

MIL-STD-1201B
9 JUNE 1987
SUPERSEDING
MIL-STD-1201A
16 JUNE 1967

MILITARY STANDARD

ETHYL ALCOHOL (ETHANOL), TECHNICAL AND DENATURED GRADES



AMSC N/A

FSC 6810

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MIL-STD-1201B

DEPARTMENT OF DEFENSE
Washington, DC 20301

Ethyl Alcohol (Ethanol), Technical and Denatured Grades

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1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.
2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, U.S. Army Chemical Research, Development and Engineering Center, Attn: SMCCR-SPD-TS, Aberdeen Proving Ground, MD 21010-5423, 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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FOREWORD

This standard is approved for use by all Departments and Agencies of the Department of Defense in the selection of items for application. It is intended to prevent the entry of unnecessary items (sizes, types, varieties) into the Department of Defense logistics system. This document is not intended to restrict any service in selecting new items resulting from state-of-the-art changes.

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1. SCOPE

1.1 Purpose. The purpose of this standard is to present the nomenclature, formulas, physical and chemical properties and requirements, military and commercial uses, packaging and labeling information, safety information, storage information and disposal instruction for ethyl alcohol, technical and denatured grades. This standard does not necessarily include all of the items represented by the title, or all those items which are commercially available. It does contain items preferred for use in the selection of ethyl alcohol, technical and denatured grades, for application by the Department of Defense.

1.2 Application. Ethyl alcohol, technical and denatured grades, are mainly used as processing solvents, chemical reaction media, and as chemical intermediates in the manufacture of other chemical compounds and explosives. Other applications include the formulation of various products such as cleaning compounds, antifreeze solutions, and fuels.

1.3 Classification. The items in this standard are classified on the basis of chemical composition as ethyl alcohol, technical and denatured grades.

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2. REFERENCED 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 standard to the extent specified herein.

SPECIFICATIONS

FEDERAL

- O-E-760 - Ethyl Alcohol (Ethanol); Denatured Alcohol; Proprietary Solvents and Special Industrial Solvents.
 PPP-C-2020 - Chemicals, Liquid, Dry and Paste, Packaging of

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- MIL-E-463 - Ethyl Alcohol for Ordnance Use
 MIL-E-51454 - Ethyl Alcohol (Ethanol)

STANDARDS

FEDERAL

- FED-STD-313 - Material Safety Data Sheets, Preparation And The Submission Of

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

- DOD 4145.19-R-1 - Storage And Materials Handling
 DOD 4160.21-M - Defense Utilization And Defense Manual
 DOD 6050.5 - DOD Hazardous Materials Information System, Hazardous Item Listing
 TB MED 502 - Occupational And Environmental Health Respiratory
 (DLAM 1000.2) Protection Program
 TB MED 506 - Occupational And Environmental Health Occupational Vision
 TM 38-250 - Packaging, Materials Handling - Preparation Of Hazardous Materials For Military Air Shipment

CODE OF FEDERAL REGULATIONS (CFR)

- Title 27 - Department of the Treasury, Bureau of Alcohol, Tobacco and Firearms; Regulations Relating to the Formulas, Distribution and Use of Denatured Alcohol.
 Title 29 - Department Of Labor, Occupational Safety And Health Agency; General Industry Standards And Interpretations
 Title 40 - Environmental Protection Agency; Hazardous Waste And Consolidated Permit Regulations

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Title 49 - Department Of Transportation; Hazardous Materials Regulations

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

Registry of Toxic Effects of Chemical Substances
Recommendation for Environmental Exposure Limits

(Copies of specifications, standards, handbooks, drawings, and publications required by contractors 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 document(s) form a part of this standard 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 DODISS specified in the solicitation. The issues of documents which have not been adopted shall be those in effect on the date of the cited DODISS.

AMERICAN CONFERENCE OF GOVERNMENT INDUSTRIAL HYGIENISTS (ACGIH)

TLVs Threshold Limit Values for Chemical Substances in the Work Environment Adopted by American Conference of Government Industrial Hygienists (ACGIH) with Intended Changes.

(Application for copies should be addressed to American Conference of Governmental Industrial Hygienists, 6500 Glenway Avenue, Bldg D-7, Cincinnati, OH 45211.)

ASTM

ASTM D 1209 - Test Method for Color of Clear Liquids (Platinum-Cobalt Scale)

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

National Fire Codes

(Application for copies should be addressed to National Fire Protection Association, Battery March Park, Quincy, MA 02269.)

U.S.I. CHEMICALS (USI)

Ethyl Alcohol Handbook

(Application for copies should be addressed to National Distillers and Chemical Corporation, 99 Park Avenue, New York, NY 10016.)

(Nongovernment standards are generally available for reference from libraries. They are also distributed among nongovernment standards bodies and using Federal agencies.)

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

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3. DEFINITIONS

3.1 Alcohol proof - A legal term expressing the ethyl alcohol content of an ethyl alcohol-water solution as twice the percentage by volume of ethyl alcohol at 60°F (15.56°C).

3.2 Apparent proof - A legal term that is applied to denatured alcohol. It is equivalent to the proof of an alcohol-water solution having the same specific gravity at 60°/60°F (15.56°/15.56°C) as the denatured alcohol. The apparent proof, therefore, is not necessarily the true alcohol proof of the denatured alcohol solution.

3.3 Bitrex - Denatonium benzoate.

3.4 Denatonium benzoate - Benzyl-diethyl [(2,6-xylyl-carbamoyl) methyl] ammonium benzoate.

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4. GENERAL REQUIREMENTS

4.1 Packaging data and labeling. All chemicals included in this standard shall be packaged in accordance with Federal Specification PPP-C-2020 and all applicable documents referenced therein. Shipping containers shall be labeled in accordance with current Department of Transportation (DOT) Hazardous Materials Regulations applicable to each chemical when shipping by military aircraft the requirements of TM 38-250 shall apply. In addition, each item shall be packaged and labeled as specified in the applicable contract or order. All labels shall also comply with Hazard Communication Standard, 29 CFR 1910.1200 (f).

4.2 Hazardous materials information. DOD 6050.5, DOD Hazardous Materials Information System (HMIS) acquires, reviews, stores, and disseminates Material Safety Data Sheet (MSDS) information for all hazardous materials used by DOD. The contractual acquisition of a MSDS is accomplished through use of Federal Acquisition Regulation, paragraph 52.223-3, Hazardous Material Identification and Material Safety Data. The MSDS is prepared in accordance with the instructions in FED-STD-313; and shall comply with requirements of Hazard Communication Standard, 29 CFR 1910.1200 (g).

4.3 Safety.

4.3.1 Personal protective measures. The necessary respiratory, eye and skin protection to be used when handling chemicals shall be prescribed by the responsible installation industrial hygiene, medical and safety authorities.

4.3.1.1 Respiratory protection. Respirators, approved by the National Institute for Occupational Safety and Health (NIOSH) or the Mine Safety and Health Administration (MSHA) or by particular respiratory schedules of the Bureau of Mines (BM) for the compounds being used, may be employed for intermittent exposure or for supplementing other control measures (refer to TB MED 502 or DLAM 1000.2). Ventilation shall be adequate to remove hazardous concentrations.

4.3.1.2 Skin protection. Personnel using these compounds shall be provided with and required to use impervious gloves, sleeves, aprons, and boots whenever indicated. Protective creams and ointments commonly known as "barrier creams" may be of value in certain cases. However, barrier creams shall not be used to replace protective clothing. In case of contact with the skin, wash affected areas thoroughly with water. Eye lavages and emergency showers shall be located where there is a potential for direct contact with harmful chemicals.

4.3.1.3 Face and eye protection. Personnel using these compounds shall be provided with and required to wear chemical splash-proof safety goggles. In addition, face shields shall be provided and worn over the goggles if splashing could occur. In case of contact with the eyes, immediately irrigate with copious amounts of water for at least 20-30 minutes, and obtain medical attention. (Refer to TB MED 506.)

4.3.1.4 Training. Employers shall provide employees with training and information including MSDSs on all chemical items in their work area, in accordance with 29 CFR 1910.1200 (h), to ensure that employees know potential hazards of the chemicals with which they come in contact and the symptoms of exposure as well as how these chemicals affect the body and bodily functions. Employees shall be adequately trained to render first aid.

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4.3.1.5 Exercises. Participation in exercises shall be stressed to demonstrate skills in the use of personal protective equipment and emergency response equipment.

4.3.2 Storage conditions. DOD 4145.19-R-1 describes general storage practices and requirements for hazardous materials in the DOD supply system. Specific requirements provided in the following paragraphs are supplementary in nature and shall be observed in consonance with the DOD storage regulations.

4.3.2.1 Flammable, combustible, pyrophoric and ignitable materials. A flammable material is generally any solid, liquid, vapor or gas that ignites easily and burns rapidly. Combustible materials are generally those that are difficult to ignite and burn slowly. The DOT, in Part 173, Subpart D, Section 173.115 of 49 CFR, defines a flammable liquid as one having a closed cup flash point below 100°F (37.8°C). A combustible liquid is defined, by DOT in the above reference, as one having a closed cup flash point at or above 100°F and below 200°F (93.3°C). A pyrophoric liquid is defined, by DOT in the above reference, as one that ignites spontaneously in dry or moist air at or below 130°F (54.5°C). Materials with flash points of 200°F or higher are not considered to be nonflammable or noncombustible, but are to be considered as burnable. The Environmental Protection Agency (EPA), in Part 261, Subpart C, Section 261.21 of 40 CFR*, designates the criteria for flammable and combustible materials and oxidizers that exhibit the characteristic of ignitability (I). Liquids with closed cup flash points of less than 140°F (60°C) are defined by EPA as ignitable. The autoignition point (temperature) of a substance is generally defined as the minimum temperature required to initiate or cause self-sustained combustion in the absence of a spark or flame. Materials that ignite easily under normal industrial conditions are considered to be dangerous fire hazards. Such materials shall be stored in a manner to prevent ignition and combustion. Easily ignitable substances, such as reducing agents, shall be kept away from strong oxidizing agents. All containers shall be tightly sealed. It is important to provide adequate ventilation in storage areas, and to locate the storage areas of these items away from fire hazards. Ample fire-control equipment shall be easily accessible. Storage buildings, rooms and cabinets shall comply with provisions of the National Fire Codes. The building shall be electrically grounded and signs posted to prevent the lighting of matches or smoking in the area. Flammable storage areas shall be equipped with smoke or fire detection equipment.

4.3.2.2 Water-sensitive fire and explosive hazardous materials. These are materials that react on contact with water or steam to ignite or evolve heat or explosive gases. Such materials exhibit the characteristic of reactivity (R) as designated by the EPA in Section 261.23 of the above reference.* These materials shall be stored in well-ventilated, cool, dry areas. All containers shall be tightly sealed. These materials are a fire hazard in contact with water or moisture; therefore, it is essential that no sprinkler be used. Otherwise, the building shall conform to that required for storage of flammable materials. The building shall be waterproof, located on high ground, and separated from other storage areas.

4.3.2.3 Incompatible materials. Materials that are chemically incompatible shall be segregated in the storage of both serviceable and unserviceable items.

*Refers only to materials that have become waste materials.

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The degree of segregation will depend upon DOD 4145.19-R-1 and local supplementary requirements that insure safe storage conditions. Hazardous storage compatibility codes are provided in the HMIS referred to in 4.2.

4.3.3 Chemical hazardous exposure limits. Chemical hazardous exposure limits for airborne concentrations of substances are obtained from the current TLVs® Threshold Limit Values for Chemical Substances in the Work Environment, adopted by the American Conference of Government Industrial Hygienists (ACGIH) current Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL), 29 CFR, Section 1910.1000; and NIOSH Recommendation for Environmental Exposure Limits. Such information is also shown in MSDSs and the HMIS referred to in 4.2. Carcinogenic substances are listed by OSHA in Category I for confirmed carcinogens, and in Category II for suspected carcinogens. Category I substances have standard exposure limits set at the lowest possible levels. Category II substances have standard exposure limits set to prevent acute or chronic effects.

4.3.4 Toxicity. Toxicity information for chemical compounds is available from various publications and from MSDSs, which are collected in DOD 6050.5 Hazardous Materials Information System.

4.3.4.1 EPA Toxic (T). Some chemical compounds have been designated by the EPA as toxic (T) in accordance with the criteria shown in Part 261, Subpart B, Section 261.11(a)(3) of 40 CFR.* Some commercial chemical products are listed as toxic under Subpart D, Section 261.33(f).

4.3.4.2 EPA Acute Hazardous Toxicity (H). Some chemical compounds have been designated by the EPA as acute hazardous (H) in toxicity in accordance with the criteria shown in Subpart B, Section 261.11(a)(2) of the above reference.* Some commercial chemical products are listed as acute hazardous in toxicity under Subpart D, Section 261.33(e).

4.3.4.3 Hazardous toxic constituents. A list of chemical compounds and substances, shown to have toxic effects on humans or other life forms, is contained in Appendix VIII to 40 CFR Part 261; and the Registry of Toxic Effects of Chemical Substances.

4.4 Pollution and disposal.

4.4.1 Pollution potential. All items described in this standard shall be assumed to have a pollution potential. However, to minimize this potential, the proper use, storage and disposal methods shall be strictly followed.

4.4.2 Disposal of excess or unserviceable material. To minimize disposal problems, it is recommended that no more than a one year's supply of each item listed in this standard be stocked. When stocks have been declared excess or unserviceable, they will be disposed of in accordance with the Defense Utilization and Disposal Manual, DOD 4160.21-M, and applicable DOD Policy Memoranda. Guidance can be obtained from your servicing Defense Reutilization and Marketing Office (DRMO) on procedures required for proper reporting and turn-in.

*Refers only to materials that have become waste materials.

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4.4.3 Disposal and storage of hazardous wastes. Items are classified and managed as hazardous wastes as defined by the Resource Conservation and Recovery Act (RCRA) (Public Law 94-580). Items have been identified as meeting the characteristics (i.e., ignitable, corrosive, reactive or EP toxic) or are listed (i.e., toxic or acute hazardous) according to Identification and Listing of Hazardous Waste, Part 261; 40 CFR; or have been determined to be hazardous wastes by declaration of the Defense Reutilization and Marketing Service (DRMS) in accordance with procedures set forth in DOD 4160.21-M. Disposal of such items shall be managed in accordance with the Installation Environmental Office, the DRMO, or the Safety and Health Office to insure proper reporting of disposal and treatment actions to the US EPA and State; and shall be managed in accordance with Federal, State and local laws. The three main disposal methods are turn-in to the DRMO, on-post disposal by installation personnel, or disposal by commercial contract. Hazardous wastes that cannot be used, or disposed of as stated in 4.4.3.2, shall be stored under environmentally safe conditions until suitable methods of disposal are determined. Short-term storage (less than 90 days) requires proper containment (i.e., packaging and facilities) in accordance with Section 262.34, Part 262 of the above reference. Long-term storage (greater than 90 days) requires permitting by the EPA or by the state under Public Law 94-580 (RCRA), in compliance with the requirements of 40 CFR Parts 264 and 265. Physical custody will be accomplished by the activity with conforming storage or most nearly conforming storage. When physical custody is in question, the Post Commander will make the final decision. In all cases where the wastes are to be collected, stored, transported and disposed of at a state or local permitted disposal facility, the identity and description of the waste shall be maintained and recorded in accordance with Part 262 of the above reference. Transportation of the waste shall be in accordance with Part 263 of the above reference, Standards Applicable to Transporters of Hazardous Waste.

4.4.3.1 Cleanup of liquid spills. To control the migration of spilled or leaking liquids, dike around the item with an inert, dry absorbent (e.g., clay, sawdust or vermiculite) or follow installations spill plans (Spill Prevention Control and Countermeasure Plan and Installations Spill Contingency Plan). Control entry to the spill site and segregate salvageable materials away from the spill area. Initiate waste cleanup operations immediately in accordance with local procedures. The residue shall be safely handled and transported to an approved or permitted disposal or storage facility. Packaging, labeling, transportation and record-keeping requirements for this waste material are determined by the appropriate Federal and State agencies and local procedures. It is recommended that all activities involving disposal preparation and transportation to commercial facilities be properly coordinated with the appropriate Federal and State agencies responsible for health and environmental aspects of hazardous materials. It is imperative that the proper description of waste accompany the packaged item at all times. Final disposal of the waste item shall be accomplished by reutilization, transfer, donation or sales by DRMS in accordance with DOD 4160.21-M or by ultimate disposal as described in 4.4.3.2. Spill residue, including contaminants, to be turned in to the DRMO shall first be properly identified, containerized, and labeled. For large scale spills that grossly contaminate the environment, the Chemical Transportation Emergency Center (CHEMTREC), can be called for assistance. Applicable procedures

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of the local spill control plan shall be followed. Necessary respiratory, eye, and skin protection measures are to be used while performing cleanup operations.

4.4.3.2 Ultimate disposal. Ultimate disposal shall be accomplished at a permitted or approved hazardous waste treatment or disposal facility designated by the Installation Environmental Office, DRMO, or Safety and Health Offices.

4.4.4 DISCLAIMER. RECOMMENDED DISPOSAL INSTRUCTIONS ARE FORMULATED FOR USE BY ELEMENTS OF THE DEPARTMENT OF DEFENSE. THE UNITED STATES OF AMERICA IN NO MANNER WHATSOEVER EITHER EXPLICITLY OR IMPLICITLY WARRANTS, STATES, OR INTENDS SAID INSTRUCTION, TO HAVE ANY APPLICATION, USE OR VIABILITY BY OR TO ANY PERSON OR PERSONS CONTRACTING OUTSIDE THE DEPARTMENT OF DEFENSE OR ANY PERSON OR PERSONS CONTRACTING WITH ANY INSTRUMENTALITY OF THE UNITED STATES OF AMERICA AND DISCLAIMS ALL LIABILITY FOR SUCH USE. ANY PERSON USING THESE INSTRUCTIONS WHO IS NOT A MILITARY OR CIVILIAN EMPLOYEE OF THE UNITED STATES OF AMERICA SHOULD SEEK COMPETENT PROFESSIONAL ADVICE TO VERIFY AND ASSUME RESPONSIBILITY FOR THE SUITABILITY OF THESE INSTRUCTIONS TO THEIR PARTICULAR SITUATION REGARDLESS OF SIMILARITY TO A CORRESPONDING DEPARTMENT OF DEFENSE OR OTHER GOVERNMENT SITUATION.

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5. DETAILED REQUIREMENTS

5.1 Introduction.

5.1.1 Manufacture. Ethyl alcohol was originally manufactured by the distillation of fermentation products from grain and sugar cane. Most of the ethyl alcohol produced in the United States at present is of synthetic origin. The latest chemical method for the synthesis of ethyl alcohol is a direct hydration process where water vapor and ethylene are combined at elevated pressure and temperature over a catalyst. Diethyl ether, a coproduct of these syntheses, is removed by distillation. The crude alcohol is treated by extractive distillation, rectification, and a final distillation to produce a pure 190 proof product. The 190 proof alcohol can be denatured, or dehydrated to anhydrous 200 proof alcohol by means of azeotropic distillation of a ternary (alcohol, water and benzene) azeotrope.

5.1.2 Industrial Alcohols. Industrial alcohols are manufactured to meet the various degrees of governmental control as the following types in decreasing order of regulation by the Bureau of Alcohol, Tobacco and Firearms (ATF).

5.1.2.1 Pure Ethyl Alcohol. Pure ethyl alcohol is 190 or 200 proof alcohol that has not been denatured. It can be refined to meet the specification requirements of the American Chemical Society (ACS) for reagent chemicals, the United States Pharmacopeia (USP) specification for reagents and drug substances, and the Food Chemicals Codex (FCC). Pure ethyl alcohol, as an industrial alcohol, is primarily used in the manufacture of specially denatured alcohol.

5.1.2.2 Specially Denatured Alcohol (SDA). Specially denatured alcohol is moderately denatured, and is available in many authorized formulas. Denaturants are substances having odorous and/or obnoxious attributes which prevent use of the alcohol for beverage purposes. The specifications for all authorized denaturants are defined by ATF IN 27 CFR Part 21. The authorized SDA formulas and their uses are listed by ATF in this reference. SDA formulas can be based on either 190 proof or 200 proof anhydrous alcohol. The following formulas are authorized, but some are of very limited use.

SDA No.1, 2-B, 2-C, 3-A, 3-B, 4,6-B, 12-A, 13-A, 17, 18, 19, 20, 22, 23-A, 23-F, 23-H, 25, 25-A, 27, 27-A, 27-B, 28-D, 29, 30, 31-A, 32, 33, 35, 35-A, 36, 37, 38, 38-B, 38-C, 38-D, 38-F, 39, 39-A, 39-B, 39-C, 39-D, 40, 40-A, 40-B, 40-C, 42, 44, 45, 46.

Some formulas have more than one denaturing option, and in some individual formulas more than one denaturant or combination of denaturants is authorized. In the case of SDA 38-B, thirty-six denaturants are authorized as ten pounds of one, or a total of ten pounds of two or more denaturants per 100 gallons of alcohol, thereby allowing an infinite number of formula variations.

Substitute and alternate denaturants may be authorized by the Director of ATF, when a user can show that no presently authorized denaturant or combination of denaturants can be used in the manufacture of a particular product.

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SDA Formulas No.1 and 3A are the most frequently used, and are the primary components of proprietary solvents and special industrial solvents. There are three authorized formulas for SDA-1. The original formula, of five gallons wood alcohol added to 100 gallons of ethyl alcohol, is not in use because wood alcohol is not commercially available. The other two optional denaturant formulas are used extensively for the preparation of proprietary solvents. These formulas are designated as the denatonium benzoate (Bitrex) option and the methyl isobutyl ketone (MIBK) option. These formulas are shown in Table I.

TABLE I. SDA NO.1 formula options.

Component	Bitrex Option	MIBK Option
Ethyl alcohol, gallons	100	100
Methyl alcohol, gallons	4	4
Denatonium benzoate, NF, av oz	1/8	
Methyl isobutyl ketone, gallons		1

In the formulation of SDA No.1, either 190 proof or 200 proof (anhydrous) ethyl alcohol can be used as specified. There is only one formulation for SDA No.3, consisting of five gallons methyl alcohol added to 100 gallons ethyl alcohol (190 or 200 proof).

5.1.2.3 Special Industrial Solvents. Special industrial solvents containing more than 25 percent by volume ethyl alcohol, are formulated based on SDA No.1 or SDA No. 3A as authorized by ATF. The formulations based on SDA No.3A are preferred commercially. The additional denaturants, added to the specially denatured alcohols to obtain the special industrial solvents, are isopropyl alcohol, methyl isobutyl ketone, methyl alcohol, and ethyl acetate. The specially denatured alcohols can be either the 190 proof or the anhydrous 200 proof types. Authorized formulations for special industrial solvents, as the amounts of additional denaturants to be added to SDA No.1 or SDA No.3A, are shown in Table II.

TABLE II. Special industrial solvents denaturant formulations for 100 gallons of SDA No.1 or No. 3-A.

Denaturant	Volume (gallons)							
	10	--	5	--	15	--	100	
Isopropyl alcohol	10	--	5	--	15	--	100	
Methyl isobutyl ketone	1	1	1	1	1	1	--	
Methyl alcohol	--	10	5	--	--	15	--	
Ethyl acetate (pure)*	--	--		4.25	--	--	--	

*Note: Authorized formula for 5 gallons ethyl acetate (85 to 88% purity) is equivalent to about 4.25 gallons of pure ethyl acetate.

These formulations do not cloud when diluted with water because of the absence of hydrocarbons. Also they do not soften hydrocarbon soluble rubbers and polymers because of the absence of hydrocarbons.

5.1.2.4 Proprietary Solvents. Proprietary solvents, containing more than 25 percent by volume ethyl alcohol, are formulated based on SDA No.1, with both the Bitrex and MIBK options, as authorized by ATF. The additional denaturants added to the SDA No.1, to obtain the proprietary solvents, are methyl isobutyl ketone, ethyl acetate, and heptane or rubber hydrocarbon solvent.

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ATF also authorizes the use of wood alcohol, tertiary butyl alcohol and secondary butyl alcohol in proprietary solvent formulations. The SDA No.1 can be either the 190 proof or the anhydrous 200 proof types. The most widely used authorized proprietary solvent formulations with the amounts of additional denaturants to be added to SDA No.1 are shown in Table III.

TABLE III. Proprietary solvent formulations - based on 100 gallons SDA No.1-Bitrex or MIBK options.

Denaturant	Volume (Gallons)	
Methyl isobutyl ketone	1	-
Ethyl acetate (pure)*	0.87	4.25
Heptane or rubber hydrocarbon solvent	1	1

*Note: Authorized formula for 1 gallon ethyl acetate (85 to 88% purity) is equivalent to about 0.87 gallon of pure ethyl acetate.

5.1.2.5 Completely Denatured Alcohol (CDA). Completely denatured alcohol is ethyl alcohol with prescribed denaturants added to render it entirely unfit for human consumption. CDA can be marketed and used with a minimum of government regulation. CDA is formulated with ethyl alcohol of not less than 160 proof. The formula, CDA 19, that is mainly used, is formulated with either 190 proof or anhydrous 200 proof ethyl alcohol. The authorized formula for CDA 19 is shown in Table IV.

TABLE IV. Composition of CDA 19.

Ethyl alcohol, gallons	100
Methyl isobutyl ketone, gallons	4
Gasoline, kerosene or rubber hydrocarbon solvent, gallon	1

An additional authorized formula, CDA 18, has less commercial use. It is formulated with ethyl alcohol of not less than 160 proof. The authorized formula for CDA 18 is shown in Table V.

TABLE V. Composition of CDA 18.

Ethyl alcohol, gallons	100
Methyl isobutyl ketone, gallons	2.5
Kerosene or gasoline, gallons	1
Pyronate (water-soluble petroleum sulfonates), gallon	1
Acetaldo1 (3-hydroxybutanal), gallon	0.125
	0.5

Since CDA is denatured with impure hydrocarbons (kerosene, gasoline), it is not suitable for many manufacturing uses. It is useful in products such as fuels and cleaning fluids.

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5.2 Name. Ethyl Alcohol CH₃CH₂OH FW 46.07
 Ethanol (IUPAC)
 Methyl Carbinol

5.2.1 Technical description. Ethyl alcohol (pure) is a colorless liquid with the physical properties and characteristics shown in Table VI. It is an associated liquid due to hydrogen bonding. It is miscible with water, acetone ether, acetic acid, and other short chain alcohols. It is soluble in benzene. Ethyl alcohol, as a primary alcohol, can be oxidized to acetaldehyde and then to acetic acid. It can react with hydrogen halides to form ethyl halides. It can react with carboxylic acids to form ethyl esters. It can react with active metals to form metal ethoxides. It can be dehydrated to yield ethylene.

TABLE VI. Ethyl alcohol (pure) - physical properties and characteristics.

Density (20°C), g/cm ³	0.7893
Refractive index (20°C)	1.3611
Melting point, °C	-114.1
Boiling point (760 mm Hg), °C	78.29
Vapor pressure (20°C), mm Hg	44
Flash point (closed cup), °F(°C)	57(14)
Autoignition temperature, °F(°C)	793(423)
Explosive limits, % by volume	
Lower	3.3
Upper	19
Vapor density (air=1)	1.6
Surface tension(20°C), dynes/cm	22.3
Viscosity (20°C), centipoises	1.22

5.2.2 Specifications, federal and military.

5.2.2.1 Federal specification. O-E-00760, Ethyl Alcohol (Ethanol); Denatured Alcohol; Proprietary Solvents and Special Industrial Solvents.

This specification covers five types of ethyl alcohol.

Type I - Analytical reagent (ACS grade)

 Grade A - Absolute (99.5 percent by volume)

 Grade B - 95 percent by volume

Type II - Pharmaceutical

 Grade A - Anhydrous, not less than 99.8 percent by volume

 Grade B - USP, not less than 94.9 percent by volume

Type III - Denatured

Type IV - Proprietary Solvents (Standard formulas designated by ATF)

Type V - Special Industrial Solvents (Standard formulas designated by ATF)

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Types I and II do not fall under the coverage of this military standard. Type III ethyl alcohol shall be made from ethyl alcohol conforming to the requirements of Type II prior to denaturing. In addition it shall be one of the approved ATF formulas for specially denatured alcohol. Unless otherwise specified, Type III denatured alcohol shall conform to Formula No. 3-A for specially denatured alcohol. Type IV ethyl alcohol shall consist of specially denatured alcohol, Formula No. 1 or Formula No. 3-A, further modified in accordance with formulas authorized by ATF for standard proprietary solvents. Type V ethyl alcohol shall consist of specially denatured alcohol, Formula No. 1 or Formula No. 3-A, further modified in accordance with formulas authorized by ATF for special industrial solvents.

5.2.2.2 Military specification. MIL-E-463, Ethyl Alcohol (For Ordnance Use).

This specification covers six grades of ethyl alcohol.

- Grade 1 - 95.0 percent by volume without denaturant or dye.
- Grade 2 - 94.9 percent by volume with toluene denaturant.
- Grade 3 - 99.0 percent by volume (anhydrous), with toluene denaturant.
- Grade 4 - 94.9 percent by volume, denatured with tertiary butyl alcohol and benzyl-diethyl [(2,6-xylyl)carbonyl methyl] ammonium benzoate.
- Grade 5 - 95.0 percent by volume with methyl alcohol denaturant.
- Grade 6 - 88.3 percent by volume

Grade 1 ethyl alcohol shall contain neither dye nor denaturant. It is pure 190 proof ethyl alcohol. Grade 2 ethyl alcohol shall be made by the addition of toluene to ethyl alcohol that complies with the requirements of Grade 1, or to ethyl alcohol that has been recovered from the manufacturing operation in which it will be used. It is 190 proof type SDA Formula 2-B, with the toluene option. Grade 3 ethyl alcohol shall be made by the addition of toluene to an anhydrous grade of alcohol that complies with the requirements of Grade 1 ethyl alcohol. It is anhydrous (200 proof) type SDA Formula 2-B with the toluene option. Grade 4 ethyl alcohol shall be made by the addition of 1/2 gallon of tert-butyl alcohol and 1/4 avoirdupois ounce of benzyl-diethyl [(2,6-xylyl)carbonyl methyl] ammonium benzoate to 100 gallons of ethyl alcohol that complies with the requirements of Grade 1 ethyl alcohol, and it shall be dyed with one part by weight of fuchsin dye to 500,000 parts by weight of ethyl alcohol. It is SDA Formula 40-B except that the amounts of denaturants are increased. Grade 5 ethyl alcohol shall be made by the addition of 5 gallons of anhydrous methyl alcohol to 100 gallons of anhydrous ethyl alcohol. It is anhydrous (200 proof) type SDA Formula 3-A. Grade 6 ethyl alcohol shall be made by the addition of 5 gallons of ethyl acetate and 1 gallon of methyl isobutyl ketone to 100 gallons of either anhydrous denatured alcohol (SDA Formula 3-A) or Grade 5 ethyl alcohol. It is a special industrial solvent formula. The six grades of ethyl alcohol shall conform to the chemical and physical requirements shown in Table VII.

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TABLE VII. Ethyl alcohol, ordnance grades 1 to 6 - chemical and physical requirements.

	Gr 1	Gr 2	Gr 3	Gr 4	Gr 5	Gr 6
Ethyl alcohol, % by vol, min	95.0	94.9	99.0	94.9	95.0	88.3
Toluene, % by vol, max	0.01	0.75	0.75			
Acidity, as acetic acid, g/100 mL, max	0.006	0.01			0.01	0.01
Aldehydes, mg/100mL, max	20					
Nonvolatile matter, %	0.004	0.006				
Organic impurities, % max	0.1					
Water, % by wt, max					0.3	0.3
Methyl alcohol, % by vol max					5.0	4.5
Ethyl acetate, % by vol max						5.4
Methyl isobutyl ketone % by vol, max						1.5

5.2.2.3 Military Specification. MIL-E-51454, Ethyl Alcohol (Ethanol)

This specification covers four types of ethyl alcohol.

Type I - Pharmaceutical

Grade A - Anhydrous, not less than 99.8 percent by volume.

Grade B - 94.9 to 96.0 percent by volume (meets requirements for United States Pharmacopeia (USP) alcohol).

Type II - Denatured (standard formulas designated by the Bureau of Alcohol, Tobacco and Firearms).

Type III- Proprietary solvents (standard formulas designated by the Bureau of Alcohol, Tobacco, and Firearms).

Type IV - Special industrial solvents (restricted sale, standard formulas designated by the Bureau of Alcohol, Tobacco and Firearms).

Type I pharmaceutical ethyl alcohol does not fall under the coverage of this military standard. Type II denatured ethyl alcohol shall be made from alcohol which conforms to the requirements of Type I prior to denaturing. In addition, it shall be one of the formulas contained in 27 CFR 21, Formulas for Denatured Alcohol and Rum. Unless otherwise specified in the contract, Type II denatured alcohol shall conform to SDA Formula No. 3-A. Type III proprietary solvents shall consist of specially denatured alcohol, Formula No. 1, further modified in accordance with formulas in 27 CFR 21. Type IV special industrial solvents shall consist of specially denatured alcohol, Formula No. 1 or Formula No. 3-A, further modified in accordance with formulas in 27 CFR 21.

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5.2.3 Commercial specifications and typical properties.

5.2.3.1 Pure ethyl alcohol. Pure ethyl alcohol, technical grade, is manufactured in 190 and 200 proof forms, that have not been denatured. A manufacturer's specifications are shown in Table VIII for both forms. The typical properties are shown in Table IX.

TABLE VIII. Pure ethyl alcohol, technical grade - chemical and physical requirements.

	190 Proof	200 Proof
Ethyl alcohol, volume %, min	95	99.9
Acidity, as acetic acid, g/100 mL max	0.0025	0.0025
Permanganate time (reducing substances), minutes, min	50	30
Specific gravity (15.56/15.56°C), max	0.816	0.794
*Color (Pt-Co Scale), max	10	10

* In accordance with ASTM D 1209.

TABLE IX. Pure ethyl alcohol, technical grade - typical properties.

	190 Proof	200 Proof
Boiling point, °C	78.3	78.4
Density (15.56°C), g/cm ³	0.814	0.791
Flash point (closed cup), °F	62	57
°C	17	14

Ethyl alcohol, 190 proof, is composed of 95.0 parts by volume of ethyl alcohol and 6.18 parts by volume of water before mixing. The total volume will be equal to 100 parts after mixing, because a shrinkage of volume occurs when ethyl alcohol and water are mixed. The percent by volume of ethyl alcohol is assumed to be equal to the parts by volume before mixing, when used to calculate the alcohol proof of the solution. Ethyl alcohol, 190 proof, contains 92.42 percent by weight of ethyl alcohol.

5.2.3.2 Specially denatured alcohol No. 1. SDA Formula No. 1 is prepared in two formula options from 190 or 200 proof ethyl alcohol as shown in Table I. A manufacturer's specification requirements are shown in Table X. The typical properties are shown in Table XI.

TABLE X. Specially denatured alcohol No. 1 - chemical and physical requirements.

	Bitrex Option		MIBK Option	
	190 Proof	200 Proof	190 Proof	200 Proof
Specific gravity (15.6°/15.6°C)	0.8144 to 0.8156	0.7934 to 0.7944	0.8142 to 0.8154	0.7934 to 0.7944
Acidity, as acetic acid, wt %, max	0.0025	0.0025	0.0025	0.0025
Nonvolatile matter, g/100 mL, max	0.0025	0.0025	0.0025	0.0025

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TABLE X. Specially denatured alcohol No. 1 - chemical and physical requirements (Continued).

	Bitrex Option		MIBK Option	
	190 Proof	200 Proof	190 Proof	200 Proof
*Color (Pt-Co Scale), max	10	10	10	10
Water content, vol %, max	---	0.10	---	0.10

* In accordance with ASTM D 1209.

TABLE XI. Specially denatured alcohol No. 1 - typical properties.

	Bitrex Option		MIBK Option	
	190 Proof	200 Proof	190 Proof	200 Proof
Apparent proof at 60°F (15.56°C)	190.4	199.9	190.5	199.9
Composition, wt %				
Ethyl alcohol	88.95	96.14	88.12	95.22
Methyl alcohol	3.76	3.86	3.72	3.82
Denatonium benzoate	0.001	0.001	--	--
Methyl isobutyl ketone	--	--	0.94	0.96
Water	7.29	--	7.22	--
Flash point (closed cup), (°F)	56	53	58	52
(°C)	13	12	14	11

5.2.3.3 Specially denatured alcohol No. 3-A. SDA Formula No. 3-A, is prepared by the addition of 5 gallons of methyl alcohol to 100 gallons of either 190 or 200 proof ethyl alcohol. A manufacturer's specification requirements are shown in Table XII. The typical properties and characteristics are shown in Table XIII.

TABLE XII. Specially denatured alcohol No. 3-A - chemical and physical requirements.

	190° Proof		Anhydrous	
	Min	Max	Min	Max
Specific gravity (15.56°/15.56°C)	0.8144	0.8156	0.7934	0.7944
(20°/20°C)	0.8113	0.8124	0.7902	0.7912
Acidity, as acetic acid, wt %	---	0.0025	---	0.0025
Nonvolatile matter g/100 mL	---	0.0025	---	0.0025
*Color (Pt-Co Scale)	---	10	---	10
Water content, volume %	---	---	---	0.10

* In accordance with ASTM D 1209.

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TABLE XIII. Specially denatured alcohol No. 3-A - typical properties.

	190° Proof	Anhydrous
Apparent proof at 60°F (15.56°C)	190.4	199.9
Composition, wt %		
Ethyl alcohol	88.12	95.22
Methyl alcohol	4.65	4.78
Water	7.23	---
Flash point, closed cup, (°F)	60	55
(°C)	16	13

5.2.4 Use. Ethyl alcohol (for ordnance use) is intended for use in the manufacture of mercury fulminate, smokeless powder, small arms primers, and optical elements; and in shellac mixtures for ammunition. Specially Denatured Alcohol, SDA No. 3-A, is intended for military use in the washing of rubber parts of aircraft hydraulic systems, and for flushing of aircraft hydraulic systems. For commercial applications, the uses of denatured alcohols, authorized by ATF, are shown in 27 CFR 211 - Distribution and Use of Denatured Alcohol and Rum. The uses of specially denatured alcohols are given by code numbers for the authorized formulas. Special industrial solvents are used in flexographic printing operations as a cleaning agent, and in ink formulations; in dyeing of textiles and fabrics; and in chemical and drug processing. Proprietary solvents are used in latex coagulants, in cutting and thinning shellac, in spirit varnishes, as a chemical reaction medium, and in cleaning compounds and fuel oil conditioners. Completely denatured alcohols are used in fuels, cleaning fluids, detergents, antifreeze solutions and brake fluids.

5.2.5 Packaging. Ethyl alcohol shall be packaged as specified in the contract or order. Packages shall be labeled to comply with the requirements of applicable laws and regulations.

5.2.6 Safety.

5.2.6.1 Health hazard. Ethyl alcohol vapor, at concentrations from 6,000 to 9,000 ppm, is irritating to the eyes and mucous membranes. The vapor can be toxic at high concentrations, above 9,000 ppm. The PEL and TLV for ethyl alcohol is 1,000 ppm (1900 mg/m³). The liquid can cause eye and skin irritation. In case of contact with eyes, flush with water for at least 20 minutes, and obtain medical attention. The health hazards of denatured alcohols are dependent on the added materials. (Refer to 4.3.1)

5.2.6.2 Fire and explosion hazard. Ethyl alcohol, denatured alcohols and solvents, are very flammable liquids that can produce explosive vapor mixtures with air.

5.2.6.3 Reactivity. Ethyl alcohol is reactive with strong oxidizing agents.

5.2.7 Storage. Ethyl alcohol and denatured alcohols, that do not contain acidic or halide denaturants, can be stored in mild steel containers. Alcohols with acidic denaturants shall be stored in resin-coated steel or stainless steel containers. Alcohol, with halide denaturants, shall be stored in polyethylene-lined steel containers. Alcohol, with alkaline denaturants, shall be stored in mild steel containers, but contact with copper and copper alloys

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shall be avoided. Ethyl alcohol and denatured alcohols, in bulk quantities shall be stored in tanks that are diked, electrically grounded, and vented. Tank vents shall be equipped with a flame arrestor, and a desiccant drier to prevent absorption of moisture by the alcohol. Alcohol in drums or smaller containers shall be stored in a cool dry ventilated space, away from heat, ignition sources, and oxidizing agents. Nitrogen blanketing, with a slight positive pressure, shall be used to prevent access by air and moisture into storage containers. (Refer to 4.3.2)

5.2.8 Disposal. In case of spills, eliminate all sources of ignition. Small spills can be flushed away with water, or absorbed with a nonreactive absorbent and placed in containers for disposal. Large spills shall be diked to prevent spreading and transferred to salvage containers. Water spray can be used to reduce vapor ignition hazard. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

Ethyl alcohol and denatured alcohols have an EPA Hazardous Waste Classification of Ignitable (I); Waste No. D001.

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6. NOTES

6.1 Subject term (key word) listing.

Alcohol
Completely denatured alcohols
Denatured alcohol
Ethanol
Ethyl alcohol
Exposure limits, hazardous chemicals
Hazardous wastes, disposal and storage of
Information, hazardous chemicals
Proprietary solvents
Safety, hazardous chemicals
Special industrial solvents
Specially denatured alcohols

6.2 Abbreviations. The use of abbreviations in this military standard are in accordance with MIL-STD-12 where applicable. Metric system abbreviations and symbols are in accordance with ASTM E 380.

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

Preparing activity: Army - EA

Project Number 6810-B581

Custodians:

Army - EA
Navy - SH
Air Force - 68

Review activities:

DLA - GS
Army - GL, MD, MI, SM
Navy - None

User activities:

Navy - MC, SA

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER MIL-STD-1201B		2. DOCUMENT TITLE ETHYL ALCOHOL (ETHANOL), TECHNICAL AND DENATURED GRADES	
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION <i>(Mark one)</i>	
b. ADDRESS <i>(Street, City, State, ZIP Code)</i>		<input type="checkbox"/> VENDOR <input type="checkbox"/> USER <input type="checkbox"/> MANUFACTURER <input type="checkbox"/> OTHER <i>(Specify):</i> _____	
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