

MIL-E-50011B  
15 September 1982  
SUPERSEDING  
MIL-E-50011A  
24 April 1969

## MILITARY SPECIFICATION

ETHANOLAMINES (MONOETHANOLAMINE, DIETHANOLAMINE, AND TRIETHANOLAMINE),

### TECHNICAL

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

#### 1. SCOPE

1.1 Scope. This specification covers monoethanolamine, diethanolamine, and triethanolamine, technical grade.

1.2 Classification. Ethanolamines shall be of the following types, as specified (see 6.2):

Type I - Monoethanolamine (MEA)  
Type II - Diethanolamine (DEA)  
Type III - Triethanolamine (TEA)

#### 2. APPLICABLE DOCUMENTS

##### 2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

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: Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, US Army Armament Research and Development Command, ATTN: DRDAR-TSC-S, Aberdeen Proving Ground, MD 21010 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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FSC 6810

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## SPECIFICATIONS

## FEDERAL

- NN-P-71 - Pallets, Material Handling Wood, Stringer Construction, 2-Way and 4-Way, Partial
- PPP-B-585 - Boxes, Wood, Wirebound
- PPP-B-601 - Boxes, Wood, Cleated-Plywood
- PPP-B-636 - Boxes, Shipping, Fiberboard
- PPP-C-186 - Containers, Packaging and Packing for Drugs, Chemicals and Pharmaceuticals
- PPP-D-729 - Drums, Shipping and Storage, Steel, 55-Gallon (208 Liters)
- PPP-F-320 - Fiberboard; Corrugated and Solid, Sheet Stock (Container Grade), and Cut Shapes
- PPP-P-704 - Pails - Metal: (Shipping, Steel, 1 Through 12 Gallons)

## STANDARDS

## 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

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein.

## CODE OF FEDERAL REGULATIONS (CFR)

- 49 CFR 171 to 179 - Department of Transportation Hazardous Materials Regulations

(The Code of Federal Regulations is available from the Superintendent of Documents, US Government Printing Office, Washington, DC 20402. Orders for the above publication should cite "49 CFR 171 to 179.")

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting 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. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

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## UNIFORM FREIGHT CLASSIFICATION RULES

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

## NATIONAL MOTOR FREIGHT CLASSIFICATION RULES

(Application for copies should be addressed to the American Trucking Associations, Inc., Traffic Department, 1616 P Street, NW, Washington, DC 20036.)

## ASTM STANDARDS

- D86 - Distillation of Petroleum Products
- D1193 - Reagent Water
- D1209 - Color of Clear Liquids (Platinum-Cobalt Scale)
- E203 - Water Using Karl Fischer Reagent

(Application for copies should be addressed to ASTM, 1916 Race Street, Philadelphia, PA 19103.)

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

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

## 3. REQUIREMENTS

3.1 Appearance. Ethanolamines shall be clear, viscous, and free of suspended matter in the liquid state when tested as specified in 4.2.4.1. When in solid form, ethanolamines shall have a white, crystalline appearance, without visual evidence of impurities or discoloration.

3.2 Chemical and physical characteristics. Ethanolamines shall conform to the chemical and physical characteristics of table I when tested as specified therein.

## 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.

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TABLE I. Chemical and physical characteristics

Characteristic	MEA	DEA	TEA	Test paragraph
Specific gravity at 20°/20°C	1.017 to 1.021	*1.090 to 1.095	1.124 to 1.129	4.2.4.2
Percent by volume distilled between 165°C and 175°C	90 minimum			4.2.4.3
Color, (Pt - Co scale)	20 maximum	40 maximum	100 maximum	4.2.4.4
Water content, percent by weight	1.0 maximum	1.0 maximum	1.0 maximum	4.2.4.5
MEA content, percent by weight	98 minimum	1.0 maximum	1.0 maximum	4.2.4.6
DEA content, percent by weight	1.5 maximum	98 minimum	1.5 maximum	4.2.4.6
TEA content, percent by weight	1.0 maximum	1.5 maximum	98 minimum	4.2.4.6
*Specific gravity at 30°/20°C				

#### 4.2 Quality conformance inspection.

4.2.1 Lotting. A lot shall consist of the ethanolamine of one type, produced by one manufacturer, at one plant, from the same materials, and under essentially the same manufacturing conditions provided the operation is continuous. In the event the process is a batch operation, each batch shall constitute a lot (see 6.3).

#### 4.2.2 Sampling.

4.2.2.1 For examination of packaging. Sampling shall be conducted in accordance with MIL-STD-105.

4.2.2.2 For ethanolamine test (see 6.4). Sampling shall be conducted in accordance with table II. A representative specimen of approximately 1 liter shall be removed from each sample container and placed in a suitable clean, dry container labeled to identify the lot and container from which it was taken.

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TABLE II. Sampling for test

: Number of containers in batch or lot :	Number of sample containers :
: 3 to 150 :	: 3 :
: 151 to 1,200 :	: 5 :
: 1,201 to 7,000 :	: 8 :
: 7,001 to 20,000 :	: 10 :
: Over 20,000 :	: 20 :

4.2.2.3 For container leakage test. Sampling shall be conducted in accordance with MIL-STD-105.

4.2.3 Inspection procedure.

4.2.3.1 For examination of packaging. The sample unit shall be one filled unit or shipping container, as applicable, ready for shipment. Sample unit and shipping containers shall be examined for the following defects using an AQL of 2.5 percent defective:

- (a) Contents per container not as specified
- (b) Container not as specified
- (c) Container closure not as specified
- (d) Container damaged or leaking
- (e) Marking incorrect, missing, or illegible
- (f) Polyethylene insert missing or not as specified
- (g) Paint missing or not as specified (when required)
- (h) Baked-on enamel missing or not as specified (when required)
- (i) Paperboard collars missing (when required)
- (j) Fiberboard pads and partitions missing or not as specified (when required)
- (k) Box liner missing (when required)

4.2.3.2 For ethanalamine test (see 6.4). Each sample specimen taken in 4.2.2.2 shall be tested as specified in 4.2.4. Failure of any test by any specimen shall be cause for rejection of the lot represented.

4.2.3.3 For container leakage test. The sample unit shall be one container. The sample containers selected in 4.2.2.3 shall be tested as specified in 4.2.5 using an AQL of 1.5 percent defective.

4.2.4 Tests (see 6.4). Water in accordance with ASTM D1193 and reagent grade chemicals shall be used throughout the tests. Where applicable, blank determinations shall be run and corrections applied where significant. Tests shall be conducted as follows:

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4.2.4.1 Appearance. Thoroughly mix the specimen and transfer 25 milliliters (ml) into a 50-ml test tube. Stopper the test tube and allow it to stand until bubbles have disappeared completely. Examine by transmitted-light for uniformity and for freedom from particles and foreign matter.

4.2.4.2 Specific gravity. Measure the specific gravity of types I and III ethanolamine specimens at 20°/20°C, and type II ethanolamine specimen at 30°/20°C, with a specific gravity balance (chainomatic) adjusted to give a 1.000 value for the specific gravity of water at 20°C.

4.2.4.3 Percent by volume distilled between 165°C and 175°C. Determine the percent by volume distilled of the specimen between 165°C and 175°C in accordance with ASTM D86.

4.2.4.4 Color. Determine the color of the specimen in accordance with ASTM D1209.

4.2.4.5 Water content. Determine the water content of the specimen in accordance with ASTM E203.

4.2.4.6 MEA, DEA, and TEA content.

(a) Apparatus. Use a gas chromatograph with thermal conductivity detector, temperature programmer, glass lined injection port and 1-millivolt recorder.

(b) Chromatographic conditions. Recommended conditions for a Varian Model 3700 gas chromatograph are shown in table III. Other equivalent instrumentation may be used but may require modification of conditions in order to obtain good peak shape, adequate resolution, and appropriate retention times.

(c) Standard solution. Use MEA, DEA, and TEA of no less than 99 percent by weight purity in preparing the standard solution. Prepare the standard solution by thoroughly mixing equal amounts by weight of the three amines. Pass the standard solution through the column repeatedly, in 2-microliter quantities to assure accurate operation of the apparatus. Repeat the 2-microliter injections until the peak areas for MEA, DEA, and TEA duplicate within 2 percent. Measure the peak areas and calculate the average MEA, DEA, and TEA peak areas. Approximate elution times are 8, 11, and 13 minutes for MEA, DEA, and TEA, respectively.

(d) Procedure. Inject 2 microliters of the specimen into the chromatograph. Repeat 2 microliter injections until the peak areas for the MEA, DEA, and TEA duplicate within 2 percent. Calculate the average peak areas for MEA, DEA, and TEA.

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TABLE III. Chromatographic conditions

Characteristic	Condition
Column material	Nickel tubing (0.015-inch wall)
Column dimensions	5 feet (1/8-inch OD)
Column support	1.4 g of 60/80 mesh "TENAX GC"
Column temperature	180° to 260°C at 25°C/min hold for 10 min*
Injection temperature	290°C
Detector temperature	290°C
Detector current	150 ma
Filament temperature	300°C
Range mv	0.5
Carrier gas	Helium
Carrier gas flow rate, cc per min	24

\*Periodically increase the column temperature to 300°C for 15 minutes.

(e) Calculations. Calculate the percent by weight of MEA, DEA, and TEA as follows:

$$\text{Percent by weight MEA} = \frac{33.3A}{S}$$

where: A = Average MEA peak area for specimen and  
S = Average MEA peak area for standard.

$$\text{Percent by weight DEA} = \frac{33.3B}{T}$$

where: B = Average DEA peak area for specimen and  
T = Average DEA peak area for standard.

$$\text{Percent by weight TEA} = \frac{33.3C}{U}$$

where: C = Average TEA peak area for specimen and  
U = Average TEA peak area for standard.

4.2.5 Container leakage test. Place the container in each of the following positions, and leave it in each for a period of 15 minutes:

- (a) Upright
- (b) Upside down
- (c) On one side (or one quadrant)
- (d) On one end (or second quadrant)
- (e) On other side (or fourth quadrant)

Examine the container after each period for any evidence of leakage.

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## 5. PACKAGING

5.1 Unit packing. The ethanolamine shall be unit packed level A, B or C as specified (see 6.2).

5.1.1 Level A. Ethanolamine shall be unit packed level A in a 1, 5, or 55-gallon (gal) quantity as specified (see 6.2).

5.1.1.1 One-gal quantity. A 1-gal quantity [ $+1\frac{1}{2}$  or  $-0$  fluid ounces (oz)] of ethanolamine shall be unit packed in a nominal 1-gal capacity clean, dry plastic bottle. The bottle shall conform to group A, class 2, style 1, grade optional, closure A or B with outer seal A of PPP-C-186. The bottle shall be torqued closed and sealed in accordance with the bottle manufacturer's instructions. There shall be no evidence of leakage from the bottle when tested as specified in 4.2.5. Each bottle shall be placed in a close fitting box conforming to grade W5c of PPP-B-636. A cylindrical paperboard collar shall be inserted over the neck of the bottle to prevent any contact of the closure of the bottle with the under side of the closed box flaps. The box shall be closed as specified in PPP-B-636.

5.1.1.2 Five-gal quantity. A 5-gal quantity ( $+6$  or  $-0$  fluid ounces) of ethanolamine shall be unit packed in a nominal 5-gal capacity composite steel pail consisting of a Department of Transportation (DOT) specification 6D pail with polyethylene insert conforming to DOT specification 2S, 2SL, or 2U. The exterior of the pail shall be painted as specified for the pails of PPP-P-704. The containers shall be closed in accordance with the pail manufacturer's instructions. There shall be no evidence of leakage from the filled pail when tested as specified in 4.2.5.

5.1.1.3 Fifty-five gal quantity. A quantity of 55-gal ( $+1\frac{1}{2}$  or  $-0$  gal) of ethanolamine shall be unit packed in a nominal 55-gal capacity tin-plated steel drum or composite steel drum with polyethylene insert at the option of the contractor. The tin-plated steel drum shall conform to DOT specification 5A, 5B or 17C, and the composite drum shall consist of a DOT specification 6D steel drum with DOT specification 2S, 2SL or 2U polyethylene insert. Each container shall be closed in accordance with the container manufacturer's instructions. The exterior surfaces of the steel drum shall be prepared and painted as specified for the drums of PPP-D-729. There shall be no evidence of leakage of the filled drum when tested as specified in 4.2.5.

5.1.2 Level B. Ethanolamine shall be unit packed level B in a 1-gal, 5-gal or 55-gal quantity as specified (see 6.2).

5.1.2.1 One-gal quantity. A 1-gal quantity of ethanolamine shall be unit packed level B in the same manner as specified for level A in 5.1.1.1 except that the fiberboard box package shall not be required.



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5.1.2.2 Five-gal quantity. A 5-gal quantity of ethanolamine shall be unit packed level B in the same manner as specified for level A protection, except that the container shall conform to DOT specification 34 for a nominal capacity of 5-gallons.

5.1.2.3 Fifty-five gal quantity. A 55-gal quantity of ethanolamine shall be unit packed level B in the same manner as specified for level A protection, except that the exterior surfaces of the steel drum shall not require preparation and painting as specified in PPP-D-729. These surfaces shall be protected by baked-on-enamel of a quality generally furnished by the steel drum industry.

5.1.3 Level C. A specified quantity of ethanolamine (see 6.2), shall be unit packed in a manner to assure retention of original purity and quantity of contents, and integrity of container, from supply source to destination. Containers shall be acceptable by common carriers, and shall comply with Uniform Freight Classification Rules, National Motor Freight Classification Rules, and DOT regulations.

5.2 Packing. The 1-gal quantity of ethanolamine specified in 5.1 shall be packed level A or B as specified (see 6.2). Ethanolamine, unit packed as specified in 5.1 in other than a 1-gal quantity shall require no further protection for shipment aside from unitization.

5.2.1 Level A, 1-gal quantity. Four 1-gal bottles of ethanolamine of 5.1.1.1 shall be packed level A in a close-fitting box conforming to class 3, style 1 or 2 of PPP-B-585, overseas type, style A, B or I of PPP-B-601. Motion of contents shall be prevented by insertion of fiberboard pads. Fiberboard shall conform to grade V3c of PPP-F-320. The box shall be closed as specified in the appendix to the box specification.

5.2.2 Level B, 1-gal quantity. Four 1-gal bottles of ethanolamine shall be packed in a close-fitting fiberboard box conforming to grade V3c or V2s of PPP-B-636. Bottles, except those overpacked as specified in 5.1.1.1, shall be inserted in close-fitting cells formed from full bottle height, half-slotted fiberboard partitions. Also, they shall be further protected by full box face sized inner linings on all inside faces of the box sides, ends, top and bottom. Each bottle shall have a cylindrical collar, formed from paperboard, fitted over the neck. The collar shall be designed to prevent contact of the closure of the bottle with the underside of the closed box flap. Motion of contents in the box shall be prevented by the addition of extra fiberboard pads, as needed. Partitions and pads shall be formed from fiberboard conforming to grade W5c or V3c of PPP-F-320. The box shall be closed as specified in PPP-B-636.

5.3 Unitization. A uniform quantity of packs of 1-gal bottles of ethanolamine shall be unitized by palletization in accordance with load type 1 or 1a, as applicable, of MIL-STD-147. Bonding by means of strapping shall be used. Five-gal pails of ethanolamine shall be unitized in accordance with MIL-STD-147, using load type III, arranged in two tiers of pails per pallet. The pallet shall conform to NN-P-71, type IV.

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5.4. Marking. Containers and unitized loads shall be marked and labeled in accordance with MIL-STD-129 and DOT regulations, and shall show the lot or batch number and date of manufacture of the ethanolamine. In addition, containers shall be marked with the following precautionary marking:

:	:
:	:
:	(Name of material)
:	:
:	:
:	WARNING! CAUSES IRRITATION
:	COMBUSTIBLE
:	CORROSIVE*
:	:
:	Avoid contact with liquid.
:	Wear goggles, amine vapor mask, and rubber
:	overclothing (including butyl rubber gloves)
:	when handling.
:	Wash thoroughly after handling.
:	In case of contact, flush skin or eyes with
:	plenty of water for at least 15 minutes and
:	get medical attention immediately.
:	If swallowed, have victim (if conscious) drink
:	water or milk.
:	Keep away from heat and open flame.
:	Do not store with oxidizing materials.
:	Extinguish fire** with dry chemical, alcohol
:	foam, or carbon dioxide. In fire conditions
:	wear self-contained breathing apparatus.
:	Isolate and remove spilled material.
:	:

\* Monoethanolamine is classified as a corrosive material by DOT.

\*\* Triethanolamine may produce poisonous gases in a fire.

## 6. NOTES

6.1 Intended use. Monoethanolamine is intended for use as a decontaminant for riot control agent CS. It may also be used to decontaminate the equipment for dispersing chemical agent CS1. Monoethanolamine and diethanolamine are intended for the removal of carbon dioxide from air, other gases, and liquids by absorption. Triethanolamine is intended for use when an organic base is required, as in maintaining alkalinity of water solutions to prevent corrosion in such equipment as boilers, pipes, and radiators.

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6.2 Ordering data. Acquisition documents should specify the following:

- (a) Title, number, and date of this specification
- (b) Type of material required (see 1.2)
- (c) Level of unit packing required (see 5.1)
- (d) Unit quantity of ethanolamine required (see 5.1.1, 5.1.2, and 5.1.3)
- (d) Level of packing (1-gal quantity) required (see 5.2).

6.3 Batch. A batch is defined as that quantity of material which has been manufactured by some unit chemical process or subjected to some physical mixing operation intended to make the final product substantially uniform.

6.4 Sampling and testing precautions. This specification covers inspection of chemical material which is potentially hazardous to personnel. All applicable safety rules, regulations, and procedures must be followed in the handling and processing of this material. Personnel involved in sampling and testing ethanolamines on a regular basis should receive preplacement and periodic medical surveillance, with emphasis on the skin and the pulmonary, hepatic, and renal systems.

6.5 Waste disposal instructions. Recommended waste disposal instructions for liquid ethanolamines may be found in the US Army Environmental Hygiene Agency Technical Guide 126, May 1982.

Custodians:

Army - EA  
Air Force - 68

Review activities:

Army - MD, ME  
DLA - GS

User activities:

Army - MI  
Navy - AS, OS  
DLA - CT

Preparing activity:

Army - EA

Project No. 6810-0877

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NAME OF ORGANIZATION AND ADDRESS OF SUBMITTER

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