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(See 6.8)

MILITARY SPECIFICATION

ELECTRODES, WELDING, COVERED: GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification covers the general requirements, quality assurance provisions, test procedures, and instructions for preparation for delivery for covered welding electrodes.

1.2 Classification. Welding electrodes shall be furnished in the types, classes, and sizes specified in the detail specifications (see 3.1).

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

PPP-F-320 - Fiberboard; Corrugated and Solid, Sheet Stock (Container Grade), and Cut Shapes.

MILITARY

MIL-W-10430 - Welding Rods and Electrodes; Packaging of.
MIL-L-19140 - Lumber and Plywood, Fire-Retardant Treated.
MIL-I-45208 - Inspection System Requirements.

(See Supplement 1 for list of associated specifications.)

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 55Z3, 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.

AMSC N/A FSC 3439

STANDARD

MILITARY

MIL-STD-271 - Requirements for Nondestructive Testing Methods.

(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.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

PUBLICATION

MILITARY

NAVSEA 0900-LP-003-9000 - Radiographic Standards for Production and Repair Welds.

(Application for copies should be addressed to 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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

E 10 - Standard Test Method for Brinell Hardness of Metallic Materials. (DoD adopted)

E 29 - Standard Recommended Practice for Indicating Which Places of Figures are to be Considered Significant in Specified Limiting Values. (DoD adopted)

E 350 - Standard Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron.

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

AMERICAN WELDING SOCIETY (AWS)

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

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

EW 1 - Electric Arc-Welding Power Sources.

(Application for copies should be addressed to National Electrical Manufacturers Association, 2101 L Street, N.W., Washington, DC 20037.)

(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 (except for related associated detail specifications), 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 Detail specifications. The individual item requirements shall be as specified herein and in the applicable detail specifications. In the event of any conflict between the provisions of this specification and the detail specifications, the latter shall govern.

3.2 Qualification. Electrodes 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).

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

3.4 Materials. The core wire and coverings shall be processed from materials which ensure the deposited weld metal will conform to the requirements of the applicable detail specification. The coating formulation, method of processing, composition of the deposited weld metal, and procedure for moisture control between baking and packaging, shall form a part of the qualification, and any subsequent change thereto may require requalification or additional tests, and shall be subjected to the approval of the Naval Sea Systems Command (NAVSEA). The electrodes shall be asbestos free.

3.4.1 Recovered materials. Unless otherwise specified herein, all products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term “recovered materials” means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

3.5 Coverings of electrodes.

3.5.1 Handling. Coverings shall withstand ordinary handling without damage that will affect the operation of the electrode.

3.5.2 Concentricity. The coverings on all sizes of electrodes shall be concentric to the extent that 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:

Electrode size (inch)	Percentage of mean dimension
3/32 and smaller	7
1/8 and 5/32	5
3/16 and larger	4

3.5.3 Uniformity. Core wire and coverings shall be free of defects which would interfere with uniform performance of the electrodes.

3.5.4 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 that shall insulate against a difference potential of 110 volts (V), 60 hertz (Hz), alternating current (at). Any permissible exception to this requirement shall be as specified (see 3.1).

3.5.5 Flaking and cracking of covering. The sum of the surface area of the core wire exposed by flaking and cracking of the covering shall not exceed that permitted for arc ends specified in 3.5.9.1 (see 4.6.4).

3.5.6 Fumes. Covering constituents which, as welding fumes, are potentially harmful to personnel, shall be minimized,

3.5.7 Slag removal. The slags deposited by the coverings shall be removable with hand tools (not air or power operated) from the weld deposits. Grinding during test plate preparation shall not be used for slag removal and shall be limited to that specified in 3.9.

3.5.8 Stability. The stability of the coverings shall be such that electrodes after receipt from the manufacturer will comply with this specification after storage in original unopened containers under roof and on dry platforms for the following periods (see 6.5):

Type of unit container	Time Period
Class 5 of MIL-W-1043O	Up to 6 months
Classes 1 and 2 of MIL-W-1043O	Up to 1 year

3.5.9 Extent of coverings.

3.5.9.1 Arc ends. The arc end of each electrode shall be sufficiently bare and the covering tapered a minimum amount to permit striking of the electrode. The core wire shall not protrude more than 1/32 inch beyond the covering at the arc end. Chipping of the covering at the arc end may accidentally occur, but when it does occur such chipping shall not exceed one-quarter the circumference of the core wire and one-quarter of the circumference of the core wire transverse to the arc end.

3.5.9.2 Grip ends. The grip portion of the electrode for making contact with the electrode holder shall be as follows:

Electrode size	Bare portion, (min)	Distance from grip end to full thickness of covering (max)
5/32 inch and smaller	1/2 inch	1-1/4 inches
3/16 inch and larger	3/4 inch	1-1/2 inches

3.5.10 Electrode identification.

3.5.10.1 Marking. At least one legible electrode type designation or classification number (see 3.1) shall be applied to the electrode covering in such a manner that at least one complete type designation shall come within the space 2-1/2 inches from the grip end of the electrode. The prefix "MIL-" may be omitted from the type designation. When specified (see 3.1), each electrode shall also be marked with heat or lot identification.

3.5.10.2 Size and legibility. The imprinted designations shall be composed of equal-size block characters, the height of which shall be 50 to 100 percent of the overall electrode diameter (core wire plus covering) but need not exceed a 5/32 inch height. The imprinted designations shall read from the grip-end to the arc end. The color of the print shall contrast the color of the electrode covering and printed designations shall be readable under normal lighting conditions.

3.5.10.3 Stability. Printed type designations shall remain discernible on electrodes rebaked at temperatures up to 850 degrees Fahrenheit (°F) and on unused portions of partially consumed electrodes or discarded stubs, and shall resist effacement by contact incidental to normal handling, shipping and storing.

3.5.11 Covering composition. The chemical composition of the coverings except iron powder and moisture is optional with the manufacturer. Moisture and iron content, when required, shall be as specified (see 3.1, 4.6.8, and 4.6.9).

3.5.12 Production equipment. When a change is made in a production run of one MIL-type electrode to another, inspection shall be performed prior to starting the new run to assure that equipment and process lines are purged of material from the previous production run. This inspection shall be performed for all equipment used in manufacturing operations where the material is not segregated and positively identified, for example cutting to length, extruding, baking and so forth.

3.6 Core wires of electrodes.

3.6.1 Core wire dimensions. Standard core wire diameters and lengths of electrodes shall be as specified (see 3.1). The diameter of the core wire shall vary not more than plus or minus 0.003 inch. The length shall vary not more than plus or minus 1/8 inch.

3.6.2 Core wire alloy identify. Each end of rod or wire to be spliced during processing shall be tested for alloy identity just prior to splicing at the process station (see 4.6.10), except when splicing is done to repair a wire break without removing the wire from the process line.

3.6.2.1 Both ends of each coil drawn to finish size shall be tested for alloy identity (see 4.6.10) prior to cutting into electrode core wire lengths.

3.6.2.1.1 Single coil. For continuous process operations where rod coil is drawn to finish size, straightened and cut to length without removal from the machine, both ends of each rod coil shall be alloy identity tested immediately prior to the start of the continuous processing operation.

3.6.2.1.2 Multiple coil. When rod coils are to be spliced during continuous processing operations, each end of each rod coil to be spliced shall be alloy identity tested at the process station just prior to splicing. In addition, the leading end of the first coil and the tail end of the last coil for each continuous process run shall be alloy identity tested. When alloy identity testing is accomplished in accordance with 3.6.2.1.1, these requirements are satisfied as well.

3.7 Groove welds. Groove welds shall conform to the requirements specified in 3.7.1 and 3.7.2.

3.7.1 Soundness. Electrodes shall deposit groove welds conforming to class 1 criteria of NAVSEA 0900-LP-003-9000.

3.7.2 Mechanical Properties. Mechanical properties shall be as specified (see 3.1).

3.8 Chemical composition of deposited weld metal. Chemical composition shall be as specified (see 3.1).

3.9 Grinding. Grinding (or burring) during welding of a test plate shall be limited to grinding of weld starts and grinding to correct operator error. Grinding of weld starts shall be limited to the immediate start area (first 1/2 inch length of weld bead deposit maximum) only and this shall be done only when considered necessary by the welder. Grinding to correct operator error shall be limited to a maximum of 1 inch of weld bead length for a test plate. The amount of grinding employed (weld start and operator error) for each test plate shall be recorded by the welder on the test plate work sheet record. The record shall indicate the total number of weld starts that were ground and the length and location by weld layer of any grinding employed to correct operator error conditions.

3.10 Rounding-off procedure. For purposes of determining conformance with this specification, an observed or calculated value shall be rounded off to the nearest 1000 pounds per square inch for tensile and yield strength and to the “nearest unit” in the last right-hand place of figures used in expressing the limiting value for other values in accordance with the rounding-off method specified in ASTM E 29.

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Responsibility forcompliance. All items must meet all requirements of sections 3 and 5. The inspections 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).

4.2.1 Ispection conditions. Unless otherwise specified (see 6.2), all inspections shall be performed in accordance with the conditions specified herein. Environmental conditions shall be ambient laboratory conditions.

4.3 Qualification inspection. Qualification inspection shall be conducted at a laboratory satisfactory to NAVSEA. The inspection shall consist of the examinations and tests specified in 4.5, 4.6 and the applicable detail specification (see 3.1).

4.3.1 Inspection system. The manufacturer shall provide and maintain an inspection system acceptable to the Government for supplies and services covered by this specification. The inspection system shall be in accordance with MIL-I-45208.

4.3.2 Special instructions. Qualification will be authorized only to manufacturers of welding electrodes. When applying for test authorization, or after tests have been authorized and when samples are submitted, the manufacturer shall furnish the information specified in 4.3.2.1. (NOTE: This information, together with test results obtained with the electrode sample, shall form a part of the qualification test; all information will be held in confidence by the Government.)

4.3.2.1 Where lot identification is by heat of core wire (see 4.4.1.3).

(a) The lengths of the electrodes, and diameter of coating and core wire.
(b) Type and class under which approval is desired.
(c) Composition of core wire and coverings in terms of nominal percentages for each constituent.
(d) Composition of the deposited weld metal.
(e) Recommended amperages for each weld test.
(f) Brand name.

4.3.2.2 Where lot identification is by controlled core wire chemical composition (see 4.4.1.4.2). In addition to 4.3.2.1, the following shall be furnished for approval by NAVSEA:

(a) Chemical composition control limits in core wire of each MIL-type electrode.
(b) Method of determining core wire chemistry.
(c) Production line methods used to produce electrodes from chemically controlled core wire.
(d) Procedure for control of moisture content between baking and packaging.

4.3.2.3 Where lot identification is by controlled covering mixture chemical composition (see 4.4.1.2.2). In addition to 4.3.2.1 or 4.3.2.2 the following shall be furnished for NAVSEA approval:

(a) Percent allowable variation (disclosed) from standard (not disclosed) for each chemical element in the covering mixture of each MIL-type electrode:
(b) Method of determining covering mixture chemistry.
(c) Production line methods used to produce electrodes from chemically controlled covering mixture.
(d) Procedure for control of moisture content between baking and packaging.

4.3.3 Samples for qualification inspection. Each manufacturer shall furnish sample packages and electrodes of the type he desires to have inspected. Quantities shall be as requested by the qualifying activity or laboratory, and shall be selected at one time in the presence of the Government representative and so indicated. The manufacturer shall indicate on the sample whether the electrodes and packages were produced on a laboratory or experimental scale, or on a production scale.

4.4 Quality conformance inspection.

4.4.1 General. Electrodes shall be inspected in accordance with the definitions and identification of materials specified (see 4.4.1.1 through 4.4.1.4) and to inspection level A, B, C, or D as specified (see 4.4.2 through 4.4.5 and 3.1). Sample electrodes shall be subjected to the examinations and tests in 4.5 and 4.6 as specified in the applicable detail specification (see 3.1 and 6.3).

4.4.1.1 Electrode covering definitions.

4.4.1.1.1 Dry batch. A dry batch of covering mixture is defined as the quantity of dry covering ingredients mixed at one time in one mixing vessel. A dry batch may be used singly or may be subsequently sub-divided into quantities to which the liquid binders may be added to produce a number of wet mixes.

4.4.1.1.2 Dry blend. A dry blend is defined as one or more dry batches mixed in a mixing vessel and combined proportionately to produce a uniformity of mixed ingredients equal to that obtained by mixing the same total amount of dry ingredients at one time in one mixing vessel.

4.4.1.1.3 Wet mix. A wet mix is defined as the combination of a dry batch or dry blend, or portion thereof, and liquid binder ingredients at one time- in one mixing vessel.

4.4.1.2 Identification of covering mix.

4.4.1.2.1 Wet mix. Covering identified by wet mix shall consist of a single wet mix for each lot of electrodes.

4.4.1.2.2 Controlled chemical composition. Covering identified by controlled composition (rather than by wet mix) shall consist of one or more wet mixes and shall be subjected to sufficient tests, both before and after it has been applied to the core wire, to assure that all wet mixes within the lot are equivalent. These tests shall include chemical analysis, the results of which must fall within the manufacturer's acceptance limits. The identification of the test procedure and the results of the tests shall be recorded. The following additional conditions shall apply:

(a) Each wet mix shall be chemically analyzed by approved methods (see 4.3.2.3).
(b) Chemical analyses shall be certified by the laboratory and percent variation from standard made available to the Government representative.
(c) Wet mixes conforming to established covering mixture chemistry control for a specific MIL-type electrode shall be appropriately identified and segregated to avoid mixups.

4.4.1.3 Heat of core wire. A heat of metal for core wire is defined by one of the following, depending on the method of melting and refining the metal.

(a) Where slag-metal or gas-metal reactions occur in producing the metal (for example, open hearth, electric-arc, basic oxygen, argon-oxygen), a heat is the material obtained from one furnace melt.
(b) Where significant chemical reactions do not occur in producing the metal (for example, induction melting in a controlled atmosphere or in a vacuum), a heat is an uninterrupted series of elts from one melting furnace under the same melting conditions, each melt conforming to the chemical composition range approved by the purchaser of the material (the producer of the filler metal).

(c) In processes involving continuous melting and casting (for example, consumable electrode remelt), a heat is an uninterrupted series of remelts in one furnace under the same remelting conditions using one or more consumable electrodes produced from a heat, as defined in (a) or (b) above, each remelt conforming to the chemical composition range approved by the purchaser of the material (the producer of the filler q etal).

4.4.1.4 Identification of core wire.

4.4.1.4.1 Heat number. Electrode core wire identified by heat number shall consist of material from a single heat of metal.

4.4.1.4.2 Controlled core wire chemical composition. Electrode core wire, identified by controlled chemical composition, rather than by heat number, shall consist of mill coils of one or more heats from which samples have been taken for chemical analysis. The results of the analysis of each sample shall be within the manufacturer's composition limits for that material. Coils from mills that do not permit spliced-coil practice need be sampled on only one end. Coils from mills that permit spliced-coil practice shall be sampled on both ends and shall have not more than a single splice per coil. The following additional conditions shall apply:

(a) All chemical analyses shall be certified by the laboratory and made available to the Government representative.
(b) Mill coils of rod conforming to established core wire chemistry control for a specific MIL-type electrode shall be appropriately identified and segregated to avoid mixups.

4.4.2 Inspection level A.

4.4.2.1 Lot. For the purpose of selecting samples for quality conformance inspection, a lot of electrodes is defined as the quantity of any one size and type produced from one wet mix of covering mixture as specified in 4.4.1.1.3 and one heat of core wire as defined in 4.4.1.3 or 4.4.1.4.2.

4.4.3 Inspection level B.

4.4.3.1 Lot. For the purpose of selecting samples for quality conformance inspection, a lot of electrodes is the quantity, not exceeding 100,000 pounds of any one size and classification produced in one continuous 24-hour period (or three consecutive normal work shifts) from covering identified by wet mix (see 4.4.1.2.1) or controlled chemical composition (see 4.4.1.2.2) and core wire identified by heat number (see 4.4.1.4.1) or controlled chemical composition (see 4.4.1.4.2).

4,4.4 Inspection level C.

4.4.4.1 Lot. For the purpose of selecting samples for quality conformance inspection, a lot of electrodes is defined as the quantity of any one size and type produced from one or more wet mixes of covering mixture in conjunction with core wire as defined in either 4.4.1.3 or 4.4.1.4.2 during a 24-hour continuous period (or three consecutive normal work shifts).

4.4.4.2 Wet mix test. The manufacturer shall perform sufficient tests before and after application of the covering to assure that all wet mixes of covering mixture in the lot are equivalent. The test procedures and results of tests shall be recorded, These test procedures shall be made available to the Government representative and to the consignee on request (see 6.3). Wet mix identity shall be maintained as required by 4.4.6.

4.4.5 Inspection level D.

4.4.5.1 Lot. For the purpose of selecting samples for quality conformance inspection, a lot of electrodes is defined as the quantity of any one size and type produced from core wire specified in 4.4.1.3 or 4.4.1.4.2, or during a 24-hour working period (or three consecutive normal work shifts).

4.4.6 Lot identification. Lot identification shall be accomplished by marking each unit and shipping container with a unique manufacturer's control number. If these control numbers are encoded, the manufacturer shall furnish the interpretive key to the consignee. This control number shall be in a position which permits ready location by the consignee and shall contain the following information for each inspection level/lot classification:

4.4.6.1 Inspection levels A, B and C. When identification is by heat of core wire as defined in 4.4.1.3 and wet mix as defined in 4.4.1.1.3, each heat of core wire and each wet mix shall be identified.

4.4.6.2 Inspection levels A and B. When lot identification is by controlled core wire chemical composition as defined in 4.4.1.4.2 and controlled covering mixture chemical composition as defined in 4.4.1.2.2, each continuous 4-hour working period shall be identified.

4.4.6.3 Inspection level C. Where lot identification is by controlled core wire chemical composition as defined in 4.4.1.4.2 and controlled covering mixture chemical composition as defined in 4.4.1.2.2, each continuous 8-hour shift shall be identified.

4.4.7 Sampling and inspection ofcontainers. Unit packages, sealed cans, and shipping containers shall be sampled and inspected in accordance with MIL-W-10430.

4.4.8 Sampling for quality conformance inspection. Sample electrodes shall be selected either from filled unit packages or from the production line after the backing operation except where otherwise specified (see 3.1). The unit packages required for this examination may be selected from the sample of packages used for 4.4.7. If sample electrodes are selected from filled unit packages or cans, the total sample shall be in accordance with Schedule A of the following table for electrode sizes 1/8-inch and larger and Schedule B for electrode sizes 3/32-inch and smaller for single sampling, and approximately the same number of electrodes shall be selected from each of the unit packages or groups of cans (6 cans per group). Lot size shall be expressed in pounds. Sample size shall be the number of electrodes to be examined, A minimum number of unit packages shall be selected to permit sampling of ten electrodes maximum from each 50-pound package or from each 10-pound package. If the sample electrodes are selected from the production line, the total sample shall be equivalent to the above and

the electrodes shall be selected through the production period so that all parts of the lot are represented. The electrodes selected shall be identified as to type, wet batch, lot, size and other available information such as contract or order number being filled. When a lot is found to be acceptable, any electrodes in the lot found to be defective shall be replaced with non-defective electrodes prior to shipment. In no case shall known defective material be shipped.

Sampling for visual examination and dimensional tolerance determination.

LOT SIZE Pounds of electrodes	SAMPLE SIZE Number of electrodes to be examined		Schedule A		Schedule B	
	Schedule A	Schedule B	ACCEPT	REJECT	ACCEPT	REJECT
2 to 8	2	2	0	1	0	1
9 to 15	2	2	0	1	0	1
16 to 25	3	3	0	1	0	1
26 to 50	5	5	0	1	0	1
51 to 90	5	5	0	1	0	1
91 to 150	8	8	0	1	1	2
151 to 280	13	13	1	2	2	3
281 to 500	13	13	1	2	2	3
501 to 1200	20	20	2	3	3	4
1201 to 3200	32	32	3	4	5	6
3201 to 10000	32	32	3	4	5	6
10001 to 35000	50	50	5	6	7	8

4.4.8.1 Sampling for weld tests. If weld tests are specified (see. 3.1), the samples examined and measured shall be used for these tests, with additional electrodes, if necessary, to provide for three weld tests.

4.5 Examinations and measurements.

4.5.1 Visual and dimensional examination (except concentricity). Each of the sample electrodes selected as specified in 4.4.8 shall be examined to verify conformance to all requirements which do not involve tests.

4.5.2 Concentricity. Each of the sample electrodes selected as specified in 4.4.8 shall be measured as specified (see 4.6.2).

4.6 Test procedures.

4.6.1 Welding test. Inspection tests of welds and welding, when required by the applicable detail specification, shall be conducted in accordance with the conditions and procedures specified herein.

4.6.1.1 Welding equipment. Welding machines used for supply power for testing electrodes shall be variable voltage direct current (de) motor-generator type, variable voltage dc rectifier welder, or ac welding transformer conforming to NEMA EW 1. The power source shall be of sufficient rating to supply current demanded by the electrode type and size under test; open circuit voltage shall not exceed 80 V.

4.6.2 Procedure for measurement of concentricity, diameter and length.

4.6.2.1 Concentricity preparation. Each electrode required by 4.5.2 shall be prepared for concentricity measurements in accordance with the procedure below:

(a) The covering shall be removed to bare metal at three places; that is near both ends and near the mid-length of the electrode.
(b) Care shall be taken not to remove any metal.
(c) The covering shall be removed at each location in the form of a groove 1/2 inch minus 0, plus 1/4 inch wide for 360 degrees around the electrode.
(d) The side walls of the groove may be gradually sloped to a maximum width of 1 inch at the outside surface of the covering.

4.6.2.2 Concentricity measurements. Measurement of the prepared electrode shall be made with the aid of a supplemental piece of 1/4 by 1/4-inch key stock (or equal) 2 ± 1/16 inches long. The key stock shall be placed symmetrically across the groove and, using any appropriate measuring instrument, the core wire diameter plus the thickness of the cover on one side of the electrode plus the thickness of the key stock shall be measured. For instruments using a base for zero reference, the base where it is in contact with the electrode during measurement shall be 2 ± 1/16 inches wide and symmetrical about the groove in the electrode covering. The maximum and minimum dimensions shall be located for each groove of each electrode in the sample measured to the nearest 0.001 inch and recorded. The maximum and minimum pair of dimensions which show the greatest difference for the electrodes required to be measured by 4.5.2 shall be used to determine conformance to the requirements of 3.5.2.

4.6.2.3 Diameter and length of core wire. Each electrode required by 4.4.8 shall be measured for diameter and length for conformance to the requirements of 3.6.1.

4.6.3 Dielectric strength. Dielectric strength of coverings shall be determined by the method shown on figure 1. Methods other than the one shown, yielding the required results, may be used as alternates if such methods are acceptable to the Government.

4.6.4 Flaking and cracking of covering. When required by the applicable detail specification, six electrodes shall be tested for flaking and cracking tendency upon restarting and during welding in accordance with 4.6.4.1 and 4.6.4.2, respectively. The polarity shall be the same as required by the detail specification for the MIL-type electrode being tested. The welding current used shall be in the same range as required by the applicable detail specification for groove welds. The welding shall consist of depositing a bead weld on the plate surface.

4.6.4.1 Flaking and cracking upon restart. Three electrodes shall be tested. The covering shall be grooved to the core wire completely around the electrode at the midpoint of the length. The groove shall be prepared by grinding with the edge of a grind stone (intersection of flat side of grind stone with its periphery). The core wire shall be uncovered at the root of the groove to form a land 1/16 inch minimum along the length of the electrode. The core

wire shall not be undercut. The electrode shall be consumed to the root of the groove in the covering when welding shall be stopped without fusing coating beyond the groove. The half-length electrode shall be removed immediately from the electrode holder and placed upon a flat steel plate to cool until it can be held comfortably in the bare hand. After cooling, the electrode shall be inserted in the electrode holder and welding resumed. After the restart, the half-length electrode shall be consumed for 1 inch of its length. Welding shall then be stopped and the arc end of the electrode examined for conformance to the requirements of 3.5.5.

4.6.4.2 Flaking and cracking during welding. Three electrodes shall be tested. The electrode shall be consumed to a stub not over 2 inches in length. If flaking or cracking is observed during welding, the welding shall be stopped immediately and the arc end of the electrode examined for conformance to the requirements of 3.5.5. If no flaking or cracking is observed during welding, the 2-inch stub length of electrode, which is normally discarded, shall not be examined.

4.6.5 Radiograpic examination of groove welds. Radiographic examination shall be conducted in accordance with MIL-STD-271 for compliance with 3.7.1 on groove welds when required by the detail specification.

4.6.6 Hardness. When required by the applicable detail specification, but not otherwise specified, the hardness of the weld metal shall be measured by the Brinell method specified in ASTM E 10. The hardness shall be measured at approximately the center of the cross-sectional area of groove welds. Rockwell hardness numbers converted to Brinell hardness numbers shall not be used for decisive tests. Deposits of surfacing electrodes shall be measured in accordance with the applicable detail specification.

4.6.7 Chemical analysis. Chemical analyses of weld metal shall conform to the following procedures:

(a) Samples for chemical analysis of the weld metal shall be obtained for each size of electrode, using the types of current shown for that classification and size and the base metal specified (see 3.1).
(b) Samples for chemical analysis may be obtained from the weld pad specified in (c) below, or any other weld deposit provided it produces results equivalent to those obtained from the weld pad. In case of dispute, samples shall be taken from the weld pad.
(c) The weld pad shall be deposited in layers in the flat position. The width of each pass in each layer shall be 1-1/2 to 2-1/2 times the diameter of the core wire. After depositing each layer, the pad shall be immersed in water (temperature unimportant) for 15 to 45 seconds and then dried before welding is resumed. The surface of each layer shall be free of all foreign matter. The completed weld pad and the location from which the sample for analysis is taken shall conform to the requirements in table I.
(d) Chemical analysis may be made by any suitable method agreed upon by the supplier and purchaser. In case of dispute, the procedure in ASTM E 350 shall be the referee method.

TABLE I. Weld pad dimensions.

Electrode size in.	Minimum pad size in.	Minimum distance of sample from surface of base plate in.
3/32	1 by 1 by 1/2	1/4
1/8 5/32 3/16	1-1/2 by 1-1/2 by 5/8	5/16
7/32 1/4 5/16	2 by 2 by 3/4	3/8

4.6.8 Covering moisture. The following method shall be used to determine moisture content in an electrode covering: Oxygen shall be passed over the sample of covering in a nickel or clay boat placed in a fused silica or high-temperature ceramic-type combustion tube which is then heated. Liberated water shall be collected in a weighted absorption U-tube and weight of water determined by the increase in the weight of the U-tube. The moisture content shall be expressed as a percentage of the weight of the covering sample. Electrodes shall meet the minimum moisture requirements as specified in the detail specification.

4.6.8.1 Apparatus. The apparatus shall be as shown on figure 2 and shall consist of the following:

(a) A tube furnace with a heating element of sufficient length to heat at least 8 inches of the middle portion of the combustion tube to 2000°F (1093 degrees Celsius (°C)).
(b) An oxygen purifying train consisting of a needle valve, flow meter, 96 percent sulfuric acid wash bottle, spray trap, and anhydrous magnesium perchlorate drying tower.
(c) Fused silica combustion tube 7/8 inch inside diameter with plain ends and a devitrification point above 2000°F (1093"C). (A high-temperature ceramic-type tube can be used, but a higher blank value will result.) A plug of fine glass wool to filter the gases shall be inserted far enough into the exit end of the combustion tube to be heated to a temperature of 400 to 500°F (204 to 260°C).
(d) Water absorption train consisting of a U-cube (Schwartz type) filled with anhydrous magnesium perchlorate and a concentrated sulfuric acid gas-sealing bottle.

4.6.8.2 Preparation of the sample. The covering sample of at least 4 grams shall be a composite of the middle portions of covering from three electrodes from the same package and shall be removed by bending or with clean, dry forceps. The sample shall be transferred immediately to a dried, stoppered vial or sample bottle.

4.6.8.3 Conditioning procedure. The furnace shall be operated at 1650 to 1800°F (900 to 982°C) with an oxygen flow of 200 to 250 milliliters (mL) per minute. The nickel boat shall be placed in the combustion tube for drying and the absorption U-tube shall be attached to the system for "conditioning." After 30 minutes, the absorption U-tube shall be removed and placed in the balance case. The nickel boat shall be removed and placed in a desiccator in which anhydrous magnesium perchlorate is used as the desiccant. After a cooling period of 20 minutes, the absorption U-tube shall be weighed.

4.6.8.4 Blank determination procedure. In the blank determination, the procedure for an actual moisture determination shall be followed step-by-step with a single exception of omitting the sample. The nickel boat shall be removed from the desiccator and exposed to the atmosphere for a period approximating the time required to transfer the sample from the balance pan to the boat. The combustion tube shall be opened, the weighed absorption U-tube attached, the boat placed in the combustion tube, and the tube closed. After a heating period of 30 minutes, the absorption U-tube shall be removed and placed in the balance case. The nickel boat shall be transferred to the desiccator. After the 20 minute cooling period, the absorption U-tube shall be weighed and the gain in weight shall be taken as the blank value.

4.6.8.5 Moisture determination procedure. Immediately after weighing the absorption U-tube above, the sample covering shall be weighed on the balance dish and quickly transferred to the boat. The combustion tube shall be opened, the weighed absorption U-tube attached, the boat and sample transferred to the combustion tube, and the tube closed. After an ignition period of 30 minutes, the absorption U-tube shall be removed from the combustion tube and transferred to the balance case. If another sample is to be run, the boat shall be taken from the combustion tube, the ignited sample removed, and the boat transferred to the desiccator. The absorption U-tube shall be weighed after the 20 minute cooling period. Another determination may be started immediately and it is not necessary to repeat the blank determination since the same combustion boat can be used.

4.6.8.6 Calculation. The calculation shall be made according to the following formula:

$$\text{Percent moisture} = \frac{A-B}{\text{Weight of sample}} \times 100$$

Where:

A = gain in weight of absorption U-tube in moisture determination, and

B = gain in weight of absorption U-tube in blank determination.

4.6.9 Total iron content. The total iron content of the covering, as specified in the applicable detail specification (see 3.1), shall be made by wet chemical or spectrographic method. In the case of dispute, total iron content shall be determined as specified below.

(a) A 10 to 15 gram sample of electrode coatings shall be ground, well mixed and a 0.35 gram sample weighed and placed in 250 mL beaker. Add 15 mL concentrated hydrochloric acid to the beaker and heat until action ceases, Add 5 mL concentrated nitric acid and heat until action ceases. Add several drops of hydrofluoric acid and heat until action ceases. Then add 15 mL concentrated perchloric acid (70 percent) and heat until $HClO_4$ fumes appear. Dilute to 100 mL with water, filter and wash with hot water, saving the filtrate. Ignite the filter paper and residue in a platinum crucible,

(b) Fuse the ignited residue with sodium carbonate, cool and dissolve in water. Acidify with hydrochloric acid. Heat the solution, filter and combine the filtrate with the filtrate obtained above. Add 2 mL of concentrated nitric acid and boil. Add 5 grams of ammonium chloride or ammonium nitrate and macerated filter paper to the solution and make ammoniacal with ammonium hydroxide. Boil until iron hydroxide coagulates then filter and wash with 2 percent ammonium chloride or ammonium nitrate solution. Re-dissolve the residue from the paper with warm 1.1 hydrochloric acid and wash the paper thoroughly with hot water, Repeat the ammoniacal precipitation and washing as above and discard the filtrate. Ignite the residue and filter paper in a platinum crucible and fuse gently with sufficient potassium pyrosulfate ($K_2S_2O_7$) to dissolve all residue. Cool and leach the contents of the crucible with approximately 100 mL of hot 5 percent sulfuric acid solution. Remove the crucible and rinse with distilled water. Upon cooling, pass the solution through a Jones reductor into a receiving flask containing 15 mL of 0.1N ferric ammonium sulfate solution. Titrate with 0.1N potassium permanganate.

(c) Total iron content shall be determined in accordance with the following equation:

$$Fe\ (\%) = \frac{m \times N \times 5.594}{W}$$

Where:

m = mL potassium permanganate
N = Normality factor of permanganate
W = Weight of sample in grams
Fe = Total iron content

4.6.10 Alloy identity.

4.6.10.1 Procedure. The alloy identity test method may include chemical analysis, metal sorting devices, other approved methods, or a combination of methods. The test method shall be submitted for approval to NAVSEA, or the agency concerned.

4.6.10.2 Acceptance criteria. The material shall be of the type specified.

4.7 Unsatisfactory test results. If the first results of any of the specified tests are determined to be unsatisfactory, two retests for each one that failed shall be permitted. The results of all retests shall be satisfactory for lot acceptance.

4.8 Mix-up. If, subsequent to shipment, a heat or lot is found to contain material of a type or class different from that specified, the contractor shall notify all other customers, who procured to the requirements herein and in the applicable detail specification and received material from that heat or lot, of the condition. The contractor shall be responsible for re-inspection to ensure that any unused material from the same heat or lot is correct, and shall replace all incorrect material at no additional charge.

4.9 Inspection of packaging. Sample packages and packs, and the inspection of the presentation, packing and marking for shipment 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 Navy fire-retardant requirements.

(a) Lumber and plywood. Unless otherwise specified (see 6.2), all lumber and plywood including laminated veneer material used in shipping container construction members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

Levels A and B - Type II - weather resistant.
Category 1 - general use.

Level C - Type I - non-weather resistant.
Category 1 - general use.

(b) Fiberboard. Unless otherwise specified (see 6.2), fiberboard used in the construction of class-domestic, non-weather resistant fiberboard and cleated fiberboard boxes including interior packing forms shall meet the flamespread and the specific optic density requirements of PPP-F-320 and amendments thereto.

5.2 Packaging. Electrodes shall be preserved level A, C or commercial, packed level A, B, C or commercial, as specified (see 6.2), and marked in accordance with MIL-W-10430. Unless otherwise specified (see 6.2), electrodes preserved to levels A or C shall be furnished in class la unit containers in accordance with MIL-W-10430. When specified (see 6.2), 12, 14, and 18-inch electrodes may be furnished in class lb unit containers in accordance with MIL-W-10430.

5.2.1 Additional marking. Each container shall be marked “Asbestos Free”, and each container end adjacent to the electrode grip end shall be marked “Open This End”.

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 intended to provide the general requirements, inspection criteria and methods for qualification and quality conformance and packaging instructions for acquisition of covered welding electrodes.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number, and date of this specification.
(b) Title, number, and date of the applicable detail specification.
(c) 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).
(d) Test conditions, if other than specified (see 4.2.1).
(e) Navy fire-retardant requirements (see 5.1.1(a) and (b)).
(f) Level of preservation and packing required (see 5.2).

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.

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
4.4.1	DI-E-2121	Certificate of compliance	---
4.4.4.2	DI-T-5329	Inspection and test reports	---

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.

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. 22200 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 Storage. Paragraph 3.5.8 specified the manufacturer's responsibility for electrodes as being 6 months or 1 year. The 6 month or 1 year period should not be taken, by the consignee, as a limit on the useful life of the electrodes.

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.

Core wire
Shielded metal arc welding
Welding electrode

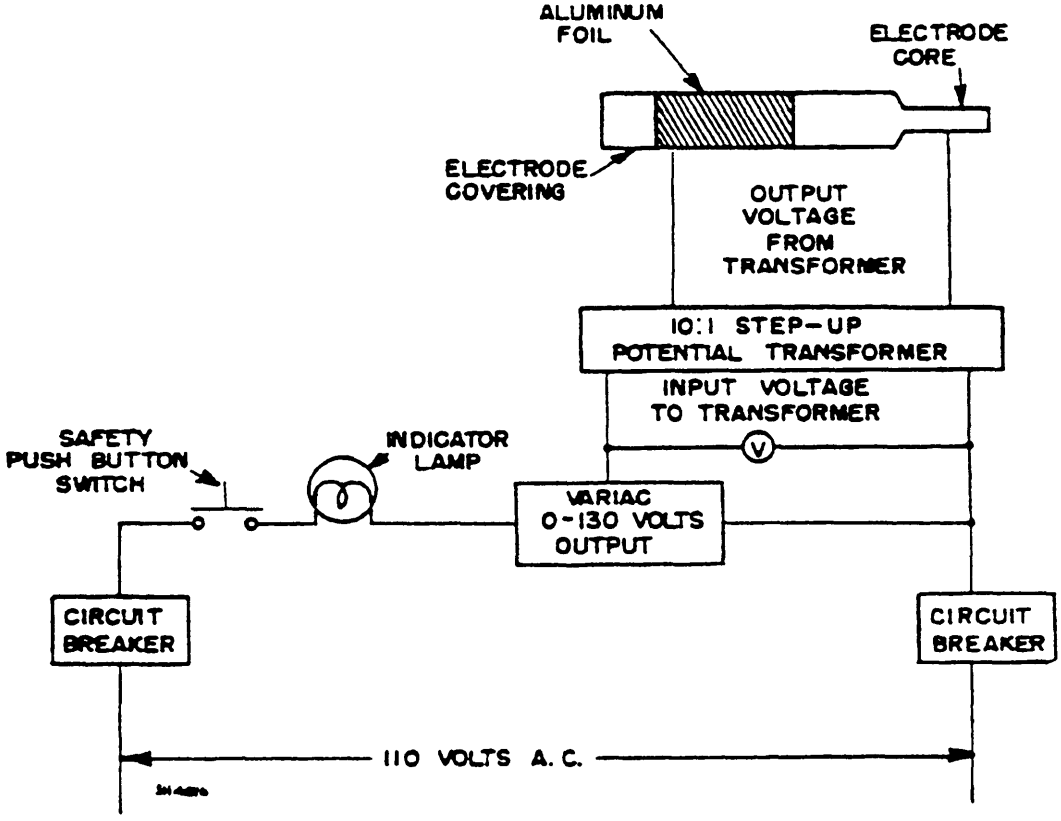
6.8 6.8 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Army - AR
Navy - SH
Air Force - 84

Review activities:
Army - MR, AR
Navy - SH, YD
Air Force - 84

User activities:
Army - AT
Navy - MC, OS

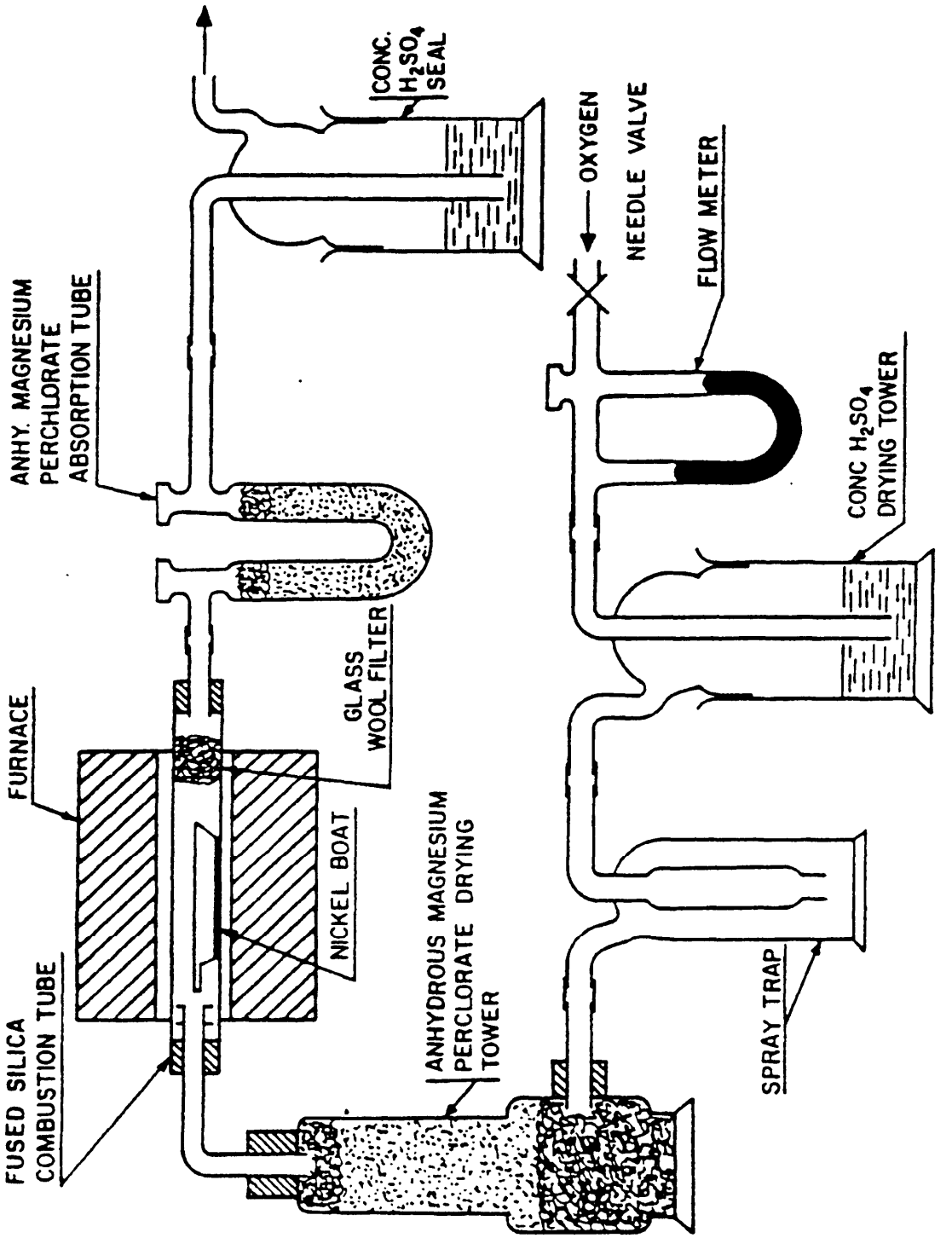
Preparing activity:
Navy - SH
(Project 3439-0710)



NOTES:

1. Wrap conducting aluminum foil around 6-inch length of electrode.
2. Place electrode with grip-end on one lug and foil covered section on other.
3. Close circuit breaker; press safety button and slowly rotate variac control.
4. Record maximum voltage before breakdown.
5. Dielectric strength is recorded voltage, multiplied by 10 (transformer ratio).
6. When dielectric strength is below 300 V, connect appropriate voltmeter across electrode terminals.

FIGURE 1. Circuit for dielectric strength determination.



SH 5228

FIGURE 2. Schematic drawing of train for moisture determination.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-E-22200G	ELECTRODES, WELDING, COVERED: GENERAL SPECIFICATION FOR

3a. NAME OF SUBMITTING ORGANIZATION

b. ADDRESS *(Street, City, State, ZIP Code)*

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ USER
- ☐ MANUFACTURER
- ☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE.

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NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document*(s)* or to amend contractual requirements.

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