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31 January 1967
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MIL-E-22200D
22 April 1963
(See 6.5)

MILITARY SPECIFICATION

ELECTRODES, WELDING, COVERED;

GENERAL SPECIFICATION FOR

This limited coordination Military specification has been prepared by the Department of the Navy, Naval Ship Engineering Center based upon currently available technical information, but it has not been approved for promulgation as a revision of Military Specification MIL-E-22200D. It is subject to modification. However, pending its promulgation as a coordinated Military specification, it may be used in procurement.

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 and sizes specified in the applicable electrode detail specifications.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

MILITARY

MIL-W-10430 - Welding Rods and Electrodes; Preparation for Delivery of.
MIL-I-45208 - Inspection System Requirements.

STANDARDS

FEDERAL

FED-STD-151 - Metals; Test Methods

FSC 3439

STANDARDS (Cont'd)

MILITARY
MIL-STD-271 - Nondestructive Testing Requirements for Metals

PUBLICATIONS

MILITARY
NAVSHIPS 0900-003-9000 - Radiographic Standards for Production and Repair Welds

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

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

AMERICAN WELDING SOCIETY (AWS)

A3.0 - AWS Definitions - Welding and Cutting

(Application for copies should be addressed to the American Welding Society, Inc., 345 East 47th Street, New York, N. Y. 10017.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

EW-1 - Electric Arc-Welding Apparatus, Requirements for

(Application for copies should be addressed to National Electrical Manufacturers Association, 155 East 44th Street, New York, N. Y. 10017.)

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

3. REQUIREMENTS

3.1 Detail requirements for individual electrode types.- Detail requirements or exceptions applicable to particular types of electrodes shall be as specified in the electrode 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.- The electrodes furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.2 and 6.2).

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 assuring that the deposited weld metal will conform to the requirements of the applicable detail specification. The coating formulation, method of processing and composition of the deposited weld metal shall form 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 Ship Engineering Center (NAVSEC).

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 5 percent.

3.5.3 Uniformity.- The coverings shall be such as to be consumed uniformly to produce satisfactory production welds.

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 sufficient to insulate effectively against a difference potential of 110 volts (v.), 60 cycle a.c. Any permissible exception to this requirement shall be as specified in the applicable detail specification.

3.5.5 Flaking or cracking of coverings.- The coverings shall not exhibit flaking or cracking upon heating or cooling which will adversely affect the operation of the electrode after approximately one half the electrode has been consumed or upon resumption of welding.

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

3.5.7 Slag removal.- The slags deposited by the coverings shall be readily 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.

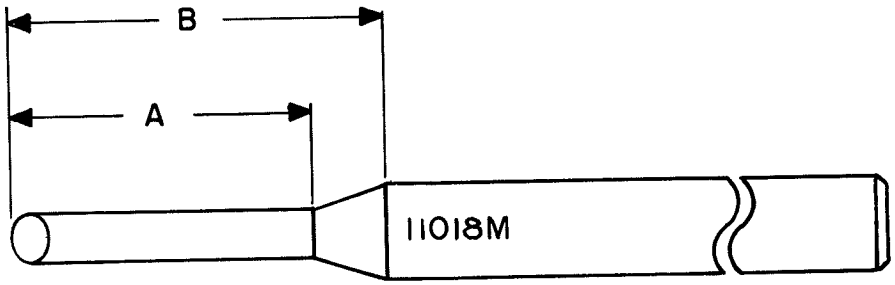
3.5.8 Stability.- The stability of the coverings shall be such that electrodes after receipt from the manufacturer will comply with this specification after storage in original unopened containers under roof and on dry platforms forms for the following periods (see 6.4):

Type of unit container	Time period
Class 5 of MIL-W-10430	Up to 6 months
Classes 1 and 2 of MIL-W-10430	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 accidently occur, but when it does occur such chipping may not exceed one-quarter the circumference of the core wire and/or one-quarter of the circumference of the core wire transverse to the arc end.

3.5.9.2 Grip ends.- The grip ends shall be bare within the limits shown on figure 1.



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Electrode class (sizes)	Bare portion (minimum) A	Distance to full thickness of covering (maximum) B
	Inch	Inches
1	1/2	1-1/4
2	3/4	1-1/2
3	3/4	1-1/2

Figure 1 - Grip-end dimensions

3.5.10 Electrode identification.-

3.5.10.1 Marking.- At least one legible electrode type designation or classification number (see detail specification) shall be applied to the electrode covering in such a manner that at least one complete type designation shall come within the space $2\frac{1}{2}$ inches from the grip end of the electrode.

3.5.10.2 Size and legibility.- The imprinted designations shall be composed of equal-size block characters, 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 5/32 inch height. The imprinted designations shall read from left to right from the grip-end as shown on figure 1. The color of the print shall contrast 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 descernible on electrodes rebaked at temperatures up to 850°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 in the applicable detail specification.

3.6 Core wires of electrodes.-

3.6.1 Tolerance in diameter.- The diameter of core wire shall not vary more than 0.003 inch from the nominal diameter.

3.6.2 Nominal length.- The nominal length of the electrodes shall be in accordance with table I, unless otherwise specified in detail specifications.

Table I - Nominal lengths.

Sizes	Nominal lenghts 1/ end-grip
Inch	Inches
1/16, 5/64, 3/32	9 and 12
1/8	9 and 14
5/32	14
3/16, 7/32, 1/4, 5/16	14 or 18

1/ The specific length required for a particular electrode shall be as specified in the detail specification.

3.6.3 Tolerance in length.- The actual length of any electrode shall vary not more than 1/8 inch from the nominal length specified in the applicable detail specification.

3.7 Groove welds.- When required by the applicable detail specification, groove welds shall conform to the following:

3.7.1 Soundness.- Electrodes shall be capable of depositing groove welds free from slag entrapments, weld metal cracking, and porosity in excess of grade I of NAVSHIPS 0900-003-9000. Radiographic indications having a maximum length of 1/8 inch may be evaluated as porosity.

3.7.2 Mechanical properities.- Mechanical properties shall be as specified in the applicable detail specification.

3.8 Chemical composition of deposited weld metal.- Chemical composition, when required, shall be as specified in the applicable detail specification.

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 Workmanship.- The coverings of electrodes shall be free from injurious scabs, blisters, pockmarks, bruises, or other surface defects which will affect adversely the operation of the electrodes.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection.- Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 The supplier shall provide and maintain an inspection system acceptable to the Government for the supplies covered by this specification. The system of inspection shall be in accordance with MIL-I-45208.

4.2 Qualification test 1/. Qualification tests shall be conducted at a laboratory satisfactory to the Naval Ship Engineering Center (NAVSEC). Qualification tests shall consist of the tests specified in 4.6 and the applicable detail specification.

4.2.1 Special instructions.- When applying for test authorization, or after tests have been authorized and when samples are submitted, the manufacturer shall furnish the following information. (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.)

4.2.1.1 Where lot identification is by heat of core wire (see 4.4.2.1 and 4.4.3.1 (a) and 4.4.3.1 (b)).-

(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.

1/ Application for qualification tests shall be made in accordance with "Provisions Governing Qualification" (see 6.2 and 6.3).

4.2.1.2 Where lot identification is by controlled core wire chemical composition (see 4.4.3.1.1).- In addition to 4.2.1.1, the following shall be furnished for approval of NAVSEC.

(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.

4.2.1.3 Where lot identification is controlled covering mixture chemical composition (see 4.4.3.1.2).- In addition to 4.2.1.1 or 4.2.1.2, the following shall be furnished for approval of the NAVSEC.

(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.

4.2.1.4 Samples for qualification test.- Each exhibitor shall furnish sufficient sample packages and electrodes of the type he desires to have tested. Quantities shall be as requested by the qualifying agency or laboratory, and shall be selected at one time in the presence of the Government inspector and so indicated. The exhibitor shall indicate on the sample whether the electrodes and packages were produced on a laboratory or experimental scale, or on a production scale.

4.3 Comparison inspection test.-

4.3.1 Comparison inspection tests may be required by NAVSEC based on the manufacturer's electrode performance.

4.3.2 Selecting samples.- The manufacturer shall select a sufficient quantity of packaged electrodes of each type and size involved, for examinations and test specified in 4.3.3.

4.3.3 Examinations and test.- In addition to the examintions and tests required under 4.5, the tests specified and required by the applicable detail specification for comparison inspection testing shall be conducted on the electrodes selected in accordance with 4.3.2.

4.3.4 Reports.- When required the manufacturer shall forward test results to NAVSEC.

4.4 Quality conformance inspection.-

4.4.1 General.- Electrodes shall be inspected in accordance with the definitions specified in 4.4.1.1 through 4.4.1.3 and to inspection level A, B, C, or D as specified in the detail specifications.

4.4.1.1 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 (see 4.4.1.3).

4.4.1.2 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.

4.4.1.3 Wet mix.- A wet mix is defined as the combination of a dry batch (see 4.4.1.1) or dry blend (see 4.4.1.2) and liquid (binder(s)) ingredients at one time in one mixing vessel.

4.4.1.4 Heat of core wire.- A heat of core wire is defined as that material obtained from ingots or billets poured from one melt.

4.4.2 Inspection level A.-

4.4.2.1 Lot.- For the purpose of selecting samples for quality conformance inspection, a lot of electrode is defined as the quantity of any one size and type produced from one wet mix of covering mixture as specified in 4.4.1.3 and one heat of core wire as defined in 4.4.1.4, or core wire as defined in 4.4.3.1.1.

4.4.3 Inspection level B.-

4.4.3.1 Lot.- For the purpose of selecting samples for quality conformance inspection, a lot of electrode is defined as the quantity of any one size and type produced from:

(a) One or more wet mixes as defined in 4.4.1.3 and one heat of core wire as defined in 4.4.1.4, or core wire as specified in 4.4.3.1.1, within a continuous 24-hour working period or
(b) One dry batch or one combined series of dry blends where manufacturing processes are such that the methods of 4.4.1.1 or 4.4.1.2 are employed and one heat of core wire as defined in 4.4.1.4 or core wire as specified in 4.4.3.1.1 or
(c) One continuous 24-hour working period where manufacturing processes are such that the method of 4.4.3.1.2 is employed with core wire as specified in 4.4.3.1.1.

4.4.3.1.1 Identification by controlled core wire chemical composition.- Where manufacturing processes are such that core wire is identified by controlled chemical composition for each MIL-type (see 4.2.1.2), in addition to 4.4.3.1, a lot of electrodes shall be the quantity produced from one or more chemically tested mill coils of rod from one or more heats of metal conforming to the approved chemistry control limits for that type electrode. The following additional conditions shall apply:

(a) Each continuously rolled mill coiled rod furnished by mills prohibiting spliced-coil practice, shall be chemically analyzed by approved methods (see 4.2.1.2). Mill-coiled rod furnished by mills permitting spliced-coil practice shall have no more than one splice per coil, and both ends of every coil received from such mills shall be chemically analyzed before processing.
(b) All chemical analyses shall be certified by the laboratory and made available to the Government inspector.
(c) 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.

4.4.3.1.2 Identification by controlled covering mixture chemical composition.- Where manufacturing processes are such that covering mixture is identified by controlled chemical composition for each MIL-type (see 4.2.1.3), in addition to 4.4.3.1, a lot of electrodes shall be the quantity produced from one or more chemically tested wet mixes conforming to the percent allowable variation (disclosed) from standard (not disclosed) for each chemical element for that type electrode. The following additional conditions shall apply:

(a) Each wet mix shall be chemically analyzed by approved methods (see 4.2.1.3).
(b) All chemical analysis shall be certified by the laboratory and percent variation from standard made available to the Government inspector.
(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.

4.4.4 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 4.4.1.4 or 4.4.3.1.1 during a 24-hour continuous period.

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 and results shall be made available to the Government inspector in accordance with 4.1.1 and to the consignee on request. 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 4.4.1.4 or 4.4.3.1.1, or during a 24-hour working period 1/.

4.4.6 Lot identification.-

4.4.6.1 Inspection levels A, B and C.- When identification is by heat of core wire as defined in 4.4.1.4 and wet mix as defined in 4.4.1.3, each heat of core wire and each wet mix shall be uniquely identified by the manufacturer's control number or other marking which shall appear on each unit and shipping container. The marking method which designated the heat and wet mix shall be in a position which permits ready location by the consignee. If control numbers or symbols must be decoded for identification of the heat of wire and wet mix, the manufacturer shall furnish the consignee the key or instruction necessary to interpret the code system used.

4.4.6.2 Inspection level B.- When lot identification is by controlled core wire chemical composition as defined in 4.4.3.1.1 and controlled covering mixture chemical composition as defined in 4.4.3.1.2, each continuous 2-hour working period shall be identified by the manufacturer's control number or other marking which shall appear on each unit and shipping container. The control number or symbol shall be in a position which permits ready location by the consignee. If the control numbers or symbols must be decoded for identification of the two hour working period, the manufacturer shall furnish the consignee the key or instructions necessary to interpret the code system used.

4.4.6.3 Inspection level C.- Where lot identification is by controlled core wire chemical composition as defined in 4.4.3.1.1 and controlled covering mixture chemical composition as defined in 4.4.3.1.2, each continuous 8 hour shift shall be identified by the manufacturer's control number or other marking which shall appear on each unit and shipping container. The control number or symbol shall be in a position which permits ready location by the consignee. If the control number or symbol must be decoded for identification, the manufacturer shall furnish the consignee the key or instructions necessary to interpret the code system used.

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

1/ A 24-hour working period may be either 24 hours around the clock or a total of three continuous normal workday shifts.

4.4.8 Sampling for examination and tests of electrodes.- Sample electrodes shall be selected either from the production line after the baking operation, or from the filled unit packages except where otherwise specified in the detail specification. The unit packages required for this examination may be selected from the sample of packages used for 4.4.7. If selected from the production line, the total sample shall be in accordance with table II and the electrodes shall be selected through the production period so that all parts of the "lot" are represented. If sample electrodes are selected from filled unit packages or cans, the total sample shall be in accordance with table II, and approximately the same number of electrodes shall be selected from each of the unit packages or groups of cans (6 cans per group). 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.

Table II - Sampling for examination of electrodes

Lot size, number of 50-pound packages or groups of 10-pound cans (6 cans per group)	Sample size, number of 50-pound packages or groups of 10-pound cans to be opened	Total sample number of electrodes to be examined	Acceptace number (defective electrodes)	Rejection number (defective electrodes)
2 to 65	2	10	0	1
66 to 110	3	15	0	1
111 to 180	3	15	0	1
181 to 300	5	25	1	2
301 to 500	5	25	1	2
501 to 800	7	35	1	2
801 to 1300	10	50	2	3

4.4.8.1 The sample electrodes shall be examined in accordance with 4.5.1.

4.4.8.2 The sample electrodes shall be subjected to the special measurement of test of 4.5.2.

4.4.8.3 If weld tests are specified in the applicable detail specification, the sample of 4.4.8.1 and 4.4.8.2 shall be used for these tests, with additional electrodes, if necessary, to provide for three weld tests.

4.5 Examination and tests.-

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

4.5.2 Concentricity.- Each of the electrodes selected in accordance with 4.4.8 shall be tested as specified in 4.6.2.

4.5.3 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 Test procedures. -

4.6.1 Welding equipment.- Welding machines used for supply power for testing electrodes shall be variable voltage d.c. motor-generator type, variable voltage d.c. rectifier welder, or a.c. 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 volts.

4.6.2 Procedure for measurements of concentricity and diameter.- The concentricity of the coverings on several sample (see 4.5.2) electrodes of each size shall be measured by either of the methods specified in 4.6.2.1 or 4.6.2.2.

4.6.2.1 Concentricity.- 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 1/2 inch wide shall be completely removed to the bare core wire, care being taken to insure that no metal is removed from the core wire. Using a micrometer and supplemental metal strip (approximately 1 inch long by any convenient thickness, for example,0.125 or 0.250 inch) or a specially adapted micrometer having a "T" shaped anvil, the diameter of the core wire plus 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 measurements shall be noted. (It is immaterial whether 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 approximately the mid-length 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 3.5.2.

4.6.2.2 Concentricity (alternative 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 the 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 midlength 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 (two adjacent measurements) which shows the greatest variation shall be used to determine the acceptability of the electrodes as specified in 3.5.2.

4.6.2.3 Diameter and length of core wire.- In the course of making the measurements specified in 4.6.2.1 or 4.6.2.2, the diameter and lengths of the core wire shall be measured.

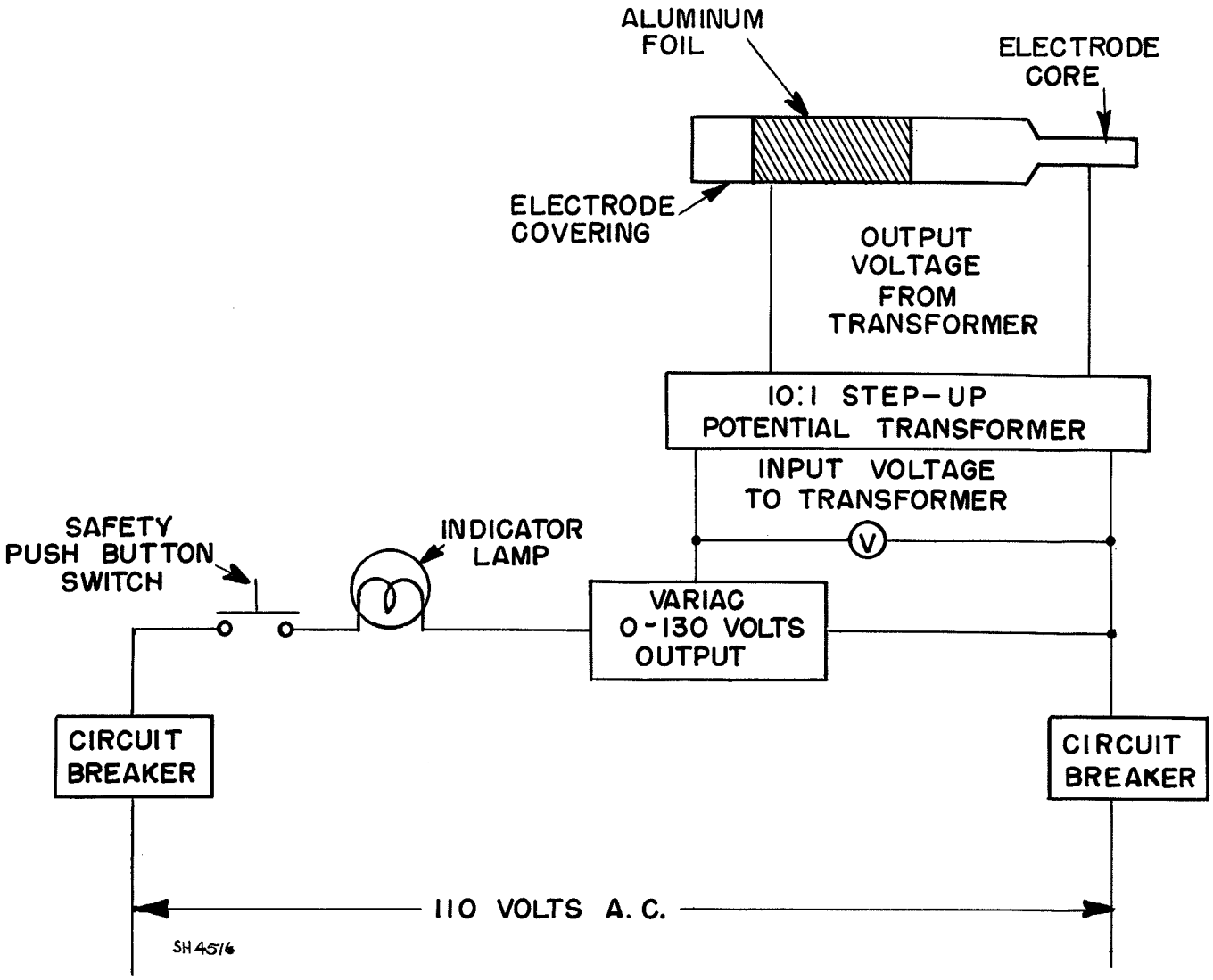
4.6.3 Dielectric strength.- Dielectric strength of coverings shall be determined by the method shown on figure 2. Methods other than the one shown, yielding the required results, may be used as alternates if such methods are acceptable to the Government.

4.6.4 Flaking or cracking of covering.- The flaking or cracking tendency of electrode coverings shall be determined by a welding test using the currents specified under the appropriate specification for this test in the manner specified in 4.6.4.1 through 4.6.4.2. Not less than five electrodes from each size shall be tested as required by the detail electrode specification.

4.6.4.1 Preparation for test.- Each electrode selected for the test shall have the covering grooved to the core wire completely around the electrode at the midpoint of its length.

4.6.4.2 Each test electrode shall be used in normal fashion, with the appropriate prescribed welding current to deposit a bead weld on a compatible base material plate surface until the electrode is consumed to the groove in the covering when welding shall be stopped. The half-length stub shall be removed immediately from the electrode holder and placed upon a flat steel plate to cool.

4.6.4.3 When the half-length stub has cooled sufficiently to be held comfortably in the bare hand, it shall be inserted in the electrode holder and welding resumed until the half-length stub has been consumed down to a stub not over 2 inches in length. Welding conditions shall be the same as for the welding with the first half of the electrode. Any flaking of the electrode covering during welding with the half-length stub shall render the particular electrode size involved subject to disqualification. Upon completion, each stub shall be examined for compliance with 3.5.5.



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 volts, connect appropriate voltmeter across electrode terminals.

Figure 2 - Circuit for dielectric strength determination.

4.6.5 Weld inspection tests.- Although primarily designed and intended as inspection procedures at the point of manufacture, as specified by the applicable detail specification, this test also shall be performed by the laboratory for qualifying the electrode and for comparison tests.

4.6.6 X-ray examination of groove welds.- X-ray examination shall be conducted in accordance with MIL-STD-271 for compliance to 3.7.1 on groove welds when required by the detail electrode specification.

4.6.7 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 FED-STD-151. 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.

4.6.8 Chemical analysis.- When required by the applicable detail specification, chemical analysis shall be made by the testing laboratory and the manufacturer from a small sample of drilling, milling, chips or slices machined with tools of high-speed steel from pads of weld metal $1\frac{1}{2}$ by $1\frac{1}{2}$ inches by $\frac{1}{2}$ inch high (minimum) for deposits with electrodes up to and including 3/16 inch diameter, or 2 by 2 inches by $\frac{1}{2}$ inch (minimum) for deposits with $\frac{1}{4}$ and 5/16 inch diameter electrodes deposited on plain low carbon-steel or base material of chemical composition similar to the electrode deposit. The quantity of drillings, millings, chips, or slices need be no more than necessary for satisfactory analysis. The top surfaces shall be machined off and the samples for chemical analysis shall be machined from the section immediately below in such a manner that no metal shall be removed within $\frac{1}{4}$ inch of the base metal. Chemical analysis shall be made by wet chemical or spectrographic methods. In case of dispute, chemical analysis by wet chemical methods shall be the basis for acceptance. The pad shall be deposited as follows:

(a) Weld metal shall be deposited in multiple pass layers. Each pass shall be deposited, so that its width is $1\frac{1}{2}$ to $2\frac{1}{2}$ times the core wire diameter of the electrode. Welds shall be deposited using common production welding techniques.

(b) The pad may be quenched in hot water (above 180°F.) after each pass to speed cooling. If this technique is employed, the pad should be cooled for approximately one minute prior to quenching and allowed to dry prior to the next pass.

(c) A record of the welding parameters, (welding current, arc voltage, pre-heat and interpass temperature) base material and approximate number of layers and passes shall be forwarded with the chemical analysis when required by the using activity.

4.6.8.1 Chemical analysis (alternate method).- Chemical analysis (wet chemical or spectrographic) may be made on sample drillings, or slices taken from deposited weld metal of groove welds. Extreme care to avoid contamination of the sample shall be exercised when using this method of sampling for chemical analysis; the drillings, or slices shall be taken along the centerline of the longitudinal axis of the deposited metal and from the upper third of the groove weld thickness.

4.6.9 Covering moisture.- The tendency for the electrode coverings to generate gas (especially hydrogen) which may be dissolved in the molten weld metal and evolved after solidification of the weld metal shall be determined by analysis of the covering of the middle portion of three electrodes of each size for total water content (hygroscopic and combined) as specified in figure 3 and the notes applying thereto. Electrodes shall be considered unacceptable unless the total water content is in conformity with the applicable detail specification.

4.6.10 Total iron content.- The total iron content of the covering, as specified in the applicable detail specification, shall be made by wet chemical or spectrographic method. In the case of dispute, total iron content shall be determined as follows:

4.6.10.1 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 cubic centimeters (c.c.) with water, filter and wash with hot water, saving the filtrate. Ignite the filter paper and residue in a platinum crucible.

4.6.10.2 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 2ml of concentrated nitric acid and boil. Add 5 grams of ammonium chloride or ammonium nitrate and mascerated 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. 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

4.7 Retest.- In case of failure of an electrode to conform with any specified test requirement, one retest using electrodes selected from the same sampling or test lot, as those of the initial test, will be permitted.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery shall be as specified in the applicable detail specification.

6. NOTES

6.1 Procurement documents should specify the title, number and date of this specification.

6.2 With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in applicable Qualified Products List whether or not such products shave actually been so listed by that date. The attention of the suppliers is called to this requirement, 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 orders for the products covered by this specification. The activity responsible for the qualified products list is the Naval Ship Engineering Center, Department of the Navy, Washington, D.C. 20360, and information pertaining to qualification of products may be obtained from that activity. Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification" (see 6.3).

6.3 Copies of "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

6.4 Storage.- Paragraph 3.5.8 specified the manufacturer's responsibility for electrodes as being six months or one year. This six months or one year period should not be taken, by the consignee, as a limit on the useful life of the electrodes.

6.5 CHANGES FROM PREVIOUS ISSUE. THE EXTENT OF CHANGES (DELETIONS, ADDITIONS, ETC.) PRECLUDE THE ANNOTATION OF THE INDIVIDUAL CHANGES FROM THE PREVIOUS ISSUE OF THIS DOCUMENT.

Preparing activity:
Navy - SH
(Project 3439-N102Sh)

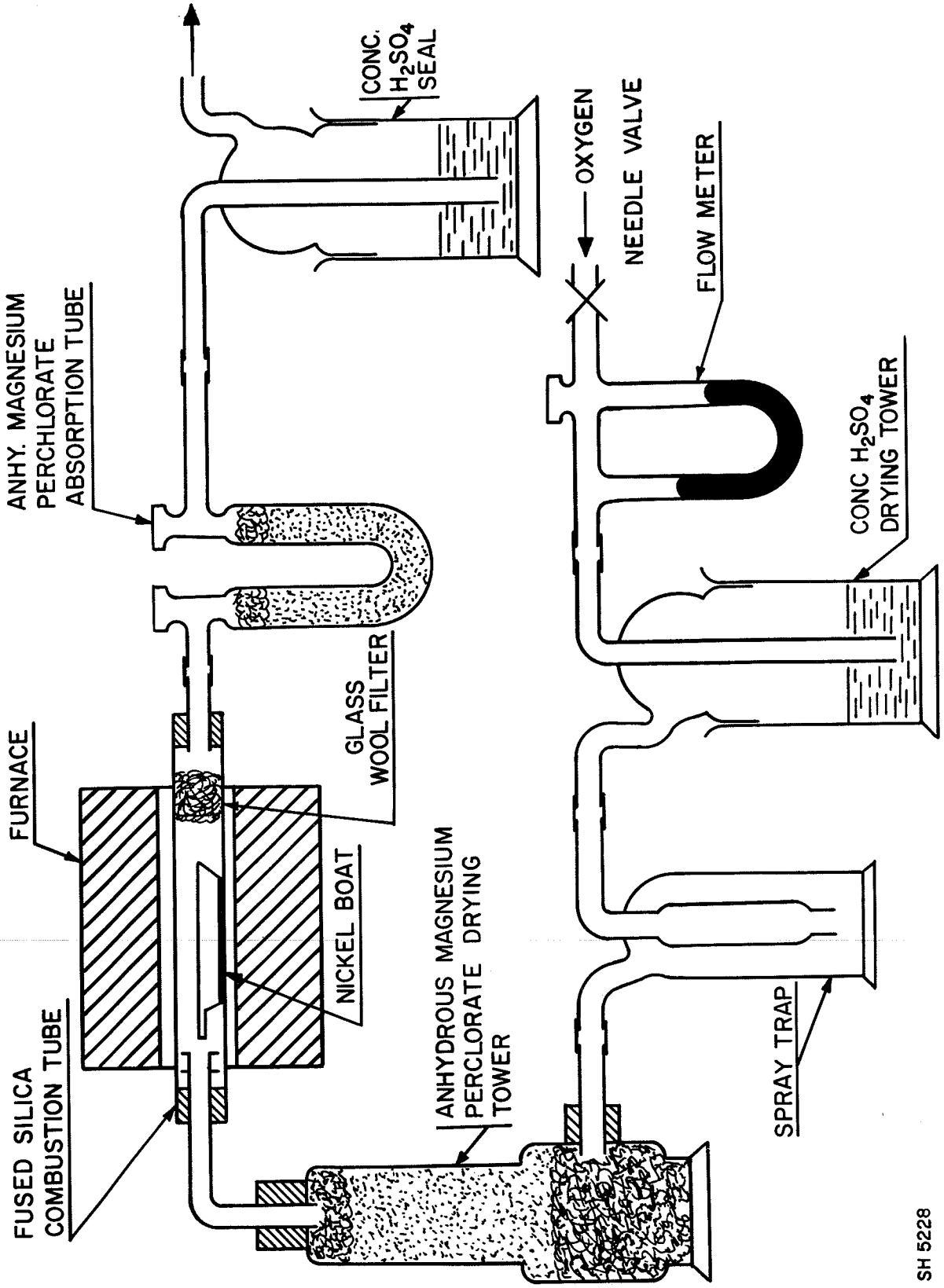


Figure 3 - Schematic drawing of train for moisture determinations.

Notes to Figure 3

METHOD OF DETERMINING TOTAL WATER CONTENT OF

LOW HYDROGEN TYPE COVERINGS OF ELECTRIC ARC WELDING ELECTRODES

1. Apparatus.

(a) Furnace: Tube furnace capable of furnishing temperatures to 2000°F. (1090°C.) within the combustion tube is satisfactory. The length of the heating element shall be sufficient to heat 8 - 10 inches of the middle portion of the combustion tube to the required temperature. Furnace shall be equipped with a temperature controller and pyrometer.

(b) Oxygen Supply: The oxygen supply should be free of organic matter. If organic matter is present, oxygen should be purified by passing it through a small combustion tube lightly packed with asbestos or copper oxide, heated to a temperature of 1100 to 1200°F. (600 to 650°C.).

(c) Oxygen drying train: This consists of a pressure reducing valve on the oxygen supply, a needle valve and oxygen flow meter to regulate the flow of oxygen, a wash bottle containing concentrated sulfuric acid (96 percent), a spray trap and a drying tower filled with anhydrous magnesium perchlorate.

(d) Combustion Tube: A fused silica combustion tube, open at both ends, with a devitrification point above 2000°F. (1100°C.) shall be used. About 6 inches of the tube shall project from either side of the furnace. A plug of fine glass wool is inserted into the outlet end of the combustion tube to filter the gases. It shall be inserted far enough into the tube so that it is heated to 400 - 500°F. (200 - 260°C.).

(e) Water Absorption Train: The water driven from the sample is collected in a U-tube absorber (Schwartz) filled with anhydrous magnesium perchlorate. A gas-sealing bottle containing concentrated sulfuric acid (96 percent) is attached to the outlet end of the moisture U-tube absorber.

2. Temperature.

A temperature of 1800°F. shall be maintained within the combustion tube for the determination.

3. Preparation and Handling of Sample

The sample shall be a composite of the coatings from the middle portions of three electrodes. It should be immediately transferred to a dried, stoppered vial or sample bottle. The sample size used in each determination shall be approximately four grams; it shall be weighed directly on the balance dish and transferred to the boat with forceps, weighing the sample to the nearest 0.001g.

4. Handling of Combustion Boat and Absorption Tube

The ignited nickel boat after removal from the combustion tube shall be transferred to a Pyrex desiccator containing anhydrous magnesium perchlorate as a disiccant. The absorption tube shall be handled with lint-free gauze at all times and shall be stored in the balance case during the cooling period so that is assumes the temperature of the atmosphere in which it is to be weighed.

5. Desiccants

The anhydrous magnesium perchlorate and sulfuric acid shall be renewed often enough to insure the best performance. In the case of the absorption tube this can be estimated roughly since it is known that anhydrous magnesium perchlorate will absorb at least 16 percent of its weight in water without any noticeable loss in drying efficiency.

6. Oxygen Flow

The flow of oxygen to the train shall be maintained at 200 to 250 ml/minute. Once the flow of oxygen is established it shall not be changed throughout the determination.

7. Combustion Boats.

A nickel combustion boat which will hold a four-gram sample shall be used. (The ignited sample can be removed after the determination and the boat re-used. A small amount of alumina in the heated zone of the combustion tube will prevent nickel boat from fusing with combustion tube.)

8. Step by Step Procedure

(a) Blank Determination

(1) With the furnace operating at a temperature of 1800°F., the oxygen flow shall be adjusted to 200 - 250 ml/minute. The nickel boat shall be placed in the middle of the heated zone of the combustion tube and the absorption U-tube attached to the train. A period of 30 minutes shall be employed to ignite the boat and "condition" the absorption U-tube.

(2) The moisture absorption U-tube shall be removed from the system and placed in the balance case and the nickel boat shall be removed from the combustion tube and placed in the desiccator. The combustion tube of the furnace shall be closed after removing the boat.

(3) After cooling for a period of 20 minutes, the absorption U-tube shall be weighed. The boat shall be removed from the desiccator and exposed for a period of time approximating the time required to transfer a sample from the balance pan to the boat in an actual determination.

(4) The combustion tube shall be opened, the moisture absorption U-tube placed in the system, the boat placed in the center of the combustion tube and the cover replaced.

(5) After a period of 30 minutes, the absorption U-tube shall be removed from the system and placed in the balance case and the boat shall be removed from the combustion tube and placed in the desiccator.

(6) The moisture absorption U-tube shall be weighed after a period of 20 minutes. The gain in weight is the blank.

(b) Moisture Determination

(1) Immediately after weighing the absorption U-tube in item 6 of the blank determination procedure, the sample shall be weighed out on the balance pan.

(2) The boat shall be removed from the desiccator and the sample quickly transferred from the balance pan to the boat.

(3) The combustion tube shall be opened, the moisture absorption U-tube placed in the line, the boat transferred to the center of the combustion tube and the cover replaced.

(4) After a period of 30 minutes, the absorption U-tube shall be removed from the system and placed in the balance case.

(5) The absorption U-tube shall be weighed after the 20-minute cooling period.

(6) If additional samples are to be run, the nickel boat may be removed from the combustion tube at step 4, the ignited sample is removed and the boat placed in the desiccator to cool. Since the same boat can be used for the following determination, it is not necessary to run a blank determination for each sample. Therefore after item 5 another determination may be started immediately.

9. Calculation

$$\% \text{ Moisture} = \frac{A-B}{\text{Wt. of sample}} \times 100$$

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

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

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity *(as indicated on reverse hereof)*.

SPECIFICATION

ORGANIZATION *(Of submitter)* | CITY AND STATE

CONTRACT NO. | QUANTITY OF ITEMS PROCURED | DOLLAR AMOUNT $

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO IF "YES", IN WHAT WAY?

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity)* | DATE

DD, FORM 1 APR 63 1426 REPLACES NAVSHIPS FORM 4863, WHICH IS OBSOLETE

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