

METRIC

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SUPERSEDING

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# MILITARY STANDARD

## ETHERS, REAGENT GRADE

(INCLUDING ACS AND USP-NF COMPOUNDS)



AMSC N/A

FSC 6810

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### FOREWORD

Ethers, Reagent Grade  
(Including ACS and USP-NF Compounds)

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 Edgewood Research, Development and Engineering center, Attn: SCBRD-EN, 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.
3. 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 Coverage. This standard is a presentation of nomenclature, chemical abstracts service registry numbers, formulas, physical and chemical properties, specification requirements, military and typical commercial uses, safety information, storage information and disposal information for ethers, reagent and analytical reagent grade (including ACS and USP-NF compounds). This standard does not 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 ethers, reagent and analytical reagent grade (including ACS and USP-NF compounds) for application by the Department of Defense.

1.2 Application. Ethers, reagent and analytical reagent grade, (including ACS and USP-NF compounds) are used as extracting agents, in solvent purification, organic synthesis as an intermediate, analytical reagent, scintillation counter, spectrophotometric analysis, histology and to improve emulsifying properties.

1.3 Classification. The items in this standard are classified on the basis of chemical composition as ethers.

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## 2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

## SPECIFICATIONS.

## FEDERAL

O-C-265	-	Chemicals, Analytical, General Specification For
PPP-C-2020	-	Chemicals, Liquid, Dry and Paste, Packaging Of

## MILITARY

MIL-C-51130	-	Chemicals, Reagent Grade; General Specification For
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## STANDARDS

## FEDERAL

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

MIL-STD-12	-	Abbreviations For Use On Drawings, And In Specifications, Standards And Technical Documents
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(Unless otherwise indicated, copies of Federal and military specifications, standards, and handbooks are available from (ATTN: DODSSP) - Customer Service, Standardization Documents Order Desk, 700 Robbins Avenue, Bldg. 4D, Philadelphia, PA 19111-5094.



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2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

## CODE OF FEDERAL REGULATIONS (CFR)

- Title 29 - Department of Labor, Occupational Safety and Health Administration (OSHA).
- Title 40 - Protection of the Environment; Environmental Protection Agency (EPA).
- Title 49 - Department Of Transportation; Hazardous Materials Regulations (DOT).
  
- DOD 4145.19-R-1 - Storage And Materials Handling
- DOD 4160.21-M - Defense Utilization And Disposal Manual
- DOD 6050.5 - DOD Hazardous Materials Information System, Hazardous Item Listing.
  
- TB MED 502 - Occupational And Environmental Health Respiratory Protection Program.
- (DLAM 1000.2)
- TB MED 506 - Occupational And Environmental Health Occupational Vision
  
- TM 38-250 - Packaging, Materials Handling-Preparation Of Hazardous Materials For Military Air Shipment.

## 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 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

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### AMERICAN CHEMICAL SOCIETY (ACS)

#### Reagent Chemicals - American Chemical Society Specifications

(Application for copies should be addressed to American Chemical Society, 1155-16th St., N.W., Washington, DC 20036.)

### AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

TLVs Threshold Limit Values and Biological Exposure Indices Adopted by American Conference of Governmental Industrial Hygienists (ACGIH).

(Application for copies should be addressed to American Conference of Governmental Industrial Hygienists, 6500 Glenway Avenue, BLDG D-7, Cincinnati, OH 45211-4438.)

### AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM D 1209 - Color Of Clear Liquids (Platinum-Cobalt Scale)  
ASTM E 380 - Standard for Metric Practice

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

### CHEMICAL ABSTRACTS SERVICE REGISTRY

The Chemical Abstracts Service (CAS) Registry number provides a key to access the wealth of information available through CAS.

(For details on how to search the CAS files and database using the registry number, contact Chemical Abstracts Services, Customer Service, P.O. Box 3012, Columbus, OH 43210.)

### INTERNATIONAL AGENCY FOR RESEARCH ON CANCER (IARC)

Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man.

(Application for copies should be addressed to World Health Organization, International Agency for Research on Cancer, 49 Sheridan Street, Albany, NY 12210.)

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### 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.)

### THE UNITED STATES PHARMACOPEIAL CONVENTION, INC. - NATIONAL FORMULARY (USP-NF)

#### The United States Pharmacopeia - National Formulary

(Application for copies should be addressed to The United States Pharmacopeial Convention, Inc. - National Formulary, Order Processing Dept., P.O. Box 2248, 12601 Twinbrook Parkway, Rockville, MD 20852.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents may also 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 standard and the references cited herein, the text of this standard shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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**3. DEFINITIONS****3.1 Definitions of Technical Terms.**

3.1.1 ACS Reagent grade - Denotes a grade of chemicals which certifies that it meets the American Chemical Society (ACS) specification for that reagent.

3.1.2 Analyzed Reagent grade - Denotes a grade of high quality chemicals for laboratory and specialized industrial use. An actual lot analysis is provided to guarantee purity and consistency.

3.1.3 Oxidizing agent - A substance that gains electrons as a result of an oxidation-reduction reaction. It causes an increase in the oxidation state of another substance.

3.1.4 Reagent grade - Denotes reagent grade chemicals which do not bear a level stating the percentages of the important impurities present. Reagent grade chemicals have limited use in analytical work because of the uncertainty as to the kind and amount of impurities present. These chemicals find extensive use in laboratory synthesis and in certain analytical procedures where the inherent impurities are not critical to the intended reaction.

3.1.5 Reducing agent - A substance that loses electrons during an oxidation-reduction reaction. It causes a decrease in the oxidation state of another substance.

3.1.6 USP-NF grade - Denotes a grade of high quality chemicals that conforms to the requirements of the United States Pharmacopeia (USP) and the National Formulary (NF). All meet the requirements necessary for their use in pharmaceutical processing and prescription compounding (USP and NF).

3.2 Definitions of abbreviations. The use of abbreviations shall be in accordance with MIL-STD-12 where applicable. Metric system abbreviations and symbols shall be in accordance with ASTM E 380.

Additional abbreviations are as follows:

CAS	- Chemical Abstracts Service Registry Number
CC	- Closed Cup
FW	- Formula Weight
LEL	- Lower Explosive Limit
OC	- Open Cup
UEL	- Upper Explosive Limit

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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 an 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, nonroutine exposure not exceeding one hour per week, when the installation medical authority determines that there are no feasible engineering or work practice controls, during interim periods when engineering controls are being designed and/or installed, during emergencies, or for supplementing other control measures (refer to TB MED 502 or DLAM 1000.2). Ventilation containment, process controls, or other feasible engineering controls shall be adequate to remove hazardous concentrations. Respiratory protection shall not be used in place of feasible engineering controls.

**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

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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 MSDS 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.

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 37.8°C (100°F). A combustible liquid is defined, by DOT in the above reference, as one having a closed cup flash point at or above 37.8°C and below 93.3°C (200°F). A pyrophoric liquid is defined, by DOT in the above reference, as one that ignites spontaneously in dry or moist air at or below 54.5°C (130°F). Materials with flash points of 93.3°C or higher 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 60°C (140°F) are defined by EPA as

\*Refers only to materials that have become waste.



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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, separated from other storage areas and meet National Fire Codes.

**4.3.2.3 Incompatible materials.** Materials that are chemically incompatible shall be segregated in the storage of both serviceable and unserviceable items. 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 and Biological Exposure Indices adopted by the American Conference of Governmental Industrial Hygienists (ACGIH); current Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL), 29 CFR, Part 1910, Subpart Z; and NIOSH Recommended Exposure Limits. Such information is also shown in MSDSs and the HMIS referred to in 4.2. The identity of sources establishing if a chemical is a carcinogen or potential carcinogen, for hazard communication purposes, is shown in 29 CFR 1910.1200 (d)(4). The International Agency for

\*Refers only to materials that have become waste.

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Research on Cancer has published monographs on "The Evaluation of the Carcinogenic Risk of Chemicals to Man" which are very helpful. The more stringent standard shall apply when there is a conflict between standards.

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 40 CFR.\* Some commercial chemical products are listed as acute hazardous in toxicity under Subpart D, Section 261.33 (e).

4.3.4.3 EPA Toxicity Characteristic Leaching Procedure (TCLP). This is a procedure used to determine the properties of a waste that are directly related to the potential of the waste to pose a hazard to groundwater when disposed of in a landfill environment. It replaces the EPA EP toxicity test. The TCLP procedure is contained in EPA Method No. 1311, SW -846. Some 40 chemical contaminants have been designated by the SPA as being a hazard to groundwater in a landfill environment. (See Section 261.24 of 40 CFR.)

4.3.4.4 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.

\*Refers only to materials that have become waste.



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4.4.2 Disposal of excess or unserviceable material. To minimize disposal problems, it is recommended that no more than a six month supply of each item listed in this standard be stocked because of the natural tendency of these chemicals to form explosive peroxides. 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.

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 are subject to toxicity characteristic leaching procedure (TCPL)) 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, 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 or vermiculite) or follow installation's 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

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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 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 into 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 at (800) 424-9300. Applicable procedures 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 HIS PARTICULAR SITUATION, REGARDLESS OF SIMILARITY TO A CORRESPONDING DEPARTMENT OF DEFENSE OR OTHER GOVERNMENT SITUATION.

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## 5. DETAILED REQUIREMENTS

- 5.1 Name. Dibutyl ether, reagent  $\text{CH}_3(\text{CH}_2)_3\text{O}(\text{CH}_2)_3\text{CH}_3$  FW 130.23  
Butyl ether. CAS 142-96-1

5.1.1 Technical description. Dibutyl ether (pure) exists as a colorless liquid with a weakly ether-like odor. Its density is  $0.7689 \text{ g/cm}^3$  at  $20^\circ/4^\circ$ . Its melting point is  $-95.3^\circ\text{C}$  and boiling point is  $142^\circ\text{C}$  at 760mm. Its refractive index is 1.3992 at  $20^\circ\text{C}$ . Its flash point is  $25^\circ\text{C}$  ( $77^\circ\text{F}$ ), closed cup (cc). Dibutyl ether is insoluble in water, very soluble in acetone and soluble in all proportions in alcohol.

5.1.2 Specification. Military, MIL-C-51130, Chemicals, Reagent Grade;  
General Specification For.

5.1.2.1 Requirements. The military specification physical requirements for dibutyl ether, reagent, are shown in Table I.

TABLE I. Dibutyl ether, reagent - physical requirements.

Characteristics	Requirement
Boiling point, $^\circ\text{C}$	138 - 141
Specific gravity at $20^\circ/4^\circ\text{C}$	0.764 - 0.769
Refractive index at $20^\circ\text{C}$	1.3988 - 1.3993

5.1.3 Use. Dibutyl ether, reagent, is used as an extracting agent, used especially for separating metals, solvent purification and organic synthesis (reaction medium).

5.1.4 Safety. Dibutyl ether is flammable and irritating to the eyes, skin and respiratory system. Contact with the liquid may produce a dry, fissured dermatitis. Inhalation of vapor or mist shall be avoided. Contact with the eyes and skin shall be avoided. Dibutyl ether shall be used with adequate ventilation. Dibutyl ether has a lower explosive limit (LEL) of 1.5% and an upper explosive limit (UEL) of 7.6% in air.

Dibutyl ether tends to form explosive peroxides, especially when anhydrous. It should not be allowed to evaporate to dryness unless the absence of peroxides has been shown. The presence of water or appropriate reducing agents lessens peroxide formation. Dibutyl ether is a dangerous fire and explosive hazard when exposed to heat, sparks and flame.

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5.1.5 Storage. Dibutyl ether shall be stored in a cool, well-ventilated place in tightly closed containers away from sources of heat, sparks and open flame.

5.1.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices.

Dibutyl ether has an EPA Hazardous Waste Classification - Ignitable, Waste Number D001.

5.2 Name. Diethyl ether, analyzed reagent ( $\text{CH}_3\text{CH}_2$ )<sub>2</sub>O      FW 74.12  
Ethyl ether.      CAS 60-29-7

5.2.1 Technical description. Diethyl ether (pure) exists as a colorless, volatile, mobile, hygroscopic liquid with an aromatic odor. Its freezing point is  $-116.2^\circ\text{C}$  and boiling point is  $34.51^\circ\text{C}$  at 760mm. Its density is  $0.71378 \text{ g/cm}^3$  at  $20^\circ/4^\circ\text{C}$ . Its refractive index is 1.3526 at  $20^\circ\text{C}$ . Its flash point is  $-45^\circ\text{C}$  ( $-49^\circ\text{F}$ ), (cc) and autoignition temperature is  $180^\circ\text{C}$  ( $356^\circ\text{F}$ ). Diethyl ether is slightly soluble in water; soluble in chloroform and benzene.

5.2.2 Specification. Federal, O-C-265, Chemicals, Analytical; General Specifications For.

5.2.2.1 Requirements. The federal specification chemical and physical requirements for diethyl ether, analyzed reagent, are shown in Table II.

TABLE II. Diethyl ether, analyzed reagent - chemical and physical requirements (ACS).

Characteristics	Requirement
Color (APHA), max <u>1</u> /	10
Density (g/mL) at $25^\circ\text{C}$	Between 0.711 and 0.714
Peroxide (as $\text{H}_2\text{O}_2$ ), ppm, max	1
Residue after evaporation, % by wt, max	0.001
Acidity (as $\text{CH}_3\text{COOH}$ ), % by wt, max	0.001
Carbonyl (as $\text{HCHO}$ ), % by wt, max	0.001
Substances darkened by sulfuric acid	To pass test
Foreign odor	To pass test

1/ Equivalent to Pt-Co Scale according to ASTM D 1209.

Note: Diethyl ether normally contains about 2% alcohol and 0.5% water as stabilizers.

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5.2.3 Use. Diethyl ether, analyzed reagent, is used in organic synthesis, especially in Grignard and Wurtz type reactions. It is also used as an extractant of active principles (hormones, etc.) from plant and animal tissue and as an analytical reagent.

5.2.4 Safety. Diethyl ether is an extremely flammable liquid. Its vapor is mildly irritating to the eyes, nose and throat. Contact with the liquid may produce a dry, scaly, fissured dermatitis. Diethyl ether has predominantly narcotic properties. Overexposed individuals may experience drowsiness, vomiting and unconsciousness. Death may result from severe overexposure. Inhalation of vapor or mist shall be avoided. Contact with the eyes and skin shall be avoided. Diethyl ether shall be used with adequate ventilation. Diethyl ether has an LEL of 1.85% and UEL of 48.0% in air.

Diethyl ether tends to form explosive peroxides, especially when anhydrous. It should not be allowed to evaporate to dryness unless the absence of peroxides has been shown. The presence of water or appropriate reducing agents lessens peroxide formation. Diethyl ether is a dangerous fire and explosive hazard when exposed to heat, sparks and flame.

5.2.5 Storage. Diethyl ether shall be stored in a cool, well-ventilated place in tightly closed containers away from sources of heat, sparks, open flame and oxidizing materials.

5.2.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices.

Diethyl ether has an EPA Hazardous Waste Classification - Ignitable; Toxic, Waste Number U117.

5.3 Name. Diethyl ether, anhydrous, analyzed reagent ( $\text{CH}_3\text{CH}_2$ )<sub>2</sub>O  
Ethyl ether. FW 74.12  
CAS 60-29-7

5.3.1 Technical description. Diethyl ether, anhydrous (pure) exists as a colorless, volatile, mobile, hygroscopic liquid with an aromatic odor. Its freezing point is -116.2°C and boiling point is 34.51°C at 760mm. Its density is 0.71378 g/cm<sup>3</sup> at 20°/4°C. Its refractive index is 1.3526 at 20°C. Its flash point is -45°C (-49°F) (cc) and autoignition temperature is 180°C (356°F). Diethyl ether is slightly soluble in water; soluble in alcohol, chloroform and benzene.

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5.3.2 Specification. Federal, O-C-265, Chemicals, Analytical; General Specification For.

5.3.2.1 Requirements. The federal specification chemical and physical requirements for diethyl ether, anhydrous, analyzed reagent are shown in Table III.

TABLE III. Diethyl ether, anhydrous, analyzed reagent - chemical and physical requirements (ACS).

Characteristics	Requirement
Color (APHA), max <u>1</u> / <sub>1</sub>	10
Density (g/mL) at 25°C, max	0.7079
Peroxide (as H <sub>2</sub> O <sub>2</sub> ), ppm, max	1
Residue after evaporation, % by wt, max	0.001
Acidity (as CH <sub>3</sub> COOH), % by wt, max	0.001
Carbonyl (as HCHO), % by wt, max	0.001
Substances darkened by sulfuric acid	To pass test
Foreign odor	To pass test
Alcohol (CH <sub>3</sub> CH <sub>2</sub> OH), % by wt, To pass test	(Limit about 0.05)
Water (H <sub>2</sub> O), % by wt, max	0.01

1/ Equivalent to Pt-Co Scale according to ASTM D 1209.

5.3.3 Use. Diethyl ether, anhydrous, analyzed reagent is used in organic synthesis, especially in Grignard and Wurtz type reactions. It is also used as an extractant for plant and animal tissue and as an analytical reagent.

5.3.4 Safety. Diethyl ether is an extremely flammable liquid. Its vapor is mildly irritating to the eyes, nose and throat. Contact with the liquid may produce a dry, scaly, fissured dermatitis. Overexposed individuals may experience drowsiness, vomiting and unconsciousness. Death may result from severe overexposure. Inhalation of vapor or mist shall be avoided. Contact with the eyes and skin shall be avoided. Diethyl ether shall be used with adequate ventilation. Diethyl ether has an LEL of 1.85% and UEL of 48.0% in air.

Diethyl ether tends to form explosive peroxides, especially when anhydrous. It should not be allowed to evaporate to dryness unless the absence of peroxides has been shown. The formation of peroxides is more rapid in diethyl ether kept in containers that have been opened and partly emptied. Some diethyl ether may contain a stabilizer. If it does, the amount and type should be marked on the label.



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Diethyl ether is a dangerous fire and explosion hazard when exposed to heat, sparks and flame.

5.3.5 Storage. Diethyl ether, anhydrous, shall be stored in a cool, well-ventilated place in tightly closed containers away from sources of heat, sparks, open flame and oxidizing materials.

5.3.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices.

Diethyl ether has an EPA Hazardous Waste Classification - Ignitable; Toxic, Waste Number U117.

5.4	<u>Name</u> . Dioxane, analyzed reagent	$\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{O}$	FW 88.12
	1,4-Dioxane		
	Diethylene ether		CAS 123-91-1
	1,4-Diethylene dioxide		

5.4.1 Technical description. Dioxane (pure) is a colorless flammable liquid with a density of 1.0337 g/cm<sup>3</sup> at 20°/4°C. Its melting point is 11.8°C and boiling point is 101°C at 750mm. Its refractive index is 1.4224 at 20°C. Its flash point is 12°C (54°F) (cc). It is soluble in all proportions in water, alcohol, ether, acetone and benzene.

5.4.2 Specification. Federal, O-C-265, Chemicals, Analytical; General Specification For.

5.4.2.1 Requirements. The federal specification chemical and physical requirements for dioxane, analyzed reagent, are shown in Table IV.

TABLE IV. Dioxane, analyzed reagent - chemical and physical requirements (ACS).

Characteristics	Requirement
Color (APHA), max <u>1</u> /	20
Freezing point, °C, min	11.0
Peroxide (as H <sub>2</sub> O <sub>2</sub> ), % by wt, max	0.005
Residue after evaporation, % by wt, max	0.005
Neutrality	To pass test
Carbonyl (as HCHO), % by wt, max	0.01
Water (H <sub>2</sub> O), % by wt, max	0.05

1/ Equivalent to Pt-Co Scale according to ASTM D 1209.

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NOTE: Dioxane usually contains a stabilizer. If a stabilizer is present, its identity and quantity shall be stated on the label.

5.4.3 Use. Dioxane, analyzed reagent, is used as an analytical reagent and scintillation counter.

5.4.4 Safety. Dioxane is flammable and highly toxic by inhalation and is also absorbed by skin. It is irritating to the eyes, skin and mucous membranes. Contact with the eyes and skin shall be avoided. Dioxane shall be used with adequate ventilation. Dioxane has an LEL of 2.0% and an UEL of 22.2% in air. Dioxane is also listed as a suspected carcinogen by the International Agency for Research on Cancer. (IARC).

Dioxane tends to form explosive peroxides, especially when anhydrous. It should not be allowed to evaporate to dryness unless the absence of peroxides has been shown. Dioxane can react vigorously when mixed with oxidizing materials. Dioxane is a dangerous fire risk when exposed to heat, sparks and flame.

5.4.5 Storage. Dioxane shall be stored in a cool, well-ventilated place in tightly closed containers away from sources of heat, sparks, open flame and oxidizing materials.

5.4.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices.

Dioxane has been designated by the EPA as one of the substances that exhibit the characteristic of leachate toxicity (TCLP). This refers only to material that has been declared as waste.

5.5	<u>Name</u> . Diphenyl ether, analyzed reagent	$C_6H_5OC_6H_5$	FW 170.21
	Phenyl ether		
	Diphenyl oxide		CAS 101-84-8

5.5.1 Technical description. Diphenyl ether (pure) exists as a colorless liquid with a density of 1.0748 at 20°C. Its melting point is 26.84°C and boiling point is 257.93°C at 760mm and 121°C at 10mm. Its refractive index is 1.5787 at 25°C. Its flash point is 96°C (205°F) open cup (oc). It is insoluble in water and soluble in alcohol, ether and benzene.

5.5.2 Specification. Federal, O-C-265, Chemicals, Analytical; General Specification For.



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5.5.2.1 Requirements. The federal specification physical requirement for diphenyl ether, analyzed reagent, is shown in Table V.

TABLE V. Diphenyl ether, analyzed reagent - physical requirement (USP).

Characteristics	Requirement
Melting range, °C	Between 26 and 28

Diphenyl ether, analyzed reagent is also commercially available with physical and chemical requirements as shown in Table VI.

TABLE VI. Diphenyl ether, analyzed reagent - physical and chemical requirements.

Characteristics	Requirement
Typical appearance	Colorless liquid
Assay, by Gas Liquid Chromatography (GLC), % by wt, min	98
Typical assay (by GLC), % by wt	99
Melting range, °C	2° range including 27°

5.5.3 Use. Diphenyl ether, analyzed reagent, is used in organic synthesis and as a reagent in analytical chemistry.

5.5.4 Safety. Diphenyl ether is toxic by inhalation and irritating to the eyes, skin and mucous membranes. Inhalation of vapor or mist shall be avoided. Contact with the eyes and skin shall be avoided. Diphenyl ether shall be used with adequate ventilation.

Diphenyl ether tends to form explosive peroxides. It should not be allowed to evaporate to dryness unless the absence of peroxides has been shown. The presence of water or appropriate reducing agents lessens peroxide formation. Diphenyl ether is a moderate fire and explosion hazard when exposed to heat, sparks and flame.

5.5.5 Storage. Diphenyl ether shall be stored in a cool, well-ventilated place in tightly closed containers away from sources of heat, sparks and flame.

5.5.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices.

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An EPA Hazardous Waste Classification is not listed in 40 CFR.

- 5.6 Name. Ethylene glycol dimethyl ether, analyzed reagent  
 1,2 Dimethoxyethane  $\text{CH}_3\text{OCH}_2\text{CH}_2\text{OCH}_3$   
 1,2 Ethanediol dimethyl ether FW 90.12  
 CAS 110-71-4

5.6.1 Technical description. Ethylene glycol dimethyl ether (pure) exists as a colorless liquid with a density of  $0.86285 \text{ g/cm}^3$  at  $20^\circ/4^\circ\text{C}$ . Its melting point is  $-58^\circ\text{C}$  and boiling point is  $83-84^\circ\text{C}$  at 760mm. Its refractive index is 1.3796 at  $20^\circ\text{C}$ . Its flash point is  $1.1^\circ\text{C}$  ( $34^\circ\text{F}$ ) (oc). It is soluble in water, alcohol, ether, acetone, benzene and chloroform.

5.6.2 Specification. Manufacturer's requirements. (No Government Specification).

5.6.2.1 Requirements. Ethylene glycol dimethyl ether, analyzed reagent, is available commercially with chemical and physical requirements as shown in Table VII.

TABLE VII. Ethylene glycol dimethyl ether, analyzed reagent - chemical and physical requirements.

Characteristics	Requirement
Assay ( $\text{C}_4\text{H}_{10}\text{O}_2$ ), by GC corrected for $\text{H}_2\text{O}$ , % by wt, min	99.0
Density ( $\text{g/cm}^3$ ) at $20^\circ\text{C}$ , min-max	0.865 - 0.871
Residue by evaporation, % by wt, max	0.002
Water ( $\text{H}_2\text{O}$ ) (by Karl Fischer titration), % by wt, max	0.2

5.6.3 Use. Ethylene glycol dimethyl ether, analyzed reagent, is used as an inactivator of phosphorylase and as a reagent in spectrophotometric analysis.

5.6.4 Safety. Ethylene glycol dimethyl ether is flammable. It is irritating to the eyes, skin, respiratory tract and mucous membranes. It is harmful if absorbed through skin or inhaled. Inhalation of vapor or mist shall be avoided. Contact with eyes, skin and clothing shall be avoided. Ethylene glycol dimethyl ether shall be used with adequate ventilation.

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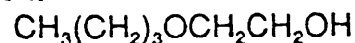
Ethylene glycol dimethyl ether is a dangerous fire hazard when exposed to heat, sparks and flame. It can react with oxidizing material. At elevated temperatures it may form explosive peroxides.

5.6.5 Storage. Ethylene glycol dimethyl ether shall be stored in a cool, well ventilated place in tightly closed containers away from sources of heat, sparks, open flame and oxidizing materials.

5.6.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices.

Ethylene glycol dimethyl ether has an EPA Hazardous Waste Classification - Ignitable, Waste Number D001.

5.7 Name. Ethylene glycol monobutyl ether, reagent  
2-Butoxyethanol



FW 118.18

CAS 111-76-2

5.7.1 Technical description. Ethylene glycol monobutyl ether (pure) exists as a colorless liquid with a density of 0.9015 g/cm<sup>3</sup> at 20°/4°C. Its boiling point is 171°C at 760mm. Its refractive index is 1.4198 at 20°C. Its flash point is 61°C (142°F) (cc). It is soluble in all proportions in water, alcohol and ether.

5.7.2 Specification. Manufacturer's Requirements. (No Government Specification).

5.7.2.1 Requirements. Ethylene glycol monobutyl ether, reagent, is available commercially with chemical and physical requirements as shown in Table VIII.

TABLE VIII. Ethylene glycol monobutyl ether, reagent - chemical and physical requirements.

Characteristics	Requirement
Typical appearance	Colorless liquid
Assay (by GLC), % by wt, min	97
Typical assay (by GLC), % by wt	99.6

5.7.3 Use. Ethylene glycol monobutyl ether, reagent, is used as a solvent and to improve emulsifying properties.

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5.7.4 Safety. Ethylene glycol monobutyl ether is a combustible liquid. It is irritating to the eyes, skin, respiratory tract and mucous membranes. It is absorbed through the skin. Inhalation of vapor or mist shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Ethylene glycol monobutyl ether shall be used with adequate ventilation. The LEL is 1.1% and the UEL is 12.7% in air.

Ethylene glycol monobutyl ether is a fire hazard when exposed to heat, sparks and flame. Burning may produce carbon dioxide and/or carbon monoxide. It can react with oxidizing materials. At elevated temperatures it may form explosive peroxides.

5.7.5 Storage. Ethylene glycol monobutyl ether shall be stored in a cool, well-ventilated place in tightly closed containers away from sources of heat, sparks, flame and oxidizing materials.

5.7.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices.

An EPA Hazardous Waste Classification is not listed in 40 CFR.

5.8 Name. Ethylene glycol monoethyl ether, analyzed reagent  
 2-Ethoxyethanol  $C_2H_5OCH_2CH_2OH$   
 FW 90.12  
 CAS 110-80-5

5.8.1 Technical description. Ethylene glycol monoethyl ether (pure) exists as a colorless liquid, practically odorless with a density of 0.9297 at 20°/4°C. Its boiling point is 135°C at 760mm. Its refractive index is 1.4080 at 20°C. Its flash point is 49°C (120°F) (cc). It is soluble in all proportions in water, alcohol and ether. It is very soluble in acetone.

5.8.2 Specification. Federal, O-C-265, Chemicals, Analytical; General Specification For.

5.8.2.1 Requirements. The federal specification physical requirements for ethylene glycol monoethyl ether, analyzed reagent, are shown in Table IX.

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TABLE IX. Ethylene glycol monoethyl ether, analyzed reagent - chemical and physical requirements (USP).

Characteristics	Requirement
Specific gravity	0.929 - 0.931
Boiling range	Not less than 95% distills between 133° and 135°C

Ethylene glycol monoethyl ether, analyzed reagent, is also available commercially with chemical and physical requirements as shown in Table X.

TABLE X. Ethylene glycol monoethyl ether, analyzed reagent - chemical and physical requirements.

Characteristics	Requirement
Typical appearance	Colorless liquid
Assay (by GLC), % by wt, min	99
Typical assay (by GLC), % by wt	99.9
Residue after evaporation, % by wt, max	0.02
Water content (by Karl Fischer) % by wt, max	0.3
Acid content (by titration) (as acetic acid), % by wt, max	0.02
Specific gravity (at 20°C), min-max	0.927 to 0.933

5.8.3 Use. Ethylene glycol monoethyl ether, analyzed reagent, is used as a reagent in analytical chemistry. It is also used in synthesis of drugs and in histology.

5.8.4 Safety. Ethylene glycol monoethyl ether is a combustible liquid. It is irritating to the eyes, skin, respiratory tract and mucous membranes. It may cause adverse reproductive effects. Inhalation of vapor or mist shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Ethylene glycol monoethyl ether shall be used with adequate ventilation. The LEL is 1.7% and the UEL is 15.6% in air.

Ethylene glycol monoethyl ether is a fire hazard when exposed to heat, sparks and flame. It can react with oxidizing materials.

5.8.5 Storage. Ethylene glycol monoethyl ether shall be stored in a cool, well-ventilated place in tightly closed containers away from sources of heat, sparks, flame and oxidizing materials.

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5.8.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices.

Ethylene glycol monoethyl ether has an EPA Hazardous Waste Classification - Ignitable, Waste Number D001.

5.9 Name. Ethylene glycol monomethyl ether, analyzed reagent  
 2-Methoxyethanol  $\text{CH}_3\text{OCH}_2\text{CH}_2\text{OH}$   
 Methyl Cellosolve FW 76.11  
 CAS 109-864

5.9.1 Technical description. Ethylene glycol monomethyl ether (pure) exists as a colorless liquid, with a density of  $0.9647 \text{ g/cm}^3$  at  $20^\circ/4^\circ\text{C}$ . Its melting point is  $-85.1^\circ\text{C}$  and boiling point is  $125^\circ\text{C}$  at 768mm. Its refractive index is 1.4024 at  $20^\circ\text{C}$ . Its flash point is  $46^\circ\text{C}$  ( $115^\circ\text{F}$ ) (cc). It is soluble in all proportions in water, ether and benzene. It is very soluble in alcohol and soluble in acetone.

5.9.2 Specification. Federal, O-C-265, Chemicals, Analytical; General Specification For.

5.9.2.1 Requirements. The federal specification physical requirements for ethylene glycol monomethyl ether, analyzed reagent, are shown in Table XI.

TABLE XI. Ethylene glycol monomethyl ether, analyzed reagent - chemical and physical requirements (ACS).

Characteristics	Requirement
Assay ( $\text{CH}_3\text{OCH}_2\text{CH}_2\text{OH}$ ), % by wt, min	99.0
Color (APHA) max <u>1</u> / <sub>1</sub>	10
Titrateable acid, max	0.002 meq/g
Water (by Karl Fischer), % by wt, max	0.1

1/ Equivalent to Pt-Co Scale according to ASTM D 1209

5.9.3 Use. Ethylene glycol monomethyl ether, analyzed reagent, is used as a solvent in spectrophotometric analysis.

5.9.4 Safety. Ethylene glycol monomethyl ether is a combustible liquid. It is irritating to the eyes, skin, respiratory tract and mucous membranes. It is absorbed through the skin. Exposure to ethylene glycol monomethyl ether may cause blood disorders, nervous system injury and adverse reproductive effects. Inhalation of vapor or mist shall be avoided. Contact with the eyes, skin and clothing shall be avoided.

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Ethylene glycol monomethyl ether shall be used with adequate ventilation. The LEL is 2.5% and the UEL is 14% in air.

Ethylene glycol monomethyl ether is a fire hazard when exposed to heat, sparks and flame. Burning may produce carbon dioxide and/or carbon monoxide. It can react with oxidizing materials. At elevated temperatures it may form explosive peroxides.

5.9.5 Storage. Ethylene glycol monomethyl ether shall be stored in a cool, well-ventilated place in tightly closed containers away from sources of heat, sparks, flame and oxidizing materials.

5.9.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices.

Ethylene glycol monoethyl ether has an EPA Hazardous Waste Classification - Ignitable, Waste Number D001.

5.10 Name. Ethylene glycol monophenyl ether, analyzed reagent  
 2-Phenoxyethanol C<sub>6</sub>H<sub>5</sub>OCH<sub>2</sub>OH FW 138.16  
 CAS 122-99-6

5.10.1 Technical description. Ethylene glycol monophenyl ether (pure) exists as a colorless, slightly viscous liquid, with a density of 1.1020 g/cm<sup>3</sup> at 20°/4°C. Its boiling point is 237°C at 760mm. Its refractive index is 1.5340 at 20°C. Its flash point is 121°C (250°F) (cc). It is slightly soluble in water, and soluble in alcohol, acetone and glycerine.

5.10.2 Specification. Federal, O-C-265, Chemicals, Analytical; General Specification For.

5.10.2.1 Requirements. The federal specification physical requirements for ethylene glycol monophenyl ether, analyzed reagent, are shown in Table XII.

TABLE XII. Ethylene glycol monophenyl ether, analyzed reagent - chemical and physical requirements (USP).

Characteristics	Requirement
Assay (C <sub>8</sub> H <sub>10</sub> O <sub>2</sub> ), % by wt, min	99
Phenol (C <sub>6</sub> H <sub>6</sub> O)	To pass color test



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5.10.3 Use. Ethylene glycol monophenyl ether, analyzed reagent, is used as a reagent in analytical chemistry. It is also used in organic synthesis.

5.10.4 Safety. Ethylene glycol monophenyl ether is irritating to the eyes, skin, respiratory tract and mucous membranes. Inhalation of vapor or mist shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Ethylene glycol monophenyl ether shall be used with adequate ventilation.

Ethylene glycol monophenyl ether is a fire hazard when exposed to heat or flame. It can react with oxidizing materials.

5.10.5 Storage. Ethylene glycol monophenyl ether shall be stored in a cool, well-ventilated place in tightly closed containers away from sources of heat, sparks, flame and oxidizing materials.

5.10.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices.

An EPA Hazardous Waste Classification is not listed in 40 CFR.

5.11 Name. Isopropyl ether, analyzed reagent

Diisopropyl ether

Diisopropyl oxide



FW 102.18

CAS 108-20-3

5.11.1 Technical description. Isopropyl ether (pure) exists as a colorless, volatile, hygroscopic liquid with an ethereal odor with a density of 0.7370 g/cm<sup>3</sup> at 20°/4°C. Its boiling point is 83°C. Its refractive index is 1.376 at 21°C. Its flash point is -12°C (9°F) (cc). It is slightly soluble in water, soluble in acetone and very soluble in alcohol.

5.11.2 Specification. Federal, O-C-265, Chemicals, Analytical; General Specification For.

5.11.2.1 Requirements. The federal specification chemical and physical requirements for isopropyl ether, analyzed reagent, are shown in Table XIII.



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TABLE XIII. Isopropyl ether, analyzed reagent - chemical and physical requirements (ACS).

Characteristics	Requirement
Assay (C <sub>3</sub> H <sub>7</sub> ) <sub>2</sub> O, % by wt, min	99.0
Color (APHA), max <u>1/</u>	25
Peroxide (as C <sub>6</sub> H <sub>14</sub> O <sub>2</sub> ), % by wt., max	0.05
Residue after evaporation, % by wt, max	0.01
Titrateable acid, max	0.0007 meq/g

1/ Equivalent to Pt-Co Scale according to ASTM D 1209.

NOTE: For spectrophotometric determination, use isopropyl ether that meets the following additional requirement: Absorbance - Its absorbance at 225mm, in a 10mm quartz cell, does not exceed 0.2, water being used as a blank.

5.11.3 Use. Isopropyl ether, analyzed reagent, is used as a solvent for animal and vegetable oils, as an extractant, as a reaction medium and in analytical chemistry.

5.11.4 Safety. Isopropyl ether is a flammable liquid. It is irritating to the eyes, skin and respiratory system. Contact with the liquid may produce a dry, fissured dermatitis. Inhalation of vapor or mist shall be avoided. Contact with the eyes and skin shall be avoided. Isopropyl ether shall be used with adequate ventilation. Isopropyl ether has a LEL of 1.4% and an UEL of 7.9% in air.


Isopropyl ether tends to form explosive peroxides. It should not be allowed to evaporate to dryness unless the absence of peroxides has been shown. The presence of water or appropriate reducing agents lessens peroxide formation. Isopropyl ether is a dangerous fire and explosion hazard when exposed to heat, sparks and flame.

5.11.5 Storage. Isopropyl ether shall be stored in a cool, well-ventilated place in tightly closed containers away from sources of heat, sparks, flame and oxidizing materials.

5.11.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices.

Isopropyl ether has an EPA Hazardous Waste Classification - Ignitable, Waste Number D001.

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5.12 Name. Tetrahydrofuran, analyzed reagent  $\text{OCH}_2\text{CH}_2\text{CH}_2\text{CH}_2$   
 Tetramethylene oxide   
 Diethylene oxide FW 72.10  
 CAS 109-99-9

5.12.1 Technical description. Tetrahydrofuran (pure) exists as a colorless liquid with ethereal odor and density of  $0.888 \text{ g/cm}^3$  at  $20^\circ\text{C}$ . Its freezing point is  $-65^\circ\text{C}$  and boiling point is  $66^\circ\text{C}$ . Its refractive index is 1.4070 at  $20^\circ\text{C}$ . Its flash point (oc) is  $-15^\circ\text{C}$  ( $5^\circ\text{F}$ ). Its autoignition temperature is  $321^\circ\text{C}$ . It is soluble in water and organic solvents.

5.12.2 Specification. Federal, O-C-265, Chemicals, Analytical; General Specification For.

5.12.2.1 Requirements. The federal specification chemical and physical requirements for tetrahydrofuran, analyzed reagent are shown in Table XIV.

TABLE XIV. Tetrahydrofuran, analyzed reagent - chemical and physical requirements (ACS).

Characteristics	Requirement
Assay ( $\text{C}_4\text{H}_8\text{O}$ ), % by wt, min	99.0
Color (APHA), max <u>1/</u>	20
Peroxide (as $\text{H}_2\text{O}_2$ ), % by wt, max	0.015
Residue after evaporation, % by wt, max	0.03
Water (by Karl Fischer), % by wt, max	0.05

1/ Equivalent to Pt-Co Scale according to ASTM D 1209.

NOTE: Generally, a stabilizer is present to retard peroxide formation.

5.12.3 Use. Tetrahydrofuran, analyzed reagent, is used as a reagent in chemical analysis, in Grignard reactions and as a chemical intermediate.

5.12.4 Safety. Tetrahydrofuran is a flammable liquid. It is highly toxic and a strong irritant to the eyes, skin, respiratory tract and mucous membranes. Inhalation of vapor or mist shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Tetrahydrofuran shall be used with adequate ventilation. Tetrahydrofuran has a LEL of 2% and an UEL of 11.8% in air.

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Tetrahydrofuran tends to form explosive peroxides. It should not be allowed to evaporate to dryness unless the absence of peroxides has been shown. It should be distilled only in the presence of a reducing agent. The presence of appropriate reducing agents lessens peroxide formation. It is a dangerous fire risk when exposed to heat, sparks and flame.

5.12.5 Storage. Tetrahydrofuran shall be stored in a cool, well-ventilated place in tightly closed containers away from sources of heat, sparks, flame and oxidizing materials.

5.12.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices.

Tetrahydrofuran has an EPA Hazardous Waste Classification - Ignitable; Toxic, Waste Number U213.

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## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This standard is intended to cite nomenclature, chemical abstracts service registry numbers, formulas, physical and chemical properties, specification requirements, military and typical commercial uses, safety information, storage information and disposal information for Ethers, Reagent Grade (Including ACS and USP-NF Compounds) preferred for application by the Department of Defense.

6.2 Subject term (key word) listing.

Dibutyl ether, reagent  
Diethyl ether, analyzed reagent  
Diethyl ether, anhydrous, analyzed reagent  
Dioxane, analyzed reagent  
Diphenyl ether, analyzed reagent  
Ethylene glycol dimethyl ether, analyzed reagent  
Ethylene glycol monobutyl, ether, reagent  
Ethylene glycol monoethyl ether, analyzed reagent  
Ethylene glycol monomethyl ether, analyzed reagent  
Ethylene glycol monophenyl ether, analyzed reagent  
Exposure limits, hazardous chemicals  
Hazardous wastes, disposal and storage of  
Information, hazardous chemicals  
Isopropyl ether, analyzed reagent  
Safety, hazardous chemicals  
Tetrahydrofuran, analyzed reagent

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

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Project Number 6810-1293

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2. DOCUMENT DATE (YYMMDD)

930312

## 3. DOCUMENT TITLE

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4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

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