MILITARY SPECIFICATION

ELECTRODES - WELDING, FLUX CORED,
GENERAL SPECIFICATION FOR

This amendment forms a part of MIL-E-24403A(SH), dated 21 December 1981, and is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

PAGE 1

TABLE I. Delete and substitute:

"TABLE I. Electrode diameter sizes.

Form	Diameter sizes (inches)
3a	0.045, 0.052
3b	0.045, 0.052, 0.0625, 5/64, 3/32
3d 3e 4	0.045, 0.052, 0.0625, 0.068, 0.072, 5/64, 3/32, 7/64, 0.120, 1/8, 5/32

"

At bottom of page "Beneficial comments" statement, line 3: Delete "SEA 3112" and substitute "SEA 55Z3".

PAGE 4

3.4.4: Add: "The chemical composition of the core ingredients necessary to produce a weld that meets all requirements is optional with the manufacturer."

3.4.6: Delete and substitute:

"3.4.6 Soundness. Unless otherwise specified in the detail specification (see 3.2), groove welds shall meet the requirements of NAVSEA 0900-LP-003-9000, class 1 for radiographic inspection."

PAGE 10

4.6.2.1 and 4.6.2.1.1: Delete and substitute:

"4.6.2.1 Radiographic inspection. Radiographic inspection shall be in accordance with level 2-2T of MIL-STD-271."

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4.6.5: Delete and substitute:

"4.6.5 Diffusible hydrogen. A sample of each lot for each size and MIL type of electrodes furnished to the requirements of this specification shall be tested for diffusible hydrogen level in the weld metal. The hydrogen level of the deposited weld metal shall be determined by the analytical method of gas chromatography (see 4.6.5.2) or by the method of collection over mercury (see 4.6.5.3). Alternate methods or apparatus which yield results of one to one correlation with the two methods above may be used.

"4.6.5.1 Specimen preparation. The test specimens for the diffusible hydrogen analysis shall be prepared according to the following:

(a) The testing of each size and MIL type electrode requires four separate diffusible hydrogen determinations, that is, four test specimens. Each test specimen consists of a 10- by 15- by 30-millimeter (mm) steel block with the weld metal deposited upon it. For collection over mercury method, specimens shall be 1/2 by 1 by 5-inch (see 4.6.5.3). These larger specimens shall be weighed to the nearest 0.1 gram before and after welding.

(b) The test specimen thickness is always the 10-mm direction of the steel block. For electrodes 1/16 inch and smaller, the test specimen welding direction is the 30-mm direction and a single test specimen between run-on and run-off pieces is used for each weld deposit. For electrodes larger than 1/16 inch, the test specimen welding direction is the 15-mm direction and two test specimens between run-on and run-off pieces are used for each weld deposit. The arrangements of test specimens with run-on and run-off pieces for the various electrode sizes are shown on figure 3.

(c) The material for the test specimen and run-on and run-off pieces shall be plain hot rolled ordinary strength steel containing not more than 0.25 percent carbon, 0.35 percent silicon, 0.03 percent phosphorous and 0.03 percent sulfur. Rimmed steel is not acceptable. The material shall be degassed by holding for 1 hour at 1200-1235°F prior to finish grinding to size. The finished surfaces shall be orthogonal with dimension tolerances of plus or minus 0.25 mm and maximum surface roughness of 120 microinches root mean square (rms) on all surfaces. For the collection over mercury method, the edges and corners shall be rounded (approximately 1/64-inch radius) to break the sharp edge to prevent scratching the eudimeter tube.

(d) Each test specimen shall be given an identification number or mark by stamping or engraving its surface opposite to the welding surface. Any upset from the identification mark or number shall be removed by lightly sanding on 600 grit paper prior to degreasing and weighing. Each test specimen shall be weighed to the nearest 0.01 gram before welding and the weight shall be recorded along with the specimen identification.

(e) Immediately prior to welding the test specimen and run-on and run-off pieces shall be thoroughly degreased.

(f) Three feet of electrode shall be fed out of the gun, cut off and discarded just prior to each test weld deposit.

(g) The welding parameters during test welding shall be the same as those used to make the test weldments as shown on figure 1.

(h) The pieces of the test assembly (see figure 3), shall be placed in the appropriate copper clamp (see figure 4), butted together and tightly clamped. An annealed copper foil (as shown on figure 4 fixture for 1/16-inch and smaller electrodes) is used between the test assembly and copper clamp. This protects the clamp from arc strikes and thermally couples the test assembly with the copper clamp. The foil may be annealed and cleaned after each use. The foil is 1 to 2 mm in thickness. Immediately prior to welding, the temperature of the test assembly and copper clamp shall be 20 ± 5 degrees Celsius (°C). The copper clamp may be water cooled.

(i) A single stringer bead (without weaving) shall be deposited in the flat position, approximately 100 mm in length.

(j) The test assembly shall be removed from the fixture, quenched in iced water within 5 seconds of extinguishing the arc, and agitated vigorously in the iced water until cold to the touch (about 20 seconds). It shall then be immediately removed from the quench and placed in a low temperature liquid bath at dry ice temperature (-78°C) or colder. At dry ice temperature the test assembly may be stored for a maximum of 3 days before loading into the hydrogen sampler cannister. At liquid nitrogen temperature (-196°C) the test assembly may be stored for a maximum of 3 weeks.

(k) Remove test assembly from low temperature bath and, while still cold, break off run-on and run-off pieces. Remove any remaining slag. If an electrode larger than 1/16 inch was used, break the test assembly into two test specimens again. During the breaking and cleaning operation, the test pieces shall not remain out of the low temperature bath for more than 60 seconds at a time. If necessary, they shall be returned to the bath for a minimum of 120 seconds each time between portions of the cleaning and breaking operation. Each cleaned 10- by 15- by 30-mm block with its weld deposit constitutes a test specimen. After completion of the cleaning and breaking operation, each test specimen shall be returned to the low temperature bath for a minimum of 120 seconds.

"4.6.5.2 Gas chromatography method. The gas chromatography method, when used, shall be conducted in accordance with the procedures as specified in 4.6.5.2.2.

"4.6.5.2.1 Equipment. A suitable apparatus is the Yanaco Model G1005 Hydrogen Analyzer and Model GS1006 Sampler or equivalent.

"4.6.5.2.2 Procedure. Continuing with the specimen from 4.6.5.1(k), the procedure shall be as follows:

(a) Using tongs, remove a first test specimen from the low temperature bath and agitate in a cool water bath (not iced) until the ice skin which formed on the specimen has just melted. Immediately withdraw from the water bath and dry with a compressed air blast lasting no longer than 5 seconds. Immediately place in the number one cannister of hydrogen sampler, close the cannister and flow welding grade argon at 5 to 10 cubic feet per hour (ft^3/h) into the cannister through the tube at the bottom of the cannister (exhausting at the top of the cannister). At the end of 30 seconds of argon flow into the cannister, turn the manifold dial to the next cannister position.

(b) Repeat for second through fourth specimens and cannisters respectively. After the fourth cannister is loaded and purged with argon for 30 seconds, turn the manifold dial to the bypass position next to the fourth cannister position and leave it there until hydrogen analysis is begun.

(c) Hold the hydrogen sampler in a constant temperature oven at 45 ± 3°C for 72 hours (plus 5, minus 0).

(d) Cool the hydrogen sampler to room temperature for a minimum of 1/2 hour and a maximum of 3 hours before hydrogen analysis. Connect the hydrogen sampler to the gas chromatograph hydrogen analyzer and determine the hydrogen volume in milliliters (mL) at standard temperature and pressure (0°C, 760 mm mercury absolute pressure) according to the manufacturer's instructions for each cannister, working in reverse order to the loading order.

(e) Remove each specimen from its cannister and match the hydrogen volume for that cannister to the specimen number. Weigh the specimen to the nearest 0.01 gram and record.

(f) The weight of the deposit weld metal shall be calculated as the difference between the final specimen weight and the initial specimen weight.

(g) The volume of hydrogen divided by the weight of the deposited weld metal shall be recorded as the hydrogen content for each test specimen, in milliliters per gram (mL/g) of deposited metal.

(h) The four values obtained and the average value, all rounded to the nearest 0.001 mL/g, shall be reported.

"4.6.5.3 Collection over mercury method. The collection over mercury method, when used, shall be conducted in accordance with the procedure as specified in 4.6.5.3.3.

"4.6.5.3.1 Warning. Working with mercury can be dangerous to health. This test should be conducted only by personnel knowledgeable in the field of mercury toxicology and can handle mercury with proper precautions. Precautions involving the handling of mercury shall be observed which include, but are not limited to, the following:

(a) The diffusible hydrogen test apparatus shall be located under a fume hood and any steps involving the handling of mercury shall be performed under a fume hood.
(b) Plastic or rubber gloves shall be used at all times while handling mercury or mercury contaminated samples and equipment.
(c) Any mercury spill shall be cleaned up immediately.
(d) When not in use the temperature bath shall be turned off and the mercury in the plastic reservoir bottles shall be capped.

"4.6.5.3.2 Equipment. The system shall be designed to conduct four separate determinations at the same time or multiple sets of four. Any brand of equipment may be used. However, equipment has been found available as follows:

(a) Fisher versa-bath, Fisher Scientific Co.
(b) Polyethylene bottles, Fisher Scientific Co.
(c) Bath oil; any quality, stabilized, nonsmoking.
(d) Eudiometer tubes, calibrated and teflon stopcocked, Adria Scientific Glass, Box 673, Geneva, OH 44041.
(e) High vacuum grease, Dow Corning.
(f) Purified mercury.
(g) Fume hood.

"4.6.5.3.3 Procedure. The procedure for the collection of diffusible hydrogen over mercury shall be conducted under a fume hood and shall be conducted as follows:

(a) With the stopcock closed insert a vacuum line over the tip of the eudiometer tube. (The stopcock should be greased with high vacuum grease.)
(b) Using tongs, remove a first test specimen (see 4.6.5.1(k)) from the low temperature bath and agitate in a cool water bath (not iced) until the ice skin which formed on the specimen has just melted. Immediately withdraw from the water bath and dry with a compressed air blast lasting no longer than 5 seconds.
(c) Using tongs, insert the weld test specimen vertically into the bottle of mercury. (The specimen will float in the mercury.) Slide the eudiometer tube over the specimen and into the mercury. The mercury shall be at room temperature.
(d) Slowly and carefully open the stopcock and allow the mercury to be pulled up and around the test specimen in the eudiometer tube. Close the stopcock when the mercury is about halfway up the calibrated portion of the eudiometer tube and bounce the sample and tube slightly against the bottom of the plastic jar to remove any entrapped air bubbles. Carefully open the stopcock again and allow the mercury to completely fill the tube and just pass through the stopcock opening. Close the stopcock and remove the vacuum line.
(e) Repeat this procedure for second through fourth specimens.
(f) Heat the assemblies (see 4.6.5.3.3(d) and (e)) in the oil bath to 45°C.
(g) After the bath has reached 45°C, hold at 45 ± 3°C for 72 hours (plus 5, minus 0).

(h) Before any readings are taken, bounce the tube to release any entrapped bubbles of hydrogen. Read the hydrogen level to the nearest 0.05 mL. Measure the head of mercury (in mm) present as shown on figure 5.

(i) Release the vacuum by opening the stopcock so that the mercury runs back into the plastic bottle, and remove the specimen from the mercury using tongs.

(j) Rinse the specimen free of any residual mercury with running water while holding over a large beaker to collect any mercury in the rinsings.

(k) Dry the specimen and weigh to the nearest 0.01 gram.

(l) Calculations. The hydrogen content is expressed in terms of mL/g of deposited weld metal.

$$A = \begin{matrix}\text{Volume of } H^2 \text{ gas at standard} \\ \text{temperature and pressure}\end{matrix} = \frac{273}{(273+T)} \frac{(P-H)}{(760)} V_O$$

T = ambient temperature (°C)
P = barometric pressure (mm Hg)
V = measured volume in eudiometer
H = see figure 5

$$H_2 \text{ content } \frac{mL}{g} = \frac{A}{B-C}$$

where A = milliliters of H_2 gas at STP calculated after 72 hours
B = weight (in grams) of test plate plus deposited weld metal
C = weight (in grams) of test plate.

(m) The four values obtained for the hydrogen content and the average value, all rounded to the nearest 0.001 mL/g shall be reported."

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4.6.7: Delete and substitute:

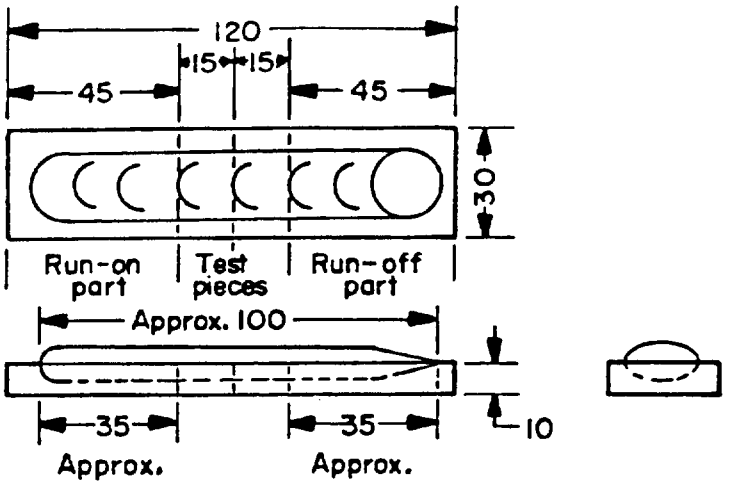
"4.6.7 Unsatisfactory weld metal test results. If the results of the first tests involving weld metal are determined to be unsatisfactory one retest involving twice the number of specimens originally required may be permitted. The results of all tests shall be satisfactory for compliance with the weld metal test requirements. The retest weldments shall be made using electrodes from the same sampling or test lot as those of the initial test. If the retest is conducted to correct welding operator error, only the kind of tests that failed need to be retested but the welding procedure shall be the same as that of the initial test. If the retest is conducted to correct welding procedure error, all of the weld metal tests originally required shall be retested."

PAGE 14

6.2(c): Delete and substitute: "Type, form, size and weight required (see 1.2 and 3.2)."

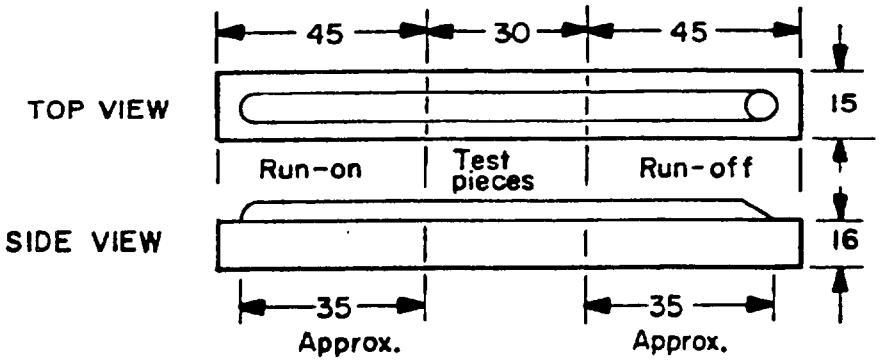
Figure 3 and notes: Delete and substitute figures 3, 4 and 5:

ALL DIMENSIONS IN mm



Test assembly for electrodes larger than 1/16-inch, provides two diffusible hydrogen test specimens.

ALL DIMENSIONS IN mm



Test assembly for electrodes 1/16-inch and smaller, provides one diffusible hydrogen test specimen.

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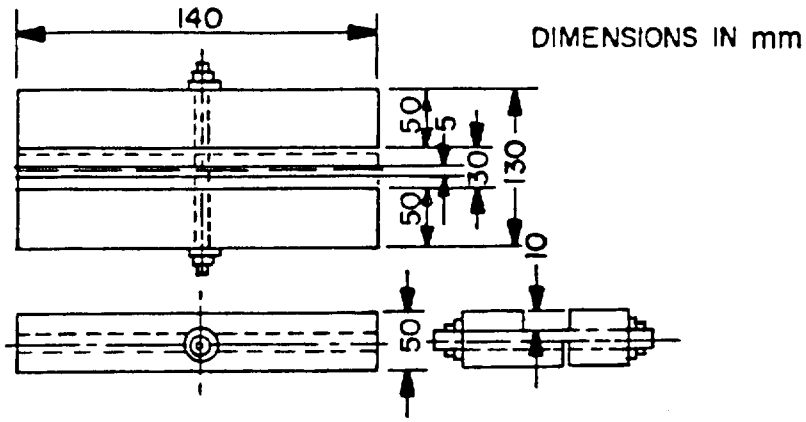
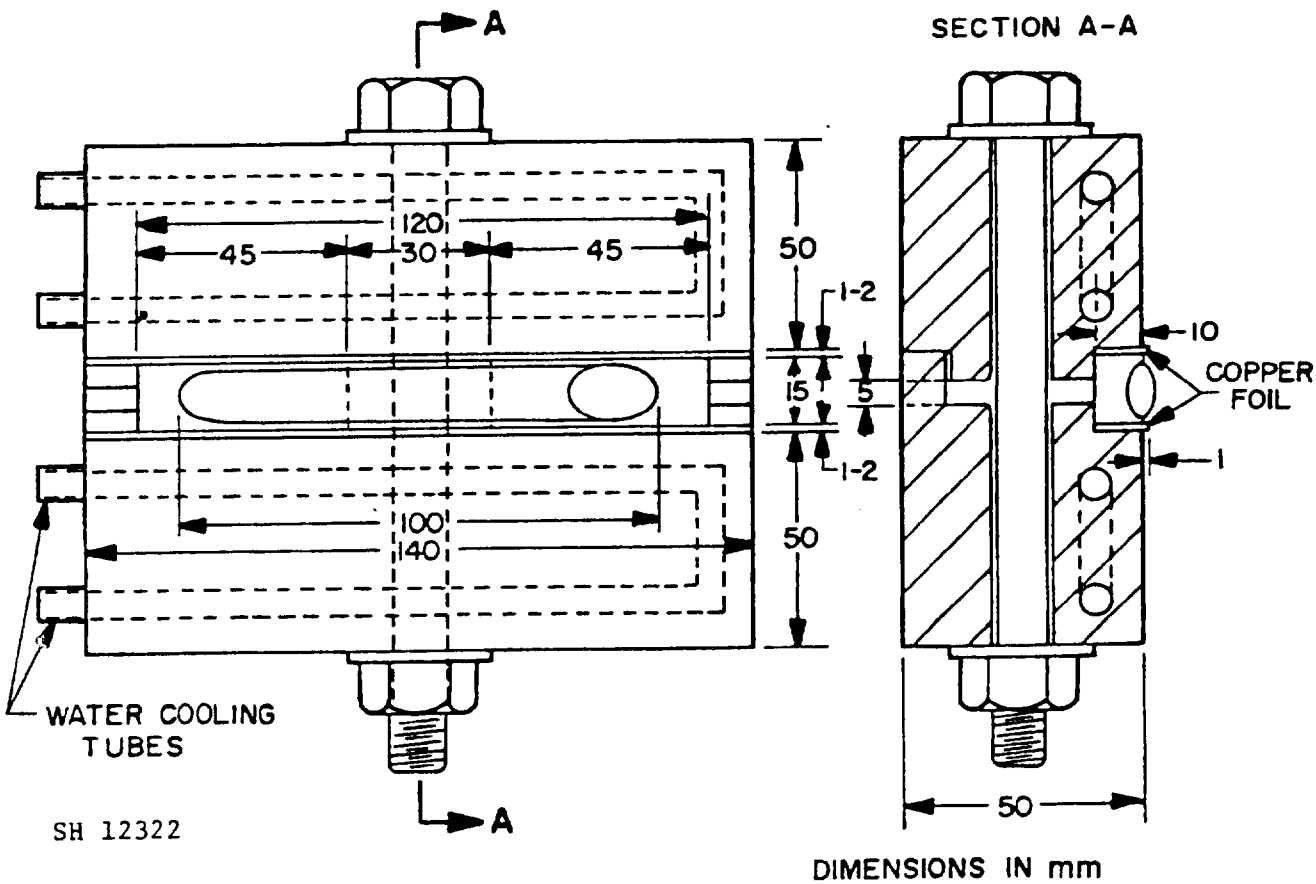
FIGURE 3. Details of stringer bead test assembly for the preparation of diffusible hydrogen test specimens for the gas chromatography method.



Fixture for welding with electrodes larger than 1/16-inch



Fixture for welding with electrodes 1/16-inch and smaller

FIGURE 4. Copper clamps for holding and cooling stringer bead test assembly during welding for the gas chromatography method.

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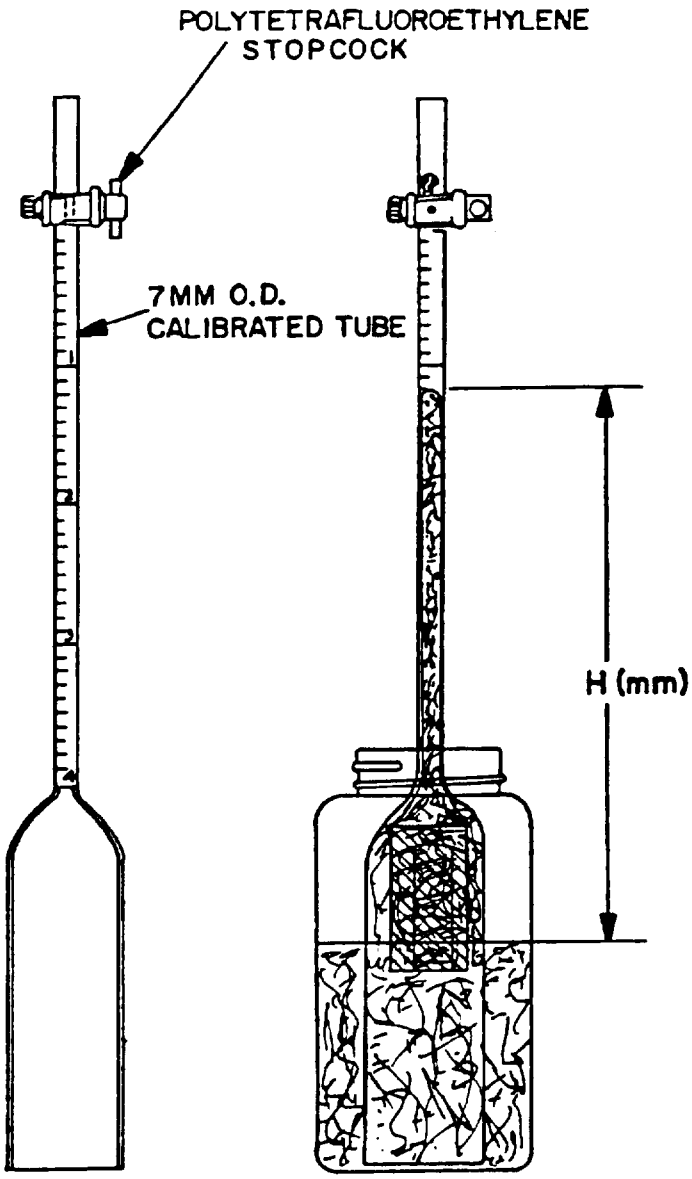

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FIGURE 5. Eudiometer tube and assembly."

LAST PAGE

DD 1426, Standardization Document Improvement Proposal: Delete address and substitute:

"COMMANDER
NAVAL SEA SYSTEMS COMMAND (SEA 55Z3)
DEPARTMENT OF THE NAVY
WASHINGTON, DC 20362"

Preparing activity:
Navy - SH
(Project 3439-N369)