MIL-M-23573B(SH)
31 October 1986
SUPERSEDING
MIL-M-23573A(SH)
26 August 1976
(See 6.6)

MILITARY SPECIFICATION

MONOETHANOLAMINE CHELATING AGENT SOLUTION

This specification is approved for use within the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers chelated-monoethanolamine for use in equipment for the removal of carbon dioxide from the air using a regenerative absorption process.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specification and standards. The following specification and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

SPECIFICATION

FEDERAL

PPP-C-1337 - Containers, Composite; (Steel Drum with Polyethylene Insert).

STANDARDS

FEDERAL

FED-STD-313 - Material Safety Data Sheets Preparation and the Submission of.

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 6810

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-147 - Palletized Unit Loads.

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

2.1.2 Other Government documents. The following other Government documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

DEPARTMENT OF TRANSPORTATION (DOT)

Code of Federal Regulations (CFR)
49 CFR, Parts 170-179 - Hazardous Material Regulations.

DEPARTMENT OF LABOR

Occupational Safety and Health Administration (OSHA)
Code of Federal Regulations (CFR)
29 CFR, Part 1910.1200 - Hazard Communication Standard.

(The Code of Federal Regulations (CFR) and the Federal Register (FR) are for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. When indicated, reprints of certain regulations may be obtained from the Federal agency responsible for issuance thereof.)

(Copies of specifications, standards and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN PUBLIC HEALTH ASSOCIATION (APHA)

Standard Methods for the Examination of Water and Waste Water.

(Application for copies should be addressed to the American Public Health Association, 1015 15th Street, NW, Washington, DC 20005.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 891 - Standard Test Methods for Specific Gravity, Apparent, of Liquid Industrial Chemicals. (DoD adopted)
D 1078 - Standard Test Method for Distillation Range of Volatile Organic Liquids. (DoD adopted)

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

(Nongovernment standards and other publications are normally available from the organizations which prepare or which 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 specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Material. The material shall be a clear, homogeneous solution of monoethanolamine and chelating agent (monosodium salt of N, N-dihydroxyethyl glycine), and contain no antifoam agent or other additive. The solution shall contain approximately 22 parts by weight of monoethanolamine to one part by weight of monosodium salt of N, N-dihydroxyethyl glycine (see 3.2 and 3.3). The mixture shall conform to the requirements specified in table I.

TABLE I. Properties of mixture.

Property	Requirement	Tests
Suspended matter	To pass test	4.4.1
Alkalinity, milliequivalents per gram (meq/g)	14.5 - 15.5	4.4.2
Nitrogen, meq/g	14.0 - 15.0	4.4.3
Iron, p/m, maximum	15	4.4.4
Chelating capacity: Against $Pb(NO_3)_2$, millimoles per gram (mmol/g)	0.16 - 0.19	4.4.5.1
Against $CaCl_2$, mL, maximum	0.5	4.4.5.2
Color, APHA, platinum-cobalt scale, maximum	20	4.4.8
Foamability	To pass test	4.4.9

3.2 Monoethanolamine. The monoethanolamine used in formulating the mixture shall conform to the requirements specified in table II.

TABLE II. Monoethanolamine properties.

Property	Requirement	Tests
Alkalinity, meq/g		4.4.2
minimum	15.9	
maximum	16.4	
Distillation range degrees Celsius (°C)		
Initial boiling point, minimum	165	4.4.6
End point, maximum	174	
Specific gravity, 20°C/20°C	1.017 - 1.021	4.4.7
Color, APHA, platinum-cobalt scale, maximum	20	4.4.8

3.3 Chelating agent. The chelating agent shall be supplied in the form of an aqueous solution containing not less than 40 percent by weight of monosodium salt of N, N-dihydroxyethyl glycine. The solution shall conform to the requirements specified in table III.

TABLE III. Chelating agent properties.

Property	Requirement	Tests
Chelating capacity		
Against $Pb(NO_3)_2$, mmol/g minimum	1.6	4.4.5.1
Against $CaCl_2$, mL maximum	0.5	4.4.5.2

3.4 Material safety data sheet. The contracting activity shall be provided a material safety data sheet (MSDS) at the time of contract award. The MSDS shall be provided in accordance with the requirements of FED-STD-313 and 29 CFR 1910.1200. When FED-STD-313 is at variance with the CFR, 29 CFR 1910.1200 shall take precedence, modify, and supplement FED-STD-313.

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 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection 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 assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.2 Sampling.

4.2.1 Sampling lot. For purposes of sampling, a lot shall consist of all material formulated as one batch and offered for delivery at one time.

4.2.2 Sampling procedure for quality conformance examination. From each lot, a 946-milliliter (mL) (1-quart) sample shall be taken from each of two separate containers selected. Individual samples shall not be mixed. The samples shall be placed in separate airtight and watertight containers, which shall be nearly filled and then covered and sealed to prevent atmospheric effects. The samples shall be labeled with information on the lot and batch number, date of sampling and applicable specifications. In addition, the ingredients used in formulating each lot shall be sampled as follows:

Monoethanolamine - 946 mL (1 quart)

Chelating agent - 237 mL (1/2 pint)

4.2.3 Sampling for examination of filled containers. A random sample of filled containers shall be selected in accordance with MIL-STD-105 at inspection level I and acceptable quality level (AQL) of 2.5 percent defective to verify conformance to all requirements regarding fill, closure, marking, and other requirements not involving tests.

4.3 Inspection.

4.3.1 Examination of containers. Each sample filled container shall be examined for defects of construction of the container and the closure, for evidence of leakage and for unsatisfactory markings. Each filled container shall be weighed to determine the amount of contents. Any container in the sample having one or more defects or under required fill shall be cause for rejection. If the number of defective containers in any sample exceeds the acceptance number for the appropriate sampling plan in accordance with MIL-STD-105, this shall be cause for rejection of the lot represented by the sample.

4.3.2 Quality conformance inspection. The samples selected in accordance with 4.2.2 shall be subjected separately to the tests specified in 4.4. These samples shall be forwarded to the Defense Personnel Support Center, 2800 South

20th Street, Philadelphia, PA 19101. Authority to ship from the contractor shall be withheld pending review of test results by the Naval Sea Systems Command, SEA 05M4, Washington, DC 20362-5101.

4.3.2.1 Action in case of failure. If any one of the samples is found to be not in conformance to this specification, this shall be cause for rejection of the lot which it represents.

4.4 Test procedures.

4.4.1 Suspended matter. Place 100 mL of the solution into a 100-mL tall form Nessler tube. Place 100 mL of distilled water into a second Nessler tube. Compare the contents of the two tubes by viewing vertically down through the tubes against a white background. The mixture shall be as free of suspended matter as the distilled water. (Do not confuse color with suspended matter.)

4.4.2 Alkalinity. Add 50 mL of distilled water to a 250-mL Erlenmeyer flask. Add 5 drops of methyl purple indicator. Neutralize to a grey end point using 0.5 N sulfuric acid. From a weighing bottle (or weighing pipette) add 1 gram of the sample to be tested weighed to the nearest 0.1 milligram (mg). Titrate with standardized 0.5 N sulfuric acid to the same grey end point.

$$\text{Alkalinity (meq/g)} = \frac{\text{(mL acid consumed by sample) (normality of acid)}}{\text{weight of sample, gram}}$$

4.4.3 Nitrogen. The apparatus and reagents used and the method of testing nitrogen shall be as specified in 4.4.3.1 through 4.4.3.3.

4.4.3.1 Apparatus. The apparatus used in testing nitrogen shall be as follows:

(a) Kjeldahl digestion unit.
(b) Kjeldahl distillation unit.
(c) Kjeldahl flask, 500 mL.

4.4.3.2 Reagents. The reagents used in testing nitrogen shall be as follows:

(a) Kjeldahl pack. Kel-Pack Powder No. 4, Matheson Scientific Catalog No. 52495.35, or equal.
(b) Boric acid indicator. Add 43 grams of H_3BO_3 (free from borax), 6 mL of methyl red indicator and 4 mL of methylene blue indicator per liter of freshly distilled water.
(c) Sodium thiosulfate, 8 percent solution (80 grams of $Na_2S_2O_3.5H_2O$ per liter of distilled water).
(d) Sodium hydroxide, approximately 11N solution (450 grams of 98 percent sodium hydroxide pellets dissolved in water to make 1 liter).
(e) Sulfuric acid, 0.1N, standardized.
(f) Zinc powder, 20 mesh.
(g) Sulfuric acid, concentrated.
(h) Glass beads or other anti-bumping agents.
(i) Alizarin yellow indicator.

4.4.3.3 Test procedure. Weigh 0.20-0.25 gram of sample directly into the bottom of a Kjeldahl digestion flask. Add 25 mL of concentrated sulfuric acid and one Kjeldahl pack. Heat on low heat for 1/2 hour, then 1-1/2 hours on high heat. Cool and add 300 mL of distilled water and a few glass beads. If sample is to be left overnight, stop at this point. To distill, use a 500-mL Erlenmey flask containing 100 mL of boric acid indicator solution as a receiver at the end of the Kjeldahl distillation unit. Make sure the end of the delivery tube is below the surface of the boric acid solution. Add 25 mL of sodium thiosulfa solution to the sample in the Kjeldahl flask and allow to react for 8 to 10 minutes. Add a small amount of zinc and alizarin yellow indicator. The soluti is yellow at the proper pH for distillation. Then, carefully add 100 mL of sodium hydroxide solution by pouring slowly down the side of the flask. Assemb with stoppers wetted with water to seal against escaping vapors. Swirl to mix the reagents thoroughly. Connect the distillation unit, heat to boiling and collect 300 mL of the distillate. Titrate with 0.1N sulfuric acid and record as A. Run a blank without sample using all the reagents in the same amounts. Titrate with 0.1N sulfuric acid and record as B.

$$\text{Total nitrogen, meq/g} = \frac{(A-B) \times N}{\text{Weight of sample, grams}}$$

A = No. of mL of 0.1N sulfuric acid for sample.
B = No. of mL of 0.1N sulfuric acid for blank.
N = Normality of sulfuric acid.

4.4.4 Iron. The reagents used and the method of testing iron shall be as specified in 4.4.4.1 through 4.4.4.3.1.

4.4.4.1 Apparatus. One each of the following is required:

(a) Nessler tubes, matched, 100 mL, tall form.
(b) Spectrophotometer, for use at 530 nanometers (nm) providing a light path of 2 centimeters (cm) or longer.
(c) Filter photometer providing a light path of 1 cm or longer, with a green filter having maximum transmittance near 530 nm.

4.4.4.2 Reagents. The reagents used in testing for iron shall be as follows:

(a) Thioglycolic acid, practical grade.
(b) Ammonium hydroxide, A.C.S. grade.
(c) Iron standard (1 mL = 0.1 mg Fe). Dissolve 0.1000 gram pure iron in 10 mL of hydrochloric acid (1 + 1) and dilute to 1 liter with iron-free water.

4.4.4.3 Test procedure. Measure 75 grams of sample into a 100-mL volumetr flask. Add 10 drops of thioglycolic acid and 10 mL of ammonium hydroxide. Dilu to volume with distilled water. Measure the pink color developed in the sample one of the following methods:

(a) For visual comparison, prepare fresh color standards as described in 4.4.4.3.1 and compare the colors in Nessler tubes.

(b) Take photometric measurements with a spectrophotometer or filter photometer and convert the reading to an iron value by means of a calibration curve. The calibration curve shall be prepared by taking readings of a series of standards ranging from 0 to 1.2 mg iron prepared as described in 4.4.4.3.1.

4.4.4.3.1 Comparison standards. To each measured amount of iron standard in a 100-mL volumetric flask add about 60 mL water, 10 drops of thioglycolic acid and 10 mL of ammonium hydroxide. Dilute to volume with distilled water.

$$\text{Iron, p/m} = \frac{\text{iron measured, mg x 1000}}{\text{weight of sample, gram}}$$

4.4.5 Chelating capacity. The reagents used and the method of testing chelating capacity shall be as specified in 4.4.5.1 through 4.4.5.2.1.

4.4.5.1 Reagents. The reagents used in testing chelating capacity against $Pb(NO_3)_2$ shall be as follows:

(a) Lead nitrate solution, 0.1M.
(b) Potassium chromate solution, 10 percent.
(c) Monoethanolamine, ingredient sample.

4.4.5.1.1 Test procedure. The test procedure shall be as follows:

(a) For the formulated solution. Transfer 10 grams of the solution to a 250-mL Erlenmeyer flask. Dilute to 100 mL and add 2 mL of potassium chromate solution. Titrate with 0.1M lead nitrate solution until the solution shows the first trace of turbidity when viewed in bright light. Record this titration as A. Determine a blank by titrating 9 grams of monoethanolamine ingredients as indicated above. (The blank titration will usually be of the order of 1 mL per 9 grams of monoethanolamine.) Record this titration as B. Calculate the active Versene Fe-3 specific content in terms of mmols lead nitrate chelated per gram of sample.

$$\text{Chelating activity, mmols } Pb(NO_3)_2 \text{ per gram} = \frac{(A-B)X \text{ molarity of } Pb(NO_3)_2}{\text{weight of sample, gram}}$$

(b) Chelating agent ingredient. Transfer 10 grams of chelating agent ingredient to a 100-mL volumetric flask. Dilute to volume, transfer a 10-mL aliquot to a 250-mL Erlenmeyer flask, dilute to 100 mL, add 9 grams of monoethanolamine ingredient, 2 mL of K_2CrO_4 solution and proceed with the titration as described above.

$$\text{Chelating activity, mmols } Pb(NO_3)_2 \text{ per gram} = \frac{10\ (A-B)X \text{ molarity of } Pb(NO_3)_2}{\text{weight of original sample, gram}}$$

solution, 10 ml of 1N hydrochloric acid and 10 ml of the starch indicator

4.4.5.2 Reagents. The reagents used in testing chelating capacity against $CaCl_2$ shall be as follows:

(a) Monoethanolamine, pure, or ingredient sample.
(b) Ammonium oxalate solution, saturated.
(c) Calcium chloride solution, 0.1M.

4.4.5.2.1 Test procedure. The test procedure shall be as follows:

(a) For formulated solution. Transfer 10 grams of the mixture to a 250-mL Erlenmeyer flask. Add 100 mL water, and 5 mL saturated ammonium oxalate solution. Titrate with 0.1M calcium chloride to turbidity. If the titration is greater than 0.5 mL, the presence of chelating agents derived from ethylenediaminetetrace tic acid and ethylenediaminetriacetic acid, rather than deriva- tives of glycine, is indicated.
(b) For chelating agent ingredient. Transfer 1 gram of sample to a 250-mL Erlenmeyer flask. Add 100 mL of water, 10 mL monoethan- olamine ingredient, and 5 mL saturated ammonium oxalate solutior Titrate as in (a) above.

4.4.6 Distillation range. Distillation range shall be determined as specified in ASTM D 1078, except that an all glass condenser may be substituted for the metal condenser.

4.4.7 Specific gravity at 20°C/20°C. Specific gravity shall be determinec using a specific gravity balance or pycnometer as specified in ASTM D 891.

4.4.8 Color. The color shall be determined by the method as specified for color in water, platinum-cobalt method, in APHA standard.

4.4.9 Foamability.

4.4.9.1 Apparatus. The apparatus used in testing foamability shall be as follows:

(a) Three 1-liter graduated cylinders, glass.
(b) One calibrated airflow meter, capacity to 1 liter per minute.
(c) One fritted dispersion tube with fused-in fritted disc of medium porosity (10 to 15 micron pore size), 30 millimeter (mm) in diameter, overall length 180 mm.
(d) One stop watch.
(e) Source of clean (dust and oil free) compressed air at about 14-34 kilopascals (kPa) (2-5 pounds per square inch (lb/in^2)), and needle control valve for air flow. Various low pressure tubings and fittings.
(f) Chromic-sulfuric acid cleaning solution.

Hook up equipment as shown on figure 1. Test airflow rate will be 750 cubic centimeters per minute (cm^3/min).

4.4.9.2 Test procedure. Clean the graduated cylinder thoroughly and carefully, using the chromic-sulfuric acid cleaning solution. Pour the solution into a cylinder, shake and swirl vigorously so as to wash all of the inside wall of the cylinder. Allow 15 minutes contact. Rinse five times with water, followed by three rinses using distilled water. Do not use detergents or soap as a cleaning agent. The test requires that the cylinders be exceptionally clean for reliable results.

4.4.9.2.1 Prepare a 4-N solution sample for testing by pouring 50 mL of concentrated MEA chelating agent solution into the 1-liter graduated cylinder. Add 150 mL of distilled water and mix well. Place 200 mL of 4N MEA test solution in each of the three clean graduated cylinders. Place fritted disc into the base of the cylinder at the bottom of the sample solution by inserting the disc into the cylinder until it rests about 6.35 mm (1/4-inch) above the cylinder base. Start the stop watch with the air flow using an air flow rate of 750 cm^3/min. At the end of the 30 seconds, shut off the air and observe the behavior of the resultant foam. Repeat for three cylinders.

4.4.9.2.2 If, at the end of 20 seconds after air shutoff (50 seconds after start of test), all the foam has disappeared from the surface of the 3 MEA test samples, the MEA is considered to be good, and can be accepted for use in Navy CO_2 scrubbers. If any foam remains on the surface of any sample after 20 seconds, this is cause for rejection. The only acceptable departure from the above criterion is the possible existence of a thin ring of small bubbles (up to 1.5 mm in diameter), at the junction of the liquid sample and the vertical cylinder wall.

4.5 Inspection of packaging. Sample packages and packs, and the inspection of the preservation-packaging, 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.)

5.1 Packing. Packing shall be level A, B or C. Monoethanolamine shall be furnished in 5- or 55-gallon single trip containers as specified (see 6.2). The containers shall conform to type II, class 1 for the 5-gallon size and type II, class 4 for the 55-gallon size (see 6.2) in accordance with PPP-C-1337, except that the polyethylene inserts shall not contain any copolymers or additives.

5.1.1 Palletized unit loads. When specified (see 6.2), 5-gallon containers shall be palletized in accordance with MIL-STD-147.

5.2 Marking. In addition to any special marking required herein or by the contract or order (see 6.2), containers and palletized unit loads shall be marked in accordance with MIL-STD-129; CFR 29, part 1910.1200; and CFR 49, parts 170-179.

5.2.1 Special marking. Each container shall be conspicuously marked with the following:

"WARNING. May cause eye injury and skin irritation. Avoid getting in eyes, on skin or clothing. In case of accidental contact, immediately flush eyes or skin with plenty of water for 15 minutes. For eyes, get prompt medical attention. Wash contaminated clothing before reuse."

6. NOTES

6.1 Intended use. Monoethanolamine chelating agent solution is intended for use in scrubbing equipment for the removal of carbon dioxide from the air.

6.2 Ordering data. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.
(b) Size of container required (see 5.1).
(c) Palletization if required (see 5.1.1).
(d) Special marking required (see 5.2).

6.3 The material should be purchased by volume, the unit being the U.S. gallon at 25°C.

6.4 Material safety data sheets. Contracting officers will identify those activities requiring copies of completed material safety data sheets prepared in accordance with FED-STD-313 and 29 CFR, part 1910.1200. The pertinent Government mailing addresses for submission of data are listed in appendix B of FED-STD-313.

6.5 Subject term (key word) listing.

Alkalinity
Ammonium oxalate
Calcium chloride
Chelating agent
Monoethanolamine
Nitrogen

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

Preparing activity:
Navy - SH
(Project 6810-NB53)

oxidizer. All applicable safety rules, regulations and chlorate is a st

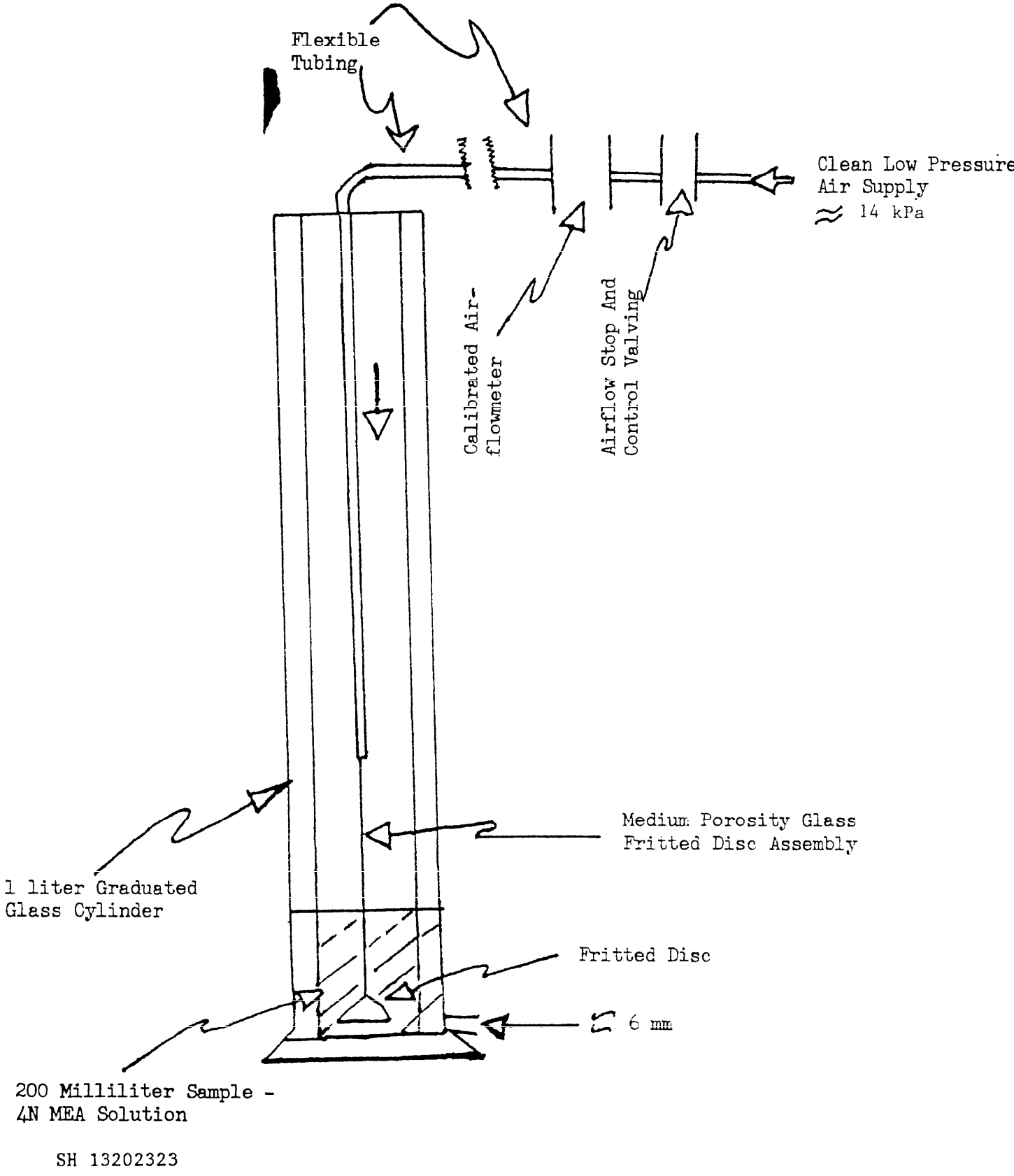

FIGURE 1. 4N MEA foam test.

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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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DEPARTMENT OF THE NAVY

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DEPARTMENT OF THE NAVY
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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-M-23573B(SH)	MONOETHANOLAMINE CHELATING AGENT SOLUTION

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ 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)*

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