

**MIL-E-278B****26 JUNE 1968****SUPERSUCCESS****MIL-E-278A****2 NOVEMBER 1960****46E12****7 SEPTEMBER 1948****MILITARY SPECIFICATION****ELECTRODES, WELDING, COVERED,  
ALUMINUM BRONZE**

*This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.*

**1. SCOPE**

1.1 Scope. This specification covers aluminum bronze electrodes for use with the shielded metal arc process.

1.2 Classification. Aluminum bronze electrodes shall be of the classes and sizes shown in Table I, as specified (see 6.2):

TABLE I. *Classes and sizes*

Class	Size (core-wire diameter)					
	1/8 in.	3/16 in.	1/4 in.	5/16 in.	3/8 in.	1/2 in.
MIL-E-CuAl-A	3/16	1/8	3/16	1/4	3/8	1/2
MIL-E-CuAl-B	—	3/16	1/4	5/16	3/8	1/2
MIL-E-CuAl-C	—	3/16	1/4	5/16	3/8	1/2
MIL-E-CuAl-D	—	—	3/16	1/4	3/8	1/2
MIL-E-CuAl-E	—	—	3/16	1/4	3/8	1/2

**2. APPLICABLE DOCUMENTS**

2.1 The following specifications and standards of the issue in effect on date of invitation for bids form a part of this specification.

**SPECIFICATIONS****FEDERAL**

QQ-S-686 — Steel, Carbon (Low Carbon) Sheets and Strips.

PPP-B-585 — Boxes, Wood, Wire-bound.

PPP-B-591 — Boxes, Fiberboard; Wood-cleated.

PPP-B-601 — Boxes, Wood, Cleated-Plywood.

PPP-B-621 — Boxes, Wood, Nailed and Lock-corner.

PPP-B-686 — Boxes, Fiber.

PPP-T-60 — Tape; Pressure Sensitive Adhesive Waterproof- for Packaging and Sealing.

**MILITARY**

JAN-P-106 — Packaging and Packaging for Overseas Shipment — Boxes; Wood, Nailed.

MIL-C-915 — Cable, Cord and Wire, Electrical (Shipboard use).

MIL-C-3955 — Cans, Fiber, Spirally Wound.

MIL-B-10377 — Boxes - Wood-cleated, Veneer, Paper, Overlaid.

MIL-L-10547 — Liners, Case, Waterproof.

**MIL-E-278B**

**MIL-W-15759** — Welding Machines;  
Arc (Direct Current-Variable Voltage).

**MIL-B-15939** — Bronze, Aluminum;  
Wrought.

**MIL-S-16112** — Steel, Plate, Hull and  
Ordnance, Structural Black (Uncoated)  
and Zinc Coated (Galvanized).

**STANDARDS****MILITARY**

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

**MIL-STD-129** — Marking for Shipment  
and Storage.

(Copies of specifications and standards required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

**3. REQUIREMENTS**

**3.1 Preproduction sample.** Unless otherwise specified in the contract or order (see 6.2), a preproduction sample (see 4.2.1) of electrode is required for each class of electrode being purchased. Samples shall be manufactured using the methods and procedures proposed for the production lot. Samples will be tested as specified in 4.3.1 and are for the purpose of determining that the manufacturers' production process will produce electrodes that will meet the requirements of this specification.

**3.2 Material.** Material used in the construction of electrodes and not specifically specified herein shall be of quality and form such as to conform to the requirements of this specification. The core wires shall be free of injurious defects, such as segregations and nonmetallic inclusions. Core wires and coverings may be made by any process yielding a product suitable for the purpose intended.

**3.3 Coverings of electrodes.**

**3.3.1 Handling.** Coverings shall withstand ordinary handling without injury.

**3.3.2 Concentricity of coverings.** The coverings shall be concentric to the extent that, for all sizes of electrodes, the maximum core-plus-one covering dimension shall not exceed the minimum core-plus-one covering dimension by more than 5 percent of the mean dimension at the respective location as hereinafter indicated in 4.4.2.1 and 4.4.2.2.

**3.3.3 Uniformity of consumption.** The coverings shall be such as to be consumed uniformly so as not to interfere with satisfactory production welds.

**3.3.4 Flaking or cracking.** The coverings shall not exhibit flaking or cracking at any time while electrodes are being used with the respective currents for general welding recommended by the manufacturer, nor shall the coverings exhibit flaking or cracking when heated or upon cooling after approximately one-half of the electrode has been consumed or upon resumption of welding.

**3.3.5 Dielectric strength.** The coverings of electrodes at room temperature and in the "dry" condition, that is, as removed from freshly opened containers, shall have a dielectric strength sufficient to insulate effectively against a difference of potential of 110 volts a.c. (60 cycles).

**3.3.6 Stability.** Stability of the coverings shall be such that electrodes will comply with this specification (see 3.3.4) after storage in original unopened containers under roof and on dry platforms for a period up to one year.

**3.3.7 Fumes.** The fumes from the burning coverings shall not be injurious to personnel when electrodes are used in adequately ventilated spaces.

**3.3.8 Slag removal.** The slags deposited by the coverings shall be readily removable with hand tools (not air or power operated) from weld deposits.

## MIL-E-2788

## 3.3.9 Extent of coverings.

**3.3.9.1 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 for all sizes of electrodes shall not exceed  $\frac{1}{8}$  inch. This measurement is the bare portion existing from arc end of the core wire to the point where the covering begins. Electrodes with chipped coverings near the arc end baring the core wire not more than  $\frac{1}{32}$  inch will be accepted provided no chip uncovers more than 50 percent of the circumference of the core.

**3.3.9.2 Grip ends.** Grip ends of electrodes shall be bare within the limits shown in Table II and Figure 1.

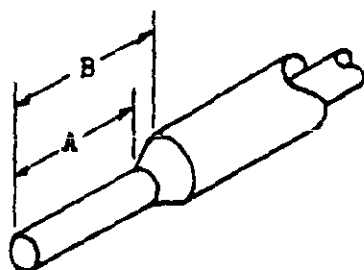


FIGURE 1. End grip electrode

TABLE II. Dimensions for grip ends of electrodes

Bare portion minimum "A"		Distance to full thickness of covering "B"	
$\frac{3}{32}$ thru $\frac{1}{8}$	$\frac{1}{8}$ & $\frac{1}{4}$	$\frac{3}{32}$ thru $\frac{1}{8}$	$\frac{1}{8}$ & $\frac{1}{4}$
<i>Inch</i>	<i>Inch</i>	<i>Inch</i>	<i>Inch</i>
$\frac{3}{32}$	$\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$
$\frac{1}{8}$	$\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$
$\frac{1}{4}$	$\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$
$\frac{1}{2}$	$\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$
$\frac{3}{4}$	$\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$

## 3.4 Core wires of electrodes.

**3.4.1 Wire diameter tolerance.** The diameter of the wire of the electrodes shall not vary

from the nominal diameter more than plus or minus 0.008 inch.

**3.4.2 Electrode lengths.** The specified lengths of electrodes shall be in accordance with Table III.

TABLE III. Electro lengths

Size	Length
<i>Inch</i>	<i>Inches</i>
$\frac{3}{32}$	11
$\frac{1}{8}$ , $\frac{3}{16}$ , $\frac{1}{4}$	14
$\frac{5}{16}$ , $\frac{3}{8}$ , $\frac{1}{2}$	18

**3.4.2.1 Tolerance of specified lengths.** The actual length of any electrode shall not vary more than plus or minus  $\frac{1}{16}$  inch from the specified length.

**3.5 Usability of electrodes.** Electrodes shall be suitable in all respects for depositing satisfactory overlays and welds, under the conditions specified in 4.4.4 exhibiting no undercut or overlap, and that when prepared and examined in accordance with 4.4.4.1 shall show no porosity or other defects exceeding 0.08 inch in length in either the "as welded" or machined condition. In all other respects electrodes must conform to the applicable requirements of section 8.

**3.5.1 Weld pads.** Weld pad specimens shall be prepared in accordance with 4.4.4. They shall meet the requirements for hardness specified in Table IV.

**3.5.2 Transverse tension test specimens.** Transverse tension test specimens shall be prepared with Class MIL-E-CuAL-A and MIL-E-CuAL-B electrodes in accordance with 4.4.5.1. They shall meet the requirements of Table IV.

**3.5.3 Hardness.** The hardness requirements of deposited weld metal shall be as specified in Table IV.

**MIL-E-278B****TABLE IV. Mechanical requirements of deposited weld metal ("as welded")**

Class	Brinell hardness range <sup>1</sup> (See 4.4) 3000 Kg load	Transverse tension Test minimum tensile strength (psi)
MIL-E-CuAl-A	180-170	60,000
MIL-E-CuAl-B	160-210	65,000
MIL-E-CuAl-C	210-260	—
MIL-E-CuAl-D	260-310	—
MIL-E-CuAl-E	310-365	—

<sup>1</sup> One or more of the hardness values exhibited by the test pad (see 4.4.3) may be outside the specified hardness range, but the average hardness shall be within the specified range.

**3.5.4 Guided bend test specimens.** Guided bend test specimens shall be made for class MIL-E-CuAl-A and class MIL-E-CuAl-B electrodes in accordance with 4.4.5. After bending, specimens shall show no cracks or open defects exceeding  $\frac{1}{8}$  inch measured in any direction. Cracks occurring on the corners of a specimen during testing shall not be considered.

**3.5.5 Soundness.** Weld pads shall be free from seams, cracks, porosity, slag inclusions, and any other injurious defects.

**3.6 Chemical composition of deposited weld metal.** Under conditions specified in 4.4.4.3 electrodes shall be capable of depositing weld metal having the composition shown in Table V.

**3.7 Color identification marking.** Grip end of electrodes shall be painted with primary,

secondary, and group colors as shown on Figure 2 and Table VI for identification. The paint used for marking shall not interfere with proper electrical contact. The primary color applied to the end of the electrode shall not extend more than  $\frac{1}{4}$  inch from the end. Coding material shall remain adherent and color stable after production drying.

**3.8 Welder performance.** Prior to performing any welding test, the welder shall be required to demonstrate his ability to handle the electrode in a manner approved by the Bureau or Agency concerned. The welder will not be permitted to use any unusual technique of manipulating the electrode, that is, 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 in this specification.

**3.9 Workmanship.** The coverings of the electrodes shall be free from injurious scabs, blisters, pockmarks, bruises or other surface defects which are detrimental to the performance of the electrodes.

**4. QUALITY ASSURANCE PROVISIONS**

**4.1 Lot.** For the purposes of sampling a lot of electrodes shall consist of a quantity of any one size and class produced uninterruptedly on the same machine, from one heat of wire, provided that such electrodes shall have been manufactured in the same covering formula with no modification of lots of covering ingredients therein.

**TABLE V. Chemical composition of deposited weld metal**

Class	Aluminum	Iron	Silicon (max.)	Lead (max.)	Copper	Other <sup>1</sup> elements (max.)
	Percent	Percent	Percent	Percent	Percent	Percent
MIL-E-CuAl-A	7.0 to 9.0	0.5 to 5.0	1.0	0.02	Remainder	0.60
MIL-E-CuAl-B	8.0 to 10.0	2.5 to 5.0	1.0	0.02	Remainder	0.60
MIL-E-CuAl-C	9.0 to 11.0	3.5 to 6.0	1.0	0.02	Remainder	0.60
MIL-E-CuAl-D	10.0 to 13.0	3.5 to 6.5	1.0	0.02	Remainder	0.60
MIL-E-CuAl-E	12.0 to 14.0	4.0 to 6.5	1.0	0.02	Remainder	0.60

<sup>1</sup> Total other elements shall not exceed the value specified.

MIL-E-278B

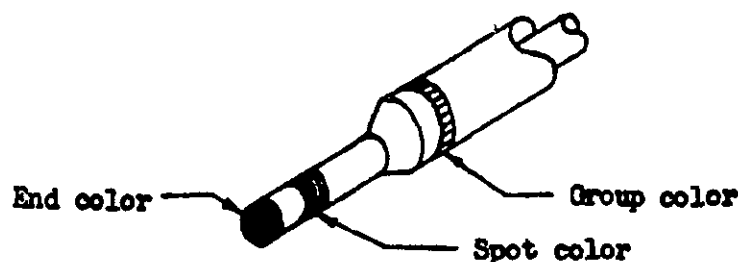


FIGURE 2. Color marking of end grip electrodes

NOTE 1—Color bands are used only to denote sequence of colors; they are not intended to show the configuration of the colors to be applied.

TABLE VI. Color marking of electrodes

Class	Primary (end) color	Secondary (spot) color	Group color
MIL-E-CuAl-A	Silver	Blue	Blue
MIL-E-CuAl-B	Silver	Brown	Blue
MIL-E-CuAl-C	Silver	Green	Blue
MIL-E-CuAl-D	Silver	Red	Blue
MIL-E-CuAl-E	Silver	Yellow	Blue

## 4.2 Sampling.

**4.2.1 Sampling for preproduction inspection and tests.** Unless otherwise specified (see 4.2.1.1), as soon as possible after the award of contract, the contractor shall submit preproduction samples (20 pounds) of electrodes of the classes, and sizes being purchased. Electrodes shall be submitted to the Government inspector for preproduction inspection and tests at the Government laboratory (see 6.8) designated in the contract or order, for purposes of determining compliance with the requirements of this specification and the contract or order. All containers of preproduction electrodes shall be plainly marked. In addition each sample shall be plainly identified by a securely attached durable tag that contains the following information:

Title, number, and date of this specification.

Class and size (see 1.2).

Sample for preproduction inspection and tests.

Manufacturer's designation or brand name.

Name of manufacturer.

Plant address.

Reference the procurement contract.

Further production of electrodes by the contractor prior to the approval of the procuring activity or completion of inspection and tests on the preproduction samples shall be at the contractor's risk. Accepted preproduction samples will become the property of the procuring activity and will not be included in the quantity of electrodes called for in the contract or order.

**4.2.1.1 Preproduction samples for subsequent contract.** If a contractor has previously delivered electrodes in accordance with the requirements of this specification and his product has been found to be satisfactory, the preproduction sample for any subsequent contract for the specific class and size of electrode previously delivered may be waived at the discretion of the procuring activity (see 6.2).

## 4.2.2 Sampling for lot acceptance inspection.

### 4.2.2.1 Packaging, packing, and marking.

A random sample of shipping containers filled with packages of electrodes shall be selected by the Government inspector in accordance with the provisions of Standard MIL-STD-105, at inspection level I and Acceptable Quality Level (AQL) 2.5 percent defective

**MIL-E-278B**

to verify compliance with 5.3 and 5.4. Upon satisfactory completion of inspection of filled shipping containers, a representative sample of filled packages shall be selected by the Government inspector in accordance with the provisions of Standard MIL-STD-105 at inspection level I and Acceptable Quality Level (AQL) 2.5 percent defective, to verify compliance with 5.2. The packages shall be selected from the shipping containers of the container inspection sample.

**4.2.2.2 Electrodes.** A random sample of electrodes shall be selected by the Government inspector in accordance with the provisions of Standard MIL-STD-105 at inspection level I and Acceptable Quality Level (AQL) 2.5 percent defective to verify compliance with this specification and the contract or order. The electrodes shall be selected from packages of the packing inspection sample.

**4.2.2.3 Weld pad construction.** A sufficient number of electrodes shall be selected at random from each lot, to be used in preparing the weld pad specified in 4.4.4.

### **4.3 Inspection.**

**4.3.1 Preproduction inspection and tests.** Preproduction inspection and tests shall consist of performing the following inspection and tests on the samples submitted to the Government laboratory under paragraph 4.2.1.

- (a) Visual and dimensional inspection (see 4.3.2.2).
- (b) Packaging, packing, and marking inspection (see 4.3.2.1).
- (c) Tests covered under 4.4.

When preproduction inspection and tests are completed, the Government laboratory shall notify the Government inspector immediately, who in turn shall notify the contractor of the test results and of any specific deficiencies in his preproduction samples. The contractor shall take the necessary action to correct any deficiency, and may be required, at the discretion of the laboratory, to submit additional

samples until the specified number of satisfactory samples have been submitted. Such samples shall be accompanied by a description of the changes made to correct the faults of the previous submissions.

**4.3.2 Lot acceptance inspection.** Lot acceptance inspection shall consist of performing the following inspections on sample electrodes and packages of electrodes selected in accordance with paragraph 4.2.2.

- (a) Packaging, packing, and marking inspection (see 4.3.2.1).
- (b) Visual and dimensional inspection (see 4.3.2.2).

The Government reserves the right to conduct any one or more of the tests specified herein when the inspector deems it necessary in determining conformance of the electrodes with the requirements of this specification and the contract or order.

**4.3.2.1 Packaging, packing, and marking.** Each of the containers, both outer shipping containers and the unit packages, in the sample selected in accordance with 4.2.2.1 shall be examined for defects of construction, for unsatisfactory markings, and for noncompliance with the requirements of this specification and contract or order. Each filled container shall also be weighed to verify compliance with this specification. If the number of rejected containers exceeds the acceptance number for the appropriate sampling plan of Standard MIL-STD-105 the lot represented by the sample shall be rejected.

**4.3.2.2 Electrodes.** Each of the sample welding electrodes selected in accordance with 4.2.2.2 shall be visually and dimensionally inspected to determine conformance to the requirements of this specification and the contract or order. Any electrodes with one or more defects shall be rejected and if the number of rejected electrodes exceeds the acceptance number for the appropriate sampling plan of Standard MIL-STD-105 the lot represented by the sample shall be rejected.



## MIL-E-2788

**4.3.3 Place of inspection and tests.** Unless otherwise specified in the contract or order (see 6.2), inspection and test shall be conducted at the place of manufacture.

**4.4. Tests and test procedures for preproduction and acceptance inspection.**

**4.4.1 Welding machines.** Welding tests shall be made using machines conforming to Specification MIL-W-15759 and having a current rating such that the manufacturer's recommended currents for the electrodes being tested do not fall in the lowest or highest ten percent of the rating of the machine. Other types may be used, but in case of dispute, the results of tests made with the specified type of machine, shall govern.

**4.4.1.1 Welding and grounding leads.** All welding and grounding leads for dc and ac welding circuits shall be 105,000 circular mils flexible cables (type TRF-105 of Specification MIL-C-915, or equivalent) not over 50 feet long, and electrode holder (10 feet of 84,000 circular mils extremely flexible cable of type TRXF-84 of Specification MIL-C-915 or equivalent), may be attached to the electrode holder, or work as directly as practicable. Leads shall not be coiled, wrapped, or kinked in any way that will introduce any appreciable reactance into the circuit. Ground connections shall be so located (and moved during welding if necessary) that magnetic arc blow is eliminated as far as practicable.

**4.4.2 Procedure for measurements of concentricity.** The concentricity of the coverings on three electrodes of each size selected in accordance with 4.2.2.2 shall be measured by either of the methods specified in 4.4.2.1 or 4.4.2.2.

**4.4.2.1 Micrometer method.** The core wire shall be exposed by removing a small amount of covering from a spot on one side of the core wire near one end of the covered length, care being taken to ensure that no metal is removed from the core wire. The diameter of the core wire plus the thickness of the covering on the side opposite the bared spot shall

be measured with a micrometer. The covering shall then be removed from a spot on the opposite side of the core wire at a point immediately adjacent to that at which the first measurement was made, and a second similar measurement made. Second and third pairs of similar measurements shall be made at approximately the mid-length and the other end of the covered portion, on diameters approximately 60 degrees, respectively, from the diameter on which the first pair of measurements was made. The pair of measurements (2 adjacent measurements) that shows the greatest variation shall be used to determine the acceptability of the electrodes as specified in 3.3.2.

**4.4.2.2 Micrometer method using supplemental strip.** At a point near one end of the covered length of the electrode a portion of the covering material in the form of a band approximately  $\frac{1}{2}$  inch wide shall be completely removed to the bare core wire, care being taken to ensure that no metal is removed from the core wire. Using a micrometer and supplemental metal strip (approximately 1 inch long by any convenient thickness, that is, 0.125 or 0.0250 inch) or a specially adapted micrometer having a "T" shaped anvil, the diameter of the core wire plus the thickness of the covering on one side of the electrode shall be measured. The metal strip shall bridge the gap left by removal of the ring of covered 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.) Several measurements shall be made on several different diameters around the area from which the covering was removed, and the minimum and maximum measurements shall be noted. A second and third series of similar measurements shall be made at approximately the midlength and other end of the covered portion, respectively. The maximum and minimum dimensions at any one section which show the greatest difference shall be used to determine the acceptability of the electrodes as specified in 3.3.2.

**4.4.3 Diameter and length of core wire.** In the course of making the above measurements,

MIL-E-278B

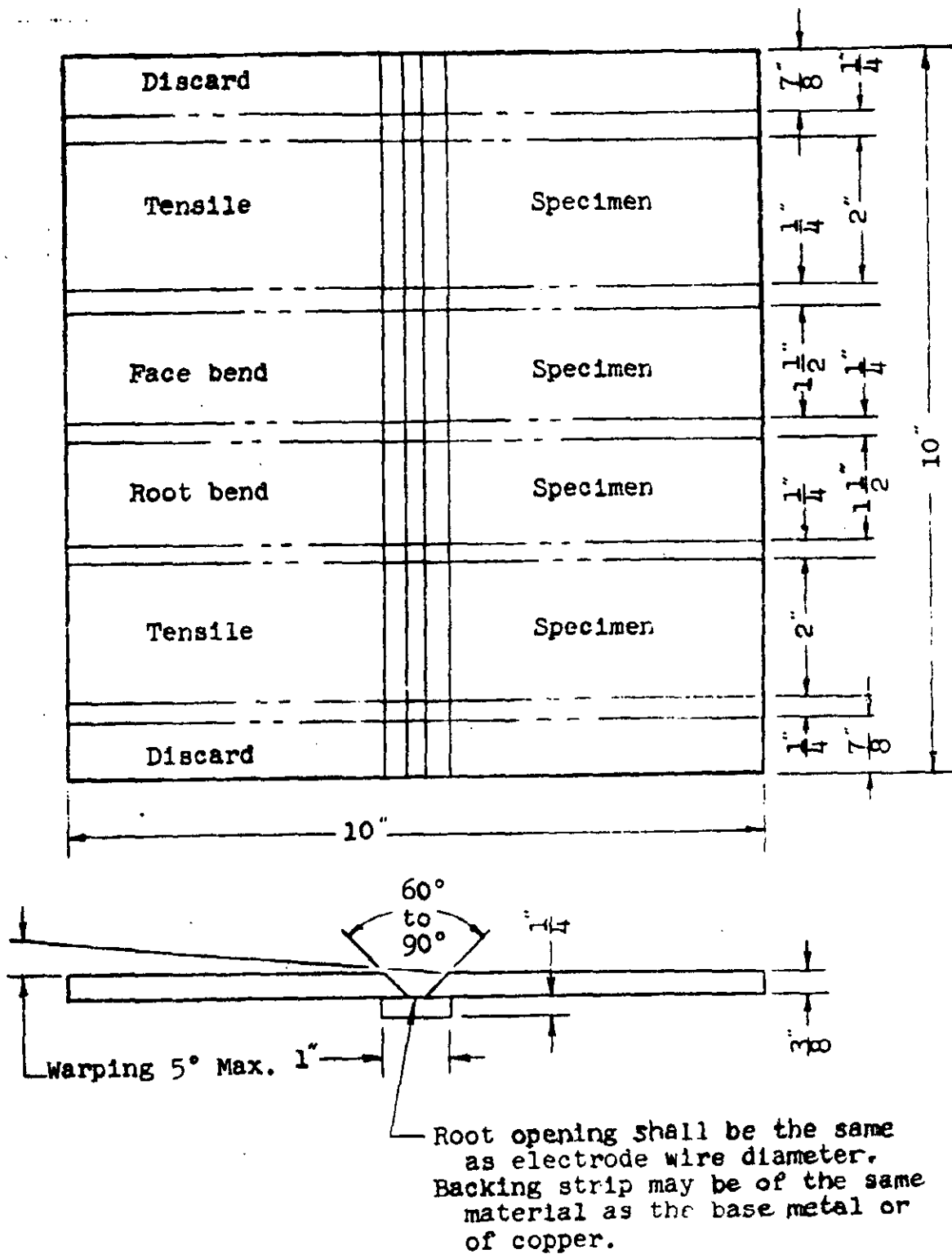


FIGURE 3. Details of test assembly



## MIL-E-2788

the average outside diameter of the coverings on each size of electrode, and the diameter and lengths of the core wire shall be measured.

**4.4.3.1 Core soundness.** Four bare electrodes selected in accordance with 4.2.2.2 shall be cut and transverse sections suitably ground and etched for inspection at 10x magnification to determine conformance to the requirements of 3.2.

**4.4.4 Preparation of weld pad specimen.** Weld pads shall be deposited in the flat position on the surface of a plate of steel (black) approximately 3 inches by 6 inches by  $\frac{3}{4}$  inch, conforming to the requirements of type I, grade M of Specification MIL-S-16113 or Specification QQ-S-636, open hearth or electric furnace grade. The pads shall be approximately  $1\frac{1}{2}$  inches by  $4\frac{1}{2}$  inches by  $\frac{1}{2}$  inch high, and shall be built up in layers made by a series of lengthwise passes. The width of each pass shall be not more than four times the diameter of the core wire of the electrode being used. The electrical conditions shall be within the ranges recommended by the manufacturer, and shall be recorded. After completion of each layer, the pad shall be allowed to cool in still air at room temperature for one minute, and then shall be immersed in boiling water for one minute. After removal from the boiling water, the pad shall be allowed to dry thoroughly, and welding shall be resumed as soon as possible.

**4.4.4.1 Soundness test.** The welded pad shall be examined for surface gas pockets, under cutting, overlapping (rolling) and weld metal cracking. The plate and pad shall then be sectioned in 2 places. The cuts shall be made transverse to the long dimensions of the pad, and approximately  $\frac{3}{4}$  inch from each end of the pad. The ends shall be discarded, and the top surface of the center section shall be machined smooth and clean, discarding the metal removed for this purpose. A two ounce sample of millings or chips from the chemical analysis test of 4.4.4.3 shall then be machined from the pad in such a manner that no metal is removed within  $\frac{1}{4}$  inch of the base plate. The

top and end surfaces shall be ground and then inspected by macroscopic examination to determine conformance to the soundness requirements of 3.5. When available, inspection shall be radiographic examination in lieu of macroscopic examination.

**4.4.4.2 Hardness test.** The tests for hardness shall be made by Brinell Readings (3000-Kilogram load, 10 millimeter ball) taken on the top surface of the pad after machining and visual examination for porosity. Eight readings shall be made, four along each side of the long dimension, approximately  $\frac{1}{2}$  inch from each other, center to center.

**4.4.4.3 Chemical analysis.** Chemical analysis of the deposited weld metal shall be made by the testing laboratory from the sample (approximately 2 ounces) machined from the weld pad as specified in 4.4.4.1.

**4.4.5 Test joint for tensile and guided bend tests.** The test joint for the transverse tensile and guided bend tests shall be as shown in Figure 3. Aluminum bronze plates conforming to Specification MIL-B-15989, Composition 5, soft, shall be used. The joint shall be prepared using the current and voltage specified by the manufacturer. The requirements of 3.8, 4.4.1, and 4.4.1.1 shall apply. The preheat and maximum interpass temperatures shall be 300 and 400 degrees Fahrenheit, respectively. Plates shall be restrained sufficiently to prevent warping in excess of 5 degrees. A test plate which has warped in excess of 5 degrees shall be discarded.

**4.4.5.1 Transverse tension test.** Two transverse tension test specimens shall be machined from the test assembly in accordance with Figures 3 and 4, and shall be subjected to tension load until failure.

**4.4.5.2 Guided bend test.** One face bend and one root bend test specimen shall be machined from the test assembly in accordance with Figures 3 and 4. Each specimen shall be bent in a jig having the working contour shown in Figure 4 and otherwise made substantially in

**MIL-E-278B**

accordance with Figure 4. Any convenient means may be used for moving the plunger member in relation to the die member. The specimens shall be placed on the die member with the weld at midspan. Face bend specimens shall be placed with the face of the weld towards the gap; root bend specimens shall be placed with the root of the weld towards the gap. The two jig members shall be forced together until the specimen conforms to a U shape and until a  $\frac{1}{16}$ -inch diameter wire cannot be placed between the specimen and any point of the curvature of the plunger member. The specimen shall then be taken out of the jig and the convex surface examined.

**4.4.6 Machining of test specimens.** Specimens machined in accordance with 4.4.5.1 and 4.4.5.2 shall have the weld reinforcement removed flush with the base metal. Undercut shall not be removed. Final machining shall be in a direction transverse to the weld.

**4.5 Retest procedure.** In case of failure of an electrode to pass any welding test, one retest is permitted. In case of failure on a retest, and prior to reporting test results in accordance with 4.8.1, the same welder shall be required to demonstrate his ability by making a duplicate weld using an electrode of the same type and size and of an approved product that has given satisfactory service in production in the testing activity's plant.

**4.6 Inspection after delivery.** Post delivery inspection of electrodes to determine conformity to this specification and for acceptance thereof, is the responsibility of the consignee. The manufacturer shall be responsible for replacement of electrodes found to be defective after being in storage, for a period up to one year.

## **5. PREPARATION FOR DELIVERY**

**5.1 General.** Welding electrodes shall be prepared for shipment in accordance with Levels A, B, or C, as specified in the contract or order (see 6.2).

**5.2 Packaging.** Electrodes shall be packaged in accordance with 5.2.1. Individual unit packages shall contain electrodes of one class and size.

### **5.2.1 Unit packaging.**

**5.2.1.1 Level A.** Unless otherwise specified in the contract or order (see 6.2), electrodes shall be packaged in net weight units in accordance with Table VII.

TABLE VII. Weight of unit package

Electrode diameter	Unit container		Commercial container
	Small unit	Large unit	
Inch	Pounds	Pounds	Pounds
$\frac{1}{16}$	8	30	25
$\frac{1}{8}$	10	40	50
$\frac{3}{16}$	10	40	50
$\frac{1}{2}$	10	40	50
$\frac{5}{8}$	12	50	50
$\frac{3}{4}$	12	50	50

**5.2.1.1.1 Conditions.** Electrodes shall not be permitted to cool below the point which will result in moisture absorption prior to packaging.

**5.2.1.1.2 Methods of unit packaging.** Unless otherwise specified in the contract or order (see 6.2), electrodes shall be packaged in close fitting rigid metal containers or spirally wound fiber cans in accordance with 5.2.1.1.2.1 and 5.2.1.1.2.2.

**5.2.1.1.2.1 Rigid metal container.** When rigid metal containers are used, they shall be made of black plate with a minimum thickness of 0.0149 inch plus or minus 0.005 inch (28 gage) and hermetically sealed. The seams, top, bottom, and side shall be crimped and sealed with a solder or with a satisfactory plastic compound applied to the lapping surfaces of the seam before crimping. A tear strip formed by parallel scores on the inside surface shall be provided near the top end of the body. The depth of the scores shall not exceed 40 percent of the thickness of the sheet. The tongue of the tear strip shall be centered between the score lines and shall be free of solder for a mini-

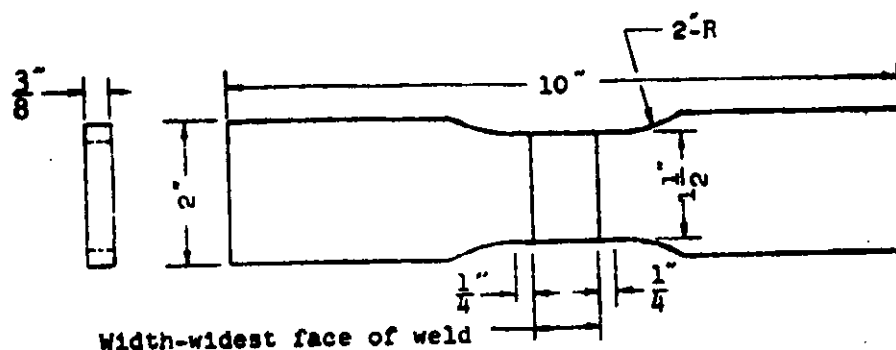
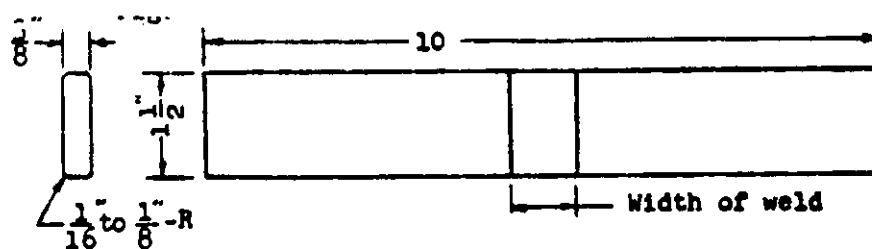
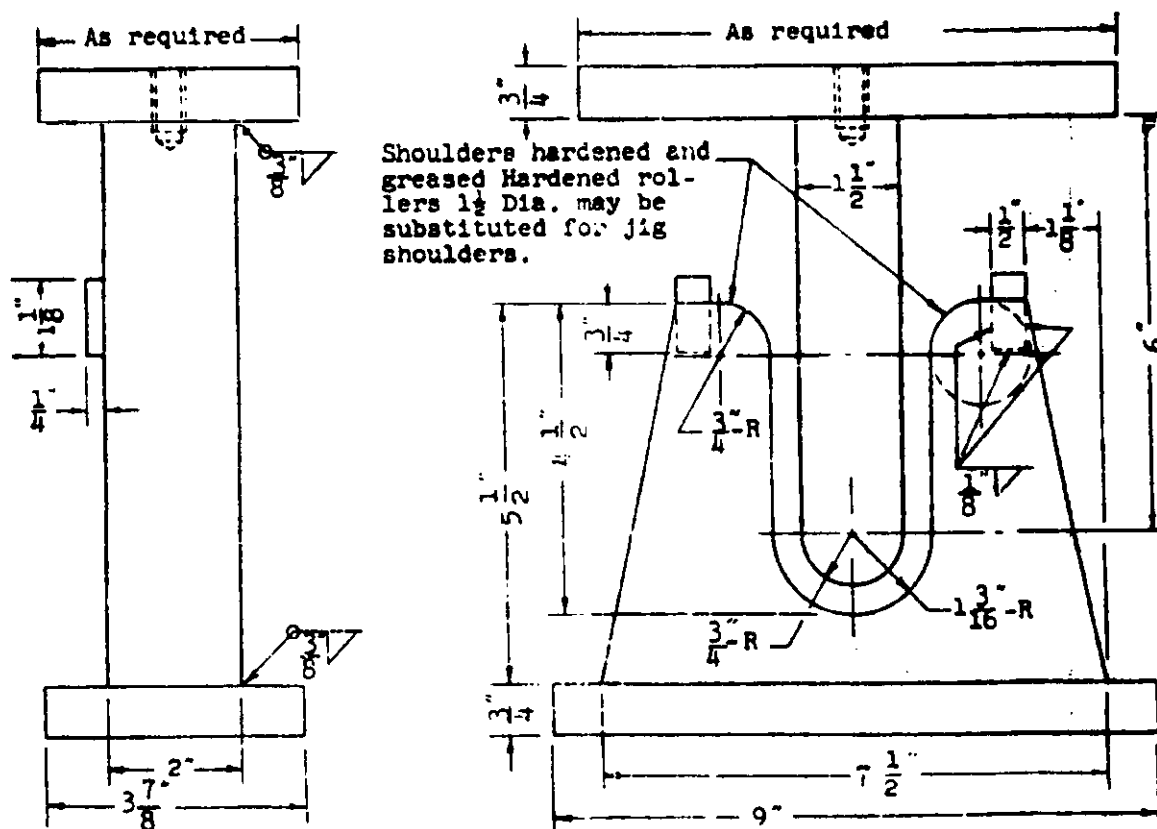


FIGURE 4-A. Transverse tension test specimen



**FIGURE 4-B. Guided bend test specimen**



**FIGURE 4-C. Guided bend test jig**

**FIGURE 4. Test specimens and test jig**

**MIL-E-278B**

imum length of  $\frac{1}{16}$  inch to facilitate opening of the container with pliers, key, or other suitable tool. The exterior of the container shall be completely protected by a suitable corrosion-resistant coating.

**5.2.1.1.2.2 Fiber can.** When spirally wound fiber cans are used they shall conform to Specification MIL-C-8955, Type II, Grade B, style as applicable. Water-resistant pressure-sensitive tape conforming to Specification PPP-T-60 shall be used for effecting closure.

**5.2.1.1.2.3 Cushioning.** Cushioning materials shall be dry and in equilibrium with the electrode covering. A fiberboard cushion or other suitable material shall be inserted at each end of the containers to restrict endwise movement of the electrodes.

**5.2.1.2 Level B.** Not applicable.

**5.2.1.3 Level C.** Unless otherwise specified in the contract or order (see 6.2), unit packaging shall be in accordance with the manufacturer's commercial practice and in quantities specified in 5.2.1.1.

**5.3 Packing.**

**5.3.1 Level A.** When Level A packing is specified in the contract or order (see 6.2), electrodes packaged as specified in 5.2.1.1 shall be packed in cleated plywood boxes, wire-bound wood boxes, nailed wood boxes, or fiberboard boxes conforming to Specification PPP-B-601 (Type II, Class 2), PPP-B-585, JAN-P-106, or PPP-B-636, respectively. Shipping containers shall be lined with sealed caseliners conforming to Specification MIL-L-10547, except container closure shall be sealed in accordance with appendixes of the applicable box specification. Gross weight shall not exceed 200 pounds for wooden boxes and 70 pounds for fiberboard boxes.

**5.3.2 Level B.** When Level B packing is specified in the contract or order (see 6.2), electrodes shall be packed in such a manner to prevent shifting of contents in wood cleated

fiberboard cleated plywood, nailed wood, wire bound wood, or overlaid paper veneer cleated wood boxes conforming to Specification PPP-B-591, PPP-B-601 (domestic type), PPP-B-621, PPP-B-585 (Class 1 or 2), or MIL-P-10377, respectively, or in fiber boxes conforming to the special requirements of Specification PPP-B-636. Closures and strapping shall be in accordance with appendixes of the applicable box specification. Gross weight of wood and wood-cleated boxes shall not exceed 200 pounds.

**5.3.3 Level C.** When Level C packing is specified in the contract or order (see 6.2), electrodes packaged in accordance with 5.2.1.3 shall be packed for shipment in accordance with the manufacturer's commercial practice.

**5.4 Marking.**

**5.4.1 Unit package.** Unless otherwise specified in the contract or order (see 6.2) unit packages shall be marked in accordance with Standard MIL-STD-129. In addition containers shall be labeled and shall contain an inserted sheet showing the manufacturer's recommendations as to currents and voltages used in each position of welding and complete directions for operation of the electrodes being furnished. Each container shall also be marked with the following information completed:

Class .....	.....
Size .....	.....
Quantity (net weight) .....	.....
Specification No. ....	.....
Manufacturer's brand or type designation .....	.....
Date of manufacture (month/year) .....	.....
Lot or control number .....	.....

**5.4.2 Marking for shipment.** In addition to any special marking required in the contract or order (see 6.2), shipping containers shall be marked in accordance with Standard MIL-STD-129 and shall also include the following:

Specification number and class designation.

## MIL-E-278B

## Size.

Commercial brand or type designation.  
 Manufacturer (firm applying covering).  
 Date of manufacture (month/year).

## 6. NOTES

6.1 Intended use. This specification is intended to cover several aluminum bronze arc welding electrodes of various alloys. Classes MIL-E-CuAl-A and MIL-E-CuAl-B are primarily used for joining aluminum bronzes, high strength copper zinc alloys, many ferrous metals and combinations of dissimilar metals. Specification class MIL-E-CuAl-B is usually preferred to class MIL-E-CuAl-A when higher tensile strength is required and lower ductility is not objectionable. Both classes are also used for corrosion and wear resistance and as overlay material where Brinell hardnesses between 120 and 180 are desired. Classes MIL-E-CuAl-C, MIL-E-CuAl-D and MIL-E-CuAl-E are intended for overlays where good bearing qualities and wear resistance are desired. The class to use should be determined by the service requirements, the harder grades having higher compressive strength but lower ductility than the softer grades.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, date, and number of this specification.
- (b) Class and size of electrode required (see 1.2).
- (c) Government test laboratory (see 4.2.1 and 6.3).
- (d) Preproduction sample waiver, when applicable (see 4.2.1.1).
- (e) Place of inspection and test if different from 4.3.3.
- (f) Required levels of packaging and packing (see 5.2 and 5.3).
- (g) Net weights if different from 5.2.1.1.
- (h) Method of unit packaging if different from 5.2.1.1.2.

- (i) Special marking, if required (see 5.4).

6.2.1 Electrodes should be ordered by the pound.

6.3 Government test laboratory. Preproduction testing for Bureau of Ordnance purchases shall be conducted at the U. S. Naval Gun Factory, Washington 25, D. C.

6.4 Expected service value for hardness. Expected service values are values of hardness obtained under normal production welding conditions, without water quench after each layer. The following values are based on surfaces three or more layers high.

Class	Brinell hardness range (30 KG load)
MIL-E-CuAl-A	180 to 160
MIL-E-CuAl-B	140 to 180
MIL-E-CuAl-C	180 to 250
MIL-E-CuAl-D	280 to 280
MIL-E-CuAl-E	270 to 320

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Army—Ordnance Corps  
 Navy—Bureau of Ordnance  
 Air Force

## Other interests:

Army—Q54g  
 Navy—ShAS

## Preparing activity:

Navy—Bureau of Ordnance

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