought copper

FIGURE 5. Root pass susceptibility test plate and back-up bar.

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INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
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1. DOCUMENT NUMBER
MIL-DTL-13080E

2. DOCUMENT DATE (YYYYMMDD)
990415

DOCUMENT TITLE ELECTRODES, WELDING, COVERING: AUSTENITIC STEEL (19-9 MODIFIED) FOR ARMOR APPLICATIONS

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

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(2) DSN
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