METRIC

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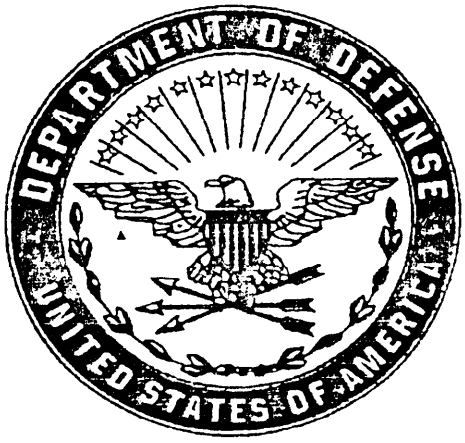
MILITARY STANDARD

ORGANIC ACIDS AND ACID ANHYDRIDES, TECHNICAL GRADE



AMSC N/A

FSC 6810

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FOREWORD

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-PET-S, Aberdeen Proving Ground, MD 21010-5423, by using the self-addressed Standardization Document Improvement Proposal (DD1426) appearing at the end of this document or by letter.

3. This standard is 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 is not a procurement document. This document is not intended to restrict any service in selecting new items required to support state-of-the-art changes.

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LIST OF TABLES

1. SCOPE

1.1 Coverage. This standard is a presentation of nomenclature, symbols, physical and chemical properties and requirements, military and typical commercial uses, directions for use, packaging data, labeling, general safety precautions, storage information, shelf life and disposal instructions for military standard organic acids. This standard does not necessarily include all classification of the items represented by the title or those which are commercially available. It does contain items preferred for use in the selection of technical grade industrial organic acids for application by the Department of Defense.

1.2 Application. Organic acids and anhydrides, technical grade, are mainly used as neutralizing and acidifying agents, preparation of high temperature lubricants for jet engines, corrosion inhibitors, cleaning agents, peptizing agents in incendiary oils and flame thrower fuels, electroplating bath additives, modifier for lubricants, manufacture of plastics, laboratory reagents, laundry agent and bleach materials ammunition and explosive materials, photographic chemical, ammunition lubricants, and crude oil deodorant.

1.3 Classification. The items in this standard are classified on the basis of chemical composition as organic acids and acid anhydrides in FSC 6810.

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-A-76	Acetic Acid, Glacial, Technical
O-O-690	Oxalic Acid, Dihydrate, Technical

MILITARY

JAN-A-187	Acid, Picric (Trinitrophenol)
MIL-S-271	Stearic Acid, Technical
JAN-A-459	Acetic Anhydride
JAN-A-465	Acid, Acetic (For Ordnance Use)
MIL-M-10452	Monochloroacetic Acid, Technical
MIL-C-11029	Citric Acid, Technical
MIL-C-13246	Cresylic Acid, Technical

STANDARDS

FEDERAL

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

MILITARY

MIL-STD-12	Abbreviations for Use on Drawings, Specifications, Standards and in Technical Documents

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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. Unless otherwise specified, the issues are those cited in the solicitation.

PUBLIC LAW (PL)

94-580	Resource Conservation and Recovery Act

CODE OF FEDERAL REGULATIONS (CFR)

Title 29	Department of Labor, Occupational Safety and Health Administration
Title 40	Protection of the Environment; Environmental Protection Agency
Title 49	Department of Transportation; Hazardous Materials Regulations

DEPARTMENT OF DEFENSE (DOD)

DODISS	Department of Defense Index of Specifications and Standards
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 506	Occupational and Environmental Health Occupational Vision
TM 38-250	Packaging, Materials Handling - Preparation of Hazardous Materials for Military Air Shipment

GOVERNMENT PRINTING OFFICE (GPO)

Style Manual

(Application for copies should be addressed to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

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

(Application for copies should be addressed to NIOSH, 4676 Columbia Parkway, Cincinnati, OH 46226-1998.)

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 shall be those listed in the issue of 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.

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.)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

Z87.1	Occupational and Educational Eye and Face Protection

(Application for copies should be addressed to American National Standards Institute, 1430 Broadway, New York, NY 10018.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 3845	Standard Specification for Glacial Methacrylic Acid
E 11	Standard Specification for Wire-Cloth Sieves for Testing Purposes
E 380	Metric Practice

(Application for copies should be addressed to American Society for Testing and Materials, 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.)

(Nongovernment standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

Abbreviations: (Abbreviations conform to the GPO Style Manual and as shown hereinafter.)

n_D^{20} - Refractive index at 20°C. The superscript indicates the temperature in degrees Celsius. The subscript indicates the wavelength for sodium light.

bp_{760} - Boiling point at 760 mm of mercury. The subscript indicating the pressure in millimeters of mercury.

cps - Centipoise (viscosity)

d_{20}^{20} - Specific gravity at 20°C and 20°C. The superscript indicating the temperature of the measured liquid, and the subscript indicating the temperature of water, viz. This example is 20 degrees Celsius for the liquid under consideration and 20 degrees is the comparative liquid water at 20 degrees Celsius.

dp_{760} - Dry point at 760 mm of mercury. The subscript indicating the pressure in millimeters of mercury.

% by wt - Percent by weight.

PEL - Permissible Exposure Limits.

LD_{50} - Lethal dose where the subscript indicates the percent of the population who do not survive.

TWA - Time weighted average is the employee's average airborne exposure in any 8-hour work week, which shall not be exceeded.

Pt/Co scale - Platinum-Cobalt scale for color.

cal/g-deg - Specific heat in calories per gram per Celcius degree.

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 of 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. Use of respirators is allowed under very specific circumstances to include: when effective engineering controls are not feasible or while being instituted. Respirators shall be approved by the National Institute for Occupational Safety (NIOSH) or by the Mine Safety and Health Administration (MSHA). Respiration protection programs shall be established. Employees shall be medically cleared, trained and fit tested prior to using respiratory protection. Respirators shall be selected based on hazard.

4.3.1.2 Skin protection. Personnel using these compounds shall be provided with and required to use protective gloves, sleeves, aprons, and boots whenever indicated. Selection of protective clothing shall be based on evaluation of compounds and their use. Supporting safety or industrial hygiene personnel should be contacted to ensure proper selection of protective clothing. 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 within 50 feet of where there is a potential for direct contact with harmful chemicals. Emergency showers and eye lavages shall meet minimum requirements of ANSI Standard Z87.1. Access to showers and eye lavages shall not be obstructed. When transferring chemicals, eye lavages and emergency showers shall be within 50 feet of the transfer point. Emergency showers shall be equipped with a valve that will fully open with one pull and deliver 30 gallons of water per minute.

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 clean, potable water for at least 20-30 minutes, open eyelids during irrigation, and obtain medical attention immediately, continue eye irrigation during transport. (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 Exercise. Participation in training 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 (54.4°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 (refers only to materials that have become waste materials), 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. (Refers only to

materials that have become waste materials.) 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. 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 and Physical Agents and Biological Exposure Indices, 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. The latest information should be provided by consulting competent professionals for values and cautions necessary in handling chemicals described herein.

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. (Refers only to materials that have become waste materials.) 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, which refers only to materials that have become waste materials. Some commercial chemical products are listed as acute hazardous in toxicity under Subpart D, Section 261.33(e).

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.

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 TCLP) 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 (CHEM-

TREC), can be called for assistance. 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 THEIR PARTICULAR SITUATION REGARDLESS OF SIMILARITY TO A CORRESPONDING DEPARTMENT OF DEFENSE OR OTHER GOVERNMENT SITUATION.

5. DETAILED REQUIREMENTS

5.1 Name. ACETIC ACID, GLACIAL CH_3COOH FW 60.05
Ethanoic acid
Methane carboxylic acid
Vinegar acid

5.1.1 Technical description. Glacial acetic acid is a clear, colorless liquid with a pungent odor. It is hazardous and is classified as a corrosive material. The commercially available acid is about 99.5% pure, the balance being water. The material contracts slightly on freezing. It is an excellent solvent for many organic compounds, also phosphorus, sulfur, and halogen acids. Miscible with water, alcohol, ether, carbon tetrachloride; insoluble in carbon disulfide. The chemical and physical properties of acetic acid, glacial are as shown in Table I.

TABLE I. Acetic acid, glacial - chemical and physical properties.

Characteristic	Value
Boiling point, bp_{760}, °C	118
Freezing point, °C	16.7
Vapor pressure, mm Hg @ 70°F	11
Vapor density (air = 1)	2.1
Specific gravity, *d*	1.05
Volatiles, % by vol	100
Flash point range (closed cup), °C	39-43
Lower explosive limit, % by vol	4
Upper explosive limit, % by vol	16
Refractive index, n_D^{20}	1.3718
LD_{50}, g/kg	3.53
pH of 1.0 M sol.	2.4
pKa	4.74

5.1.2 Specifications. Federal, O-A-76, Acetic Acid, Glacial, Technical. Military, JAN-A-465, Acid, Acetic (For Ordnance Use).

5.1.2.1 Requirements. The federal specification requirements and the military specification requirements for acetic acid, glacial are as shown in Table II.

TABLE II. Acetic acid, glacial, technical - federal and military specification requirements.

Property	Requirement			
	O-A-76		JAN-A-465	
	Min	Max	Min	Max
Acetic acid (as CH_3COOH), % by wt	99.5	---	99.90	---
Color (Pt/Co scale)	---	1/	---	10
Suspended matter	---	None	---	None
Freeze point, °C	15.7	---	16.4	---
Sediment	---	None	---	---
Turbidity	---	None	---	---
Chlorides	---	---	---	None
Sulfate	---	---	---	None
Formic acid	---	---	---	None
Sulfurous acid	---	---	---	None
Heavy metals 2/	---	---	---	None

1/ Clear liquid.
2/ Heavy metals are defined as Sb, As, Bi, Cd, Co, Cu, Pb, Mn, Hg, Ni, Sn and Zn.

5.1.3 Use. Glacial acetic acid is intended for military use as a general neutralizing and acidifying agent and as a solvent for essential oils, resins, etc. Typical commercial applications include use in the manufacture of various acetates, acetyl compounds, plastics and rubber; in tanning; as a laundry sour; printing calico and dyeing silk; preserving foods; solvent for gums, resins, volatile oils and many other substances. Widely used in commercial organic syntheses.

5.1.4 Safety. Overexposure to glacial acetic acid causes burns to the eyes and skin. Vapors are irritating to eyes, nose, throat and lungs. Ingestion may cause severe corrosion of the mouth and G.I. tract with death following. Chronic exposure may cause erosion of dental enamel, bronchitis and eye irritation. Glacial acetic acid reacts vigorously with oxidizing agents and is a moderate fire hazard when exposed to flames. Heating to decomposition will emit toxic fumes. Extinguish fires with alcohol foam, water spray, dry chemical or CO_2. Cool containers and flush and dilute spills with water spray. TLV for acetic acid is 10 ppm or 25 mg/m^3. (Refer to 4.3.1)

5.1.5 Storage. Glacial acetic acid should be stored in original container in a dry area above 16.7°C and away from sources of heat or flame. Containers should be kept tightly closed and plainly labeled. When stored under ideal conditions, this material has an indefinite shelf life. Avoid contact with chromic and nitric acids and sodium peroxide. If frozen thaw by carefully moving container to warm area as acetic acid contracts slightly on freezing.

For military use, glacial acetic acid is packaged in a 5-lb (2.27 kg) unit quantity glass bottle, and a 450-lb (204.3 kg), 55-gallon (206.25 liters) unit quantity drum.

5.1.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

An EPA Hazardous Waste Classification for acetic acid is listed in 40 CFR as F027. The DOT hazard classification is Corrosive Material with the identification number UN2789 and IMCO Classification 8 in accordance with 49 CFR Section 172.101 and 172.102.

5.2 Name. ACETIC ANHYDRIDE $(CH_3CO)_2O$ FW 102.09
Acetic oxide
Acetyl oxide

5.2.1 Technical description. Acetic anhydride is a very refractive liquid with a strong acetic odor. It is soluble in water, alcohol, chloroform and ether. It is very combustible. The physical properties of acetic anhydride are as shown in Table III.

TABLE III. Acetic anhydride - physical properties.

Characteristic	Value
Flash point, °C	54
Specific gravity, d_4^{15}	1.080
Boiling point, bp_{760}, °C	139
Melting point, °C	-73
Refractive index, n_D^{20}	1.3904
LD_{50}, g/kg	1.78

5.2.2 Specifications. Military, JAN-A-459, Acetic Anhydride.

5.2.2.1 Requirements. The military specification requirements for acetic anhydride are as shown in Table IV.

TABLE IV. Acetic anhydride - military specification requirements.

Property	Requirement	
	Min	Max
Color, Pt/Co scale	---	10
Suspended matter	---	None
Purity, % by wt	97.0	---
Chlorides	---	None
Sulfates	---	None
Heavy metals[1/]	---	None

[1/] Heavy metals are defined as Sb, As, Bi, Cd, Co, Cu, Pb, Mn, Hg, Ni, Sn, Zn.

5.2.3 Use. Acetic anhydride is used in organic synthesis as a dehydrating agent in nitrations, sulfonations and other reactions where removal of water is necessary. It is also used to manufacture acetyl compounds, cellulose acetates, as an acetulizer and solvent for examining wool fat, glycerol, fatty and volatile oils and resins and the detection of rosin.

5.2.4 Safety. Overexposure to acetic anhydride may result in irritation of eyes and skin and necrosis of tissues.

5.2.5 Storage. Acetic anhydride should be kept in a cool dry place and away from sources of heat. Containers should be tightly closed and plainly labeled. When stored under ideal conditions, this material has an indefinite storage life. Avoid contact with chromic and nitric acids and sodium peroxide.

5.2.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

An EPA Hazardous Waste Classification for acetic anhydride is not listed in 40 CFR. The DOT hazard classification is Corrosive Material with the identification number UN1715 and IMCO Classification 8 in accordance with 49 CFR Section 172.101 and 172.102.

5.3 Name. ADIPIC ACID $HOOC(CH_2)_4COOH$ FW 146.14
Hexanedioic acid (IUPAC)
1,4-Butanedicarboxylic acid

5.3.1 Technical description. Adipic acid is a white, odorless powder. It is soluble in water, alcohols, and acetone, and slightly soluble in benzene and petroleum ether, and it is insoluble in ether. The chemical and physical properties of adipic acid are as shown in Table V.

TABLE V. Adipic acid - chemical and physical properties.

Characteristic	Value
Melting point, °C	152
Boiling point (decomposition), bp_{760}, °C	338
Specific gravity, d_4^{25}	1.36
K_1 (25°C)	3.90×10^{-5}
K_2	5.29×10^{-6}
pH (sat. aq. sol. @ 25°C)	2.7
pH (0.1% aq. sol.)	3.2

5.3.2 Specifications. None.

5.3.2.1 Requirements. Refer to 5.3.1.

5.3.3 Use. Adipic acid has a possible military use as an intermediate in the preparation of a high temperature lubricant for jet engines. Typical commercial uses are manufacturing of artificial resins, plastics (nylon), and urethane foams. It is used in baking powders instead of tartaric acid, cream of tartar, and phosphates because adipic acid is not hydroscopic.

5.3.4 Safety. Since adipic acid is non-toxic, it requires only ordinary industrial precautions.

5.3.5 Storage. Solid adipic acid and its aqueous solutions are corrosive to mild steel at ordinary temperatures. Corrosion is accelerated at elevated temperatures. Molten acid and hot aqueous solutions can be handled satisfactorily in stainless steel. Dry acids can be stored and moved in aluminum equipment. The wet acid can be handled in equipment lined with epoxy and modified polyurethane coatings. For military use adipic acid is packaged in multi-walled bags containing 50-lbs (22.7 kg) and pillar-pacs containing 2000-lbs (908 kg).

5.3.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

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

5.4 Name. BENZOIC ACID (IUPAC) $C_7H_6O_2$ FW 122.12
Phenylformic acid
Benzenecarboxylic acid
Dracylic acid

5.4.1 Technical description. Benzoic acid is a white or yellowish-pinkish white crystalline flake with a slight odor suggestive of benzaldehyde. The chemical and physical properties are as shown in Table VI.

TABLE VI. Benzoic acid - chemical and physical properties.

Characteristic	Value
Melting point, °C	122
Boiling point, bp_{760}, °C	249.2
Specific gravity, d_4^{20}	1.321
Refractive index, n_D^{20}	1.5387
Solubility at 25°C, g/100 ml, in:	
Water	0.95
Water at 95°C	6.80
Carbon tetrachloride	4.14
Toluene	10.6
Methanol	71.5
Benzene	12.17
Chloroform	15.02
Acetone	55.60
Ethyl ether	40.8
Ethanol (absolute)	58.4
pH of sat. sol. at 25°C	2.8
Flash point range, °C	121-131
Auto ignition temperature, °C	570
K_1 (25°C)	6.4×10^{-5}
Vapor pressure, mm Hg @ 21°C	10
Vapor density (Air = 1)	4.21

5.4.2 Specifications. None.

5.4.2.1 Requirements. Refer to 5.4.1.

5.4.3 Use. Benzoic acid has a possible military use as an effective corrosion inhibitor by reducing the tendency of many metals to corrode in various environments. Typical commercial uses are in the preserving of foods, fats, fruit juices and alkaloidal solutions and in the manufacturing of benzoates and benzoyl compounds, dyes, as well as a mordant in calico printing and finally as an additive for curing tobacco.

5.4.4 Safety. Overexposure to benzoic acid may cause irritation to the respiratory tract. Ingestion of large quantities may cause abdominal pain, vomiting and nausea. Contact with eyes and skin may cause irritation or severe burns. Extinguish fires with water spray, dry chemicals, alcohol foam or carbon dioxide. Since benzoic acid is non-toxic, it requires only ordinary industrial precautions.

5.4.5 Storage. Store in tightly closed containers in a cool, dry, ventilated area. Isolate from oxidizers, bases, metals and flammable materials. Fine dust is a potential explosion hazard (minimal explosive concentration is 0.011 g/l air). Emits toxic fumes of phenol, benzene and carbon dioxide when heated. For possible military use benzoic acid, technical is supplied as flake in 50-lb (22.7 kg) bags per disposable shrink-wrapped pallet. Benzoic acid is also packaged in 0.25 lb (113.4 g) bottles.

5.4.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

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

5.5 Name. CITRIC ACID, MONOHYDRATE (IUPAC) FW 210.14

$HOOCCH_2C(OH)(COOH)CH_2COOH \cdot H_2O$

2-Hydroxy-1,2,3-propanetricarboxylic acid
B-Hydroxytricarballylic acid

5.5.1 Technical description. Citric acid, monohydrate occurs as colorless translucent crystals, or as a white granular to fine crystalline powder. It is odorless with a strong acid taste and is efflorescent in dry air. The chemical and physical properties of citric acid, monohydrate are as shown in Table VII.

TABLE VII. Citric acid, monohydrate - chemical and physical properties.

Characteristic	Value
Specific gravity	1.542
Melting point, °C	100
Solubility g/100g in:	
Ether	2.17
Chloroform	0.007
Amyl alcohol	15.43
Amyl acetate	5.98
Ethyl acetate	5.28
pH of 0.1N sol.	2.2
LD_{50}, mg/kg	975

5.5.2 Specifications. Military, MIL-C-11029, Citric Acid, Monohydrate, Technical.

5.5.2.1 Requirements. The military specification requirements of citric acid, monohydrate are as shown in Table VIII.

TABLE VIII. Citric acid, monohydrate (IUPAC) - military specification requirements.

Property	Requirement	
	Min	Max
Anhydrous citric acid, % by wt	99.5	---
Opalescence	---	None
Turbidity	---	None
Precipitation	---	None
Particle size, % by wt, through:		
4750 µm sieve	---	95.0
300 µm sieve	---	10

5.5.3 Use. Citric acid, monohydrate is intended for military use as a cleaning agent in applications such as distillation equipment sets and may be used to prevent solidification (setting) of bleach slurry. Commercial uses are as sequestering agents, including water conditioning and cleaning and polishing agents for stainless steel and other metals, alkyd resins and mordants.

5.5.4 Safety. Overexposure to citric acid monohydrate can cause irritation and skin sensitization. Dust is a low risk allergen. Extinguish fires with water spray, dry chemicals or carbon dioxide. Decomposition to CO, CO_2 and H_2O can be expected.

5.5.5 Storage. Citric acid is to be stored in a cool, dry place in the original containers. The shelf life is considered to be indefinite. Avoid contact with metal nitrates. Neutralize with soda ash or sodium bicarbonate.

Citric acid is packaged in 50-lb (22.7 kg) net quantities in fiber drums or 5 gallon (19 liter) pails.

5.5.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

An EPA Hazardous Waste Classification for citric acid monohydrate is not listed in 40 CFR.

5.6 Name. CRESYLIC ACID $HOC_6H_4CH_3$ FW 108.13
Cresol(s)
Cresylol
Tricresol

5.6.1 Technical description. Cresylic acid is the trade designation for commercial mixtures of phenol materials boiling above the cresol range. This chemical is a colorless to a yellowish, brownish-yellow or pinkish liquid having an antiseptic sweet phenolic odor. Cresylic acid consists of phenols, cresols, xylenols and higher phenols in various proportions, according to its source and boiling range. Cresylic acid darkens with age and with exposure to light. It is miscible with alcohol, benzene, ether, glycerol and petroleum ether. The chemical and physical properties of cresylic acid are as shown in Table IX.

TABLE IX. Cresylic acid, technical - chemical and physical properties.

Characteristic	Value
Boiling point, bp_{760}, °C	190
Melting point, °C	-17.8
Vapor pressure, mm Hg @ 70°F	1
Vapor density (Air = 1)	3.86
Specific gravity range, d_{25}^{25}	1.030-1.038
Solubility in water, %	5
pH	5.5
Flash point, °C	79
LEL	1.5

5.6.2 Specifications. Military, MIL-C-13246, Cresylic Acid, Technical.

5.6.2.1 Requirements. The military specification requirements of cresylic acid, technical are as shown in Table X.

TABLE X. Cresylic acid, technical - military specification requirements.

Property	Requirement	
	Min	Max
Water content, % by wt	---	1.0
Oil and naphthalene content, % by wt	---	0.25
Distillation, temp, in % by vol		
5.0, °C	180	208
50.0, °C	---	212
95.0, °C	---	225
Dry point, °C	---	230

5.6.3 Use. Cresylic acid is intended for military use as a peptizing agent in incendiary oils and flame thrower fuels. Typical commercial applications include use for tricresyl phosphate, disinfectants, metal cleaning compounds, phenolic resins, flotation agents, surfactants, chemical intermediates, oil additives, wire enamel solvent, solvent refining of lubrication oils, scouring compounds, detergents and pesticides.

5.6.4 Safety. Overexposure to cresylic acid will cause severe eye damage, skin discoloration yielding serious burns or systemic poisoning. Inhalation may cause systemic poisoning and irritation to eyes, nose and throat. Ingestion may cause systemic poisoning, and burning pain from mouth to stomach. May be fatal. Extinguish fires with carbon dioxide foam, dry chemical or water fog. Combustion gases may be toxic. Decomposes to CO, CO_2 and other hydrocarbons.

5.6.5 Storage. Cresylic acid, technical grade is packaged for military use in one-gallon (3.785 liter) unit quantity cans and 55-gallon (206.25 liter) unit quantity lined, low carbon, steel drums. Store material in a cool, dry, ventilated area away from sources of heat or flame. Avoid contact with strong oxidizing agents. Containers should be kept tightly closed and plainly labeled. When stored under ideal conditions, the shelf life should be five years from the date of manufacture.

5.6.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

An EPA Hazardous Waste Classification for cresylic acid is listed in 40 CFR as U052. It is labeled poison with the identification number UN2022 and IMCO Classification 6.1 in accordance with 49 CFR Section 172.102.

5.7 Name. 2-ETHYLHEXOIC ACID (SOCMA) $CH_3(CH_2)_3CH(C_2H_5)COOH$ FW 144.21
2-Ethylhexanoic acid (IUPAC)
Octoic acid

5.7.1 Technical description. 2-Ethylhexoic acid is a mild-odored liquid. It is slightly soluble in water with a freezing point of -83°C and a specific gravity of 0.91 at 20°C. The chemical and physical properties of 2-ethylhexoic acid are as shown in Table XI.

TABLE XI. 2-Ethylhexoic acid - chemical and physical properties.

Characteristic	Value	
	Min	Max
Specific gravity 20°C/20°C	0.904	0.909
Color (Pt-Co Scale)	---	50
Distillation range, % by vol, °C (760 mm)		
Initial BP, °C	222	---
5°C	224	---
95°C	---	230
Purity, % by wt	98	---

5.7.2 Specification. None.

5.7.2.1 Requirements. Refer to 5.7.1.

5.7.3 Use. 2-Ethylhexoic acid is intended for military use as a peptizer in the preparation of incendiary oil thickeners. Typical commercial applications of this material include use as herbicides and pesticides. Its metallic salts, particularly lead, manganese, cobalt, and zinc are used as high quality paint and varnish driers. Ethylhexoates, of light metals such as lithium, magnesium, calcium, and aluminum have the property of jelling agent for liquid hydrocarbons such as gasoline and common petroleum fractions used in coating thinners. High molecular weight esters of this acid are also especially useful as plasticizers.

5.7.4 Safety. 2-Ethylhexoic acid is toxic and may cause eye and skin irritation. In case of contact with the eyes, flush with water for at least 20 minutes and obtain medical attention immediately. In case of contact with the skin, flush affected areas with water.

5.7.5 Storage. Store in a cool place away from areas of acute fire hazard and powerful oxidizing agents. Heat has no appreciable effect below the boiling point. The material will freeze but it is not degraded by thawing. This material will develop a color if stored in contact with iron, otherwise the shelf life is indefinite. 2-Ethylhexoic acid shall be packaged for military use in oblong, interior lined or coated, one-gallon (3.785 liter) unit quantity cans, both ends double seamed with formed-type bridge handles. The screw-cap closure shall be provided with inner seals and self-shrinking plastic overseals, and internal surfaces shall be lined or coated with the same material as used for lining or coating the internal surfaces of the can.

5.7.6 Disposal. For appropriate procedure, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4.)

An EPA Hazardous Waste Classification for 2-ethylhexoic acid is not listed in 40 CFR.

5.8 Name. FORMIC ACID (IUPAC) HCOOH FW 46.01
Methanoic acid

5.8.1 Technical description. Formic acid is a colorless liquid with a sharp odor. It is infinitely soluble in water, ether, alcohol and glycerol. Formic acid is hazardous and is classified as a corrosive material. The chemical and physical properties of formic acid are as shown in Table XII.

TABLE XII. Formic acid - chemical and physical properties.

Characteristic	Value
Refractive index, n_D^{20}	1.3714
Specific gravity, d_4^{20}	1.220
Melting point, °C	8.4
Boiling point, bp_{760}, °C	100.7
Dissociation constant	1.8×10^{-4}
Flash point (open cup), °C	71.1
Freezing point, °C	1.1
LEL, % by vol	18.0
UEL, % by vol	57.0
pK	3.739
LD_{50}, mg/kg	1100

5.8.2 Specifications. None.

5.8.2.1 Requirements. Refer to 5.8.1.

5.8.3 Use. Formic acid has a possible military use for electroplating. Some typical commercial uses are as a reducer in dyeing wool fast colors, in dehairing and plumping hides, tanning, in regenerating old rubber, and finally in chemical analysis.

5.8.4 Safety. Overexposure to formic acid will cause corneal damage to eyes, irritation and burning pain in skin, and irritation of nose, throat and respiratory tract. Also causes chronic lung and eye damage, dermatitis, irritation and burns. Extinguish fires with dry chemical, foam, carbon dioxide or water spray. Decomposition releases CO and CO_2.

5.8.5 Storage. For military use formic acid is packaged in a 5-lb (2.27 kg) unit quantity glass bottle, and a 450-lb (204.3 kg), 55-gallon (206.25 liter) unit quantity drum. Formic acid 90% is corrosive to carbon steel, copper alloys and lead compounds. It should be stored in a warm dry area away from sources of heat or flame and well ventilated. Avoid contact with strong oxidizers and bases. When stored under ideal conditions, this material has an indefinite shelf life. It is recommended that formic acid be stored in stainless steel containers. The TLV for formic acid vapor is 5 ppm and for formic acid mist is 9 mg/m^3.

5.8.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4.)

An EPA Hazardous Waste Classification for formic acid is listed in 40 CFR as U123. It is labeled corrosive with the identification number UN1779 and IMCO Classification 8 in accordance with 49 CFR 172.102.

5.9 Name. FUMARIC ACID $C_4H_4O_4$ FW 116.07
Trans-butenedioic acid
1,2-Ethylene dicarboxylic acid (IUPAC)
(E)-2-Butenedioic acid
Allomaleic acid
Boletic acid

5.9.1 Technical description. Fumaric acid is a white odorless crystalline powder with a sour taste. The chemical and physical properties of fumaric acid are as shown in Table XIII.

TABLE XIII. Fumaric acid - chemical and physical properties.

Characteristic	Value
Boiling point, bp_{760}, °C	165
Boiling point (sealed tube), °C	290
Melting point range (sealed tube), °C	286 - 288
Sublimation point, °C	200
Specific gravity, d^{20}	1.625
Vapor pressure (mm Hg @ 70°F)	10.1
Solubility at 25°C, g/100 ml:	
Acetone	1.7
Alcohol, 95% sol. at 30°C	5.76
Benzene	0.003
Carbon Tetrachloride	0.03
Chloroform	0.02
Ethanol	5.5
Ether	0.72
Ethyl Ether	0.7
Water	0.63
Water at 100°C	9.8
Xylene	0.03
Autoignition temperature, °C	740
LEL, % by vol	3.0
UEL, % by vol	40
Dissociation constants in H_2O at 25°C:	
K_1	9.3×10^{-4}
K_2	2.9×10^{-5}

5.9.2 Specifications. None.

5.9.2.1 Requirements. Refer to 5.9.1.

5.9.3 Use. Fumaric acid has a possible military use as a viscosity index improver, and pour-point depressants for lubricating oils. Typical commercial uses are for the production of polyesters, modified alkyds, and rosin adducts and

for upgrading drying oils. It is also used as a substitute for tartaric acid in beverages and baking powders, as an antioxidant and as a mordant in dyeing.

5.9.4 Safety. Overexposure to fumaric acid may cause irritation of the nose and throat and impair breathing. Also causes irritation of skin and eyes, sore throat, vomiting and abdominal pain if ingested. Extinguish fires with carbon dioxide, halon, foam, dry chemical or water fog. Decomposition may release CO, CO_2 and irritating fumes of maleic anhydride.

5.9.5 Storage. For possible military use fumaric acid, technical is supplied as fine granular powder in 250 lb (113.5 kg) drums, 50 lb (22.7 kg) bags and 500 gr bottles. Since fumaric acid is non-toxic, it requires only ordinary industrial precautions. Fumaric acid should be stored under cool temperatures. Avoid contact with aluminum, iron and zinc.

5.9.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4.)

An EPA Hazardous Waste Classification for fumaric acid is listed in 40 CFR as U123.

5.10 Name. METHACRYLIC ACID $C_4H_6O_2$ FW 86.09
2-Methylpropenoic acid
α-methylacrylic acid

5.10.1 Technical description. Methacrylic acid is a corrosive liquid with an acrid, repulsive odor. It is soluble in warm water and miscible with alcohol and ether. It polymerizes easily, especially on heating or in the presence of HCl.

5.10.1.1 Physical properties. The chemical and physical properties of methacrylic acid are as shown in Table XIV.

TABLE XIV. Methacrylic acid - chemical and physical properties.

Characteristic	Value
Specific gravity, d_4^{20}	1.0153
Boiling point, bp_{760}, °C	163
Freezing point, °C	15
Refractive index, n_D^{20}	1.43143
Flash point (open cup), °C	76
LD_{50} g/kg	8.4

5.10.2 Specifications. ASTM D 3845, Glacial Methacrylic Acid.

5.10.2.1 Requirements. The ASTM specification requirements for glacial methacrylic acid are as shown in Table XV.

TABLE XV. Glacial methacrylic acid - ASTM specification requirements.

Property	Requirement	
	Min	Max
Assay (as methacrylic acid), % by wt	98.5	---
Water, % by wt	---	0.30
Color, Pt/Co scale	---	25
Inhibitor, methyl ether of hydroquinone	---1/	

1/ No requirement, but as agreed between purchaser and manufacturer.

5.10.3 Use. Methacrylic acid is used in the manufacture of methacrylate resins and plastics.

5.10.4 Safety. Overexposure to methacrylic acid may result in irritation of eyes and skin and is a presumed carcinogenic compound.

5.10.5 Storage. Methacrylic acid should be stored in a cool, dry place.

5.10.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

An EPA Hazardous Waste Classification for methacrylic acid is listed in 40 CFR as U008. It is labeled corrosive with the identification number UN2531 and IMCO Classification 8 in accordance with 49 CFR 172.102.

5.11 Name. MONOCHLOROACETIC ACID $Cl \cdot CH_2COOH$ FW 94.50
Chloroacetic acid (SOCMA)
Chloroethanoic acid
MCA

5.11.1 Technical description. Monochloroacetic acid is a colorless or white deliquescent crystalline solid. The commercial material has a specific gravity of 1.580, a boiling point of 189°C and a melting point range of 61-63°C. It is soluble in water, alcohol, benzene, ether, chloroform, and carbon disulfide. Monochloroacetic acid is hazardous and is classified as a corrosive material.

5.11.2 Specifications. Military, MIL-M-10452, Monochloroacetic Acid, Technical.

5.11.2.1 Requirements. The military specification requirements for monochloroacetic acid are as shown in Table XVI.

TABLE XVI. Monochloroacetic acid - military specification requirements.

Property	Requirement
Form	Crystalline
Color	Colorless to light brown
Freezing point, °C	60.0
Assay as $Cl \cdot CH_2COOH$, % by wt, min	97.0
Dichloroacetic acid, % by wt, max	1.5
Acetic acid, % by wt, max	1.5

5.11.3 Use. Monochloroacetic acid is intended for military use as a laboratory reagent. Commercial uses are as an herbicide, an intermediate in production of carboxymethylcellulose, ethyl chloroacetate, glycine, synthetic caffeine, sarcosine, thioglycolic acid, EDTA, 2,4,-D, 2,4,5-T and dyes.

5.11.4 Safety. Overexposure to monochloroacetic acid may cause irritation to skin and mucous membranes. The LD_{50} in rats, mice and guinea pigs is 76, 255 and 80 mg/kg orally, respectively.

5.11.5 Storage. Monochloroacetic acid shall be packaged in 1-kilogram (2.2 lb) unit quantity glass bottles. Store in a dry area at room temperature. Keep bottles closed when not in use to prevent formation of crust. Under these conditions the shelf life is indefinite.

5.11.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

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

5.12 Name. OXALIC ACID, DIHYDRATE $(COOH)_2 \cdot 2H_2O$ FW 126.07
Ethanedioic acid (IUPAC)

5.12.1 Technical description. Oxalic acid, dihydrate, is a transparent, colorless, odorless, crystal which will effloresce in dry air. It is the simplest dibasic organic acid and among the strongest organic acids. It is moderately soluble in cold water, extremely soluble in hot water, and soluble in alcohol, ether and glycerol, but insoluble in benzene, chloroform and petroleum ether. The chemical and physical properties of oxalic acid, dihydrate are as shown in Table XVII.

TABLE XVII. Oxalic acid, dihydrate, chemical and physical properties.

Characteristic	Value
Specific gravity, $d_4^{18.5}$	1.654
Sublimation point, °C	157
Melting point range, °C	101-102
Boiling point, bp_{760}, °C	111
Vapor pressure, mm Hg @ 70°F	Nil
Decomposition temp, °C	100
Solubility in H_2O, %	9.5
K_1	5.36×10^{-2}
K_2	5.3×10^{-5}
pH (1 M sol.)	1.3
LD_{50}, ml/kg	9.5

5.12.2 Specifications. Federal, O-O-690, Oxalic Acid, Dihydrate, Technical.

5.12.2.1 Requirements. The federal specification requirements of oxalic acid, dihydrate, technical are as shown in Table XVIII.

TABLE XVIII. Oxalic acid, dihydrate, technical - federal specification requirements.

Property	Requirement	
	Min	Max
Assay (as $H_2C_2O_4 \cdot 2H_2O$), % by wt	99.0	---
Ash, % by wt	---	0.20
Particle size, % by wt:		
For Class 1:		
Retained on a 1.4 mm sieve	85	---
For Class 2:		
Passing a 2.00 mm sieve	100	---
Retained on a 500 µm sieve	75	---
For Class 3:		
Retained on a 500 µm sieve	None	---
Passing through a 75 µm sieve	20	---

5.12.3 Use. Oxalic acid is intended for military use as a laundry sour and as a floor bleach. Typical commercial applications for this material include use as an automobile radiator cleaner, acid rinse in laundries, leather tanning and processing agent, purifying agent in the manufacture of glycerol, glycolic acid, formic acid and esters, dextrin from starch purification of tartaric acid and cream of tartar, bleaching agent, photography, medicinals, dyes and inks, purifying stearin, component of metal polishes, textile treating baths, ink and rust removers, cleaning agent in breweries, precipitating agent for rare earths, wood cleaning compositions, engraving and lithography, and as a catalyst for some organic reactions.

5.12.4 Safety. Overexposure to oxalic acid may result in delayed liver and/or kidney damage, mild to severe eye and skin irritation and dermatitis, respiratory irritation ulceration, chronic cough, albuminuria, vomiting, emaciation, irritation and corrosion of the G/I tract, vomiting, abdominal pain, convulsions, collapse or death. Decomposition may release CO, CO_2 and toxic formic acid.

5.12.5 Storage. For military use, oxalic acid, technical is packaged in one pound (.454 kg) unit quantity bottles and 100-pound (45.4 kg) unit quantity drums. Store in a cool dry place. Avoid heat, flame, oxidizing agents, silver, sodium chlorite, water, air, acids and carbon dioxide. Keep containers tightly capped and plainly marked. This material is incompatible when stored in contact with iron due to the acidic nature of the product. The shelf life of the material under proper storage conditions is at least 2 years from the date of manufacture. It is recommended that annual checks be made of the material and condition of the containers.

5.12.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

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

5.13 Name. PICRIC ACID (IUPAC) (SOCMA) $C_6H_2(NO_2)_3OH$ FW 229.11
2-Hydroxy-1,3,5-trinitrobenzene
Phenol trinitrate
Trinitrophenol
2,4,6-Trinitrophenol
Carbazotic acid
Nitroxanthic acid
Picronitric acid

5.13.1 Technical description. Picric acid occurs as pale yellow crystals or liquid and is bitter and odorless. It is soluble in water, alcohol, chloroform, benzene and ether. It has a very bitter taste. It is moderately soluble in water. (It explodes above 300°C.) In its dry and crystal form, picric acid is classified as HIGH EXPLOSIVE and will explode if subjected to shock. Picric acid, wet, with not less than 10% water is classified as a flammable solid. The chemical and physical properties of picric acid are as shown in Table XIX.

TABLE XIX. Picric acid - chemical and physical properties.

Characteristic	Value
Boiling point, bp_{760}, °C	300
Melting point, °C	122.2
Specific gravity, *d*	1.767
Flash point, °C	150
Autoignition temperature, °C	300
Vapor pressure (mm Hg @ 383°F)	1
Vapor density (Air = 1)	7.9
Decomposition temperature, °C	300
Volatiles, % by vol	10 - 15

5.13.2 Specifications. Military, JAN-A-187, Acid, Picric (Trinitrophenol).

5.13.2.1 Requirements. The military specification requirements of picric acid are as shown in Table XX.

TABLE XX. Picric acid - military specification requirements.

Property	Requirement	
	Min	Max
Granulation, through 1410 μm (No. 14) USS Sieve, %	99.5	---
Solidification point, °C	120.0	---
Moisture		
Purchase dry, % by wt	---	0.20
Purchase wet, % by wt	---	22.0
Ash, % by wt	---	0.1
Insoluble matter, % by wt	---	0.1
Acidity		
Total sulfuric acid, % by wt	---	0.1
Nitric acid	---	None
Lead, % by wt	---	0.0004

5.13.3 Use. Picric acid is intended for military use in the manufacture of ammonium picrate and of compositions used in the loading of high explosive shells. Commercial uses include dyes; matches; electric batteries; etching copper, dyeing and printing textile fabrics with compound dyes which also contain such dyes as benzaldehyde green, methyl violet and indigo carmine; and picrates.

5.13.4 Safety. Overexposure to picric acid can cause moderate to severe eye and skin irritation and burns, skin discoloration (yellow), sensitization and dermatitis, nausea, vomiting, diarrhea, dark urine, anemia, suppressed kidney function, muscle pain, bitter taste, nephritis, gastroenteritis, stupor, coma or death. Decomposition can release CO, CO_2, nitrogen oxides, toxic and irritating gases and dense smoke. The TLV• for picric acid is 0.1 mg/m^3.

5.13.5 Storage. Must be packed in specification containers as follows: wooden boxes, DOT 15A with inside tightly closed glass or earthenware containers. The net weight shall not exceed 25 pounds dry weight in an outside container. Each container shall contain a minimum of 10% water to reduce explosive potential. Store in wooden boxes or kegs with a minimum of 10% water. Store away from metals, including copper, zinc, lead and iron, oxidizing and reducing materials and hydroxides, carbonates, plaster, concrete, ammonia, and amines. Avoid exposure to heat and shock. Under these conditions, the shelf life is indefinite.

5.13.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

An EPA Hazardous Waste Classification for picric acid is listed in 40 CFR as U234. It is labeled explosive with the identification number UN0154 and IMCO Classification 1.1D in accordance with 49 CFR Section 172.102.

5.14 Name. PYROGALLOL (SOCMA) $C_6H_3(OH)_3$ FW 126.11
1,2,3-Benzenetriol
1,2,3-Trihydroxybenzene (IUPAC)
Pyrogallic acid

5.14.1 Technical description. Pyrogallol exists as white to slightly yellow lustrous needle or leaf-like crystals, plates and powder which turn gray on exposure to light. It has a characteristic odor. Pyrogallol is soluble in water, alcohol, or ether and is slightly soluble in benzene, chloroform and carbon disulfide. It sublimes when heated gradually. It is incompatible with alkalies, ammonium hydroxide, antipyrine, camphor phenol and menthol. The chemical and physical properties of pyrogallol are as shown in Table XXI.

TABLE XXI. Pyrogallol - chemical and physical properties.

Characteristic	Value
Specific gravity, *d*	1.463
Melting point range, °C	131 - 133
Boiling point, bp_{760}, °C	309
Vapor pressure, mm Hg @ 70°F	10
Vapor density (Air = 1)	4.4
LD_{50} (orally in rabbits) g/kg	1.6

5.14.2 Specifications. None.

5.14.2.1 Requirements. Refer to 5.14.1.

5.14.3 Use. Pyrogallol is intended for use by the military as a photographic chemical and as a general reagent in analysis for oxygen and other free gases in the output of shipboard nitrogen plants. Typical commercial applications of pyrogallol include use as a protective colloid in the preparation of metallic colloidal solutions, photography, dyes, synthetic drugs, medicine, process engraving, analysis of free oxygen in air and other gas mixtures, and as an antioxidant in lubricating oils.

5.14.4 Safety. Overexposure to pyrogallol may cause severe G.I. irritation, hemolysis, skin irritation/absorption or death. Decomposition may release CO and CO_2. Poisoning and death have occurred from percutaneous absorption.

5.14.5 Storage. For military use pyrogallol is packaged in 5-lb (2.27 kg) unit quantity bottles, and in bulk quantity. Store in a cool, ventilated area, away from powerful oxidizing agents. Containers should be kept closed. The material discolors on exposure to air and light. The shelf life is considered to be a minimum of two years from the date of manufacture when stored under proper conditions. This material should be checked annually.

5.14.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

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

5.15 Name. STEARIC ACID (SOCMA) $CH_3(CH_2)_{16}COOH$ FW 284.47
Octadecanoic acid (IUPAC)
n-Octadecylic acid
Stearophanic acid

5.15.1 Technical description. Stearic acid is the most common fatty acid occurring in natural animal and vegetable fats. It is a white to light yellow saturated straight-chain fatty acid with a fatty odor. As a glyceride, it occurs with oleic and palmitic acids. Stearic acid is very slightly soluble in water, moderately soluble in alcohol, acetone, benzene, chloroform, carbon tetrachloride, and carbon disulfide and very soluble in ether and amyl acetate. Of the three subgrades, single-pressed contains the most admixed oleic acid, the triple-pressed the least. This is readily illustrated by the iodine value which is 10-14 for the single-pressed, 7-9 for double-pressed, and 2-4 for triple-pressed, as compared with 0 for pure stearic acid. The stearic acid covered by this standard shall be in flake form. The chemical and physical properties of stearic acid are as shown in Table XXII.

TABLE XXII. Stearic acid - chemical and physical properties.

Characteristic	Value		
	Min	Max	Value
Boiling point range, bp_{760}, °C	---	---	361-383
Melting point range, °C	---	58-70	---
Specific gravity	0.84	---	---
Refractive index, n_D^{80}	---	---	1.4299
Vapor pressure, mm Hg @ 70°F	---	---	1
Vapor density (Air = 1)	---	---	9.80
Autoignition temperature, °C	---	---	395
Flash point, °C	---	---	196
LD_{50}, i.v. in rats, mg/kg	---	---	21.5

5.15.2 Specifications. Military, MIL-S-271, Stearic Acid, Technical.

5.15.2.1 Requirements. The military specification requirements of stearic acid are as shown in Table XXIII.

TABLE XXIII. Stearic acid - military specification requirements.

Property	Requirement	
	Min	Max
Grit	None	---
Titer (solidification pt), °C	66	---
Acidity	---	Trace
Moisture, %	---	0.10
Iodine No.	---	1.0
Granulation, % by wt:		
Passing through #50 sieve	95	---
Passing through #100 sieve	85	---

5.15.3 Use. Stearic acid is intended for use by the military as a desensitizer and as a lubricant in the manufacture of ammunition. Typical commercial applications of stearic acid include use in lubricants, soaps, candles, pharmaceuticals, and cosmetics, rubber compoundry, shoe and metal polish, coatings and food packaging.

5.15.4 Safety. Overexposure to stearic acid may cause irritation to the eyes, skin and respiratory tract. Decomposition may release acrid fumes.

5.15.5 Storage. For military use, stearic acid is packaged in 1-gallon (3.785 liter) unit quantity cans and in 5-gallon (18.925 liter) unit quantity pails. Store in a cool, well-ventilated area away from open flame, acute fire hazards, and strong oxidizing agents. When stored under these ideal conditions, technical grade stearic acid has a maximum shelf life of one year from the date of manufacture because of unsaturated impurities degeneration. This material shall not be older than one month from the date of manufacture when purchased.

5.15.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

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

5.16 Name. TANNIC ACID $C_{14}H_{10}O_9$ FW 322.23
Gallotannic acid
Gallotannin
Tannin
Digallic acid

5.16.1 Technical description. Tannic acid is a naturally-occurring substance widely found in gallnuts and the bark of various trees, such as hemlock, oak, and sumac. There are varied structures and the formula $C_{14}H_{10}O_9$ is only an average value. In the pure form it varies in color from light yellow to brown, and is available in the form of glistening scales, an amorphous powder,

bulk powder, flakes or a spongy mass. It has a faint characteristic odor and astringent taste. It darkens when exposed to air and light. Its most characteristic property is the ability to form an insoluble compound with collagen, which constitutes the tanning of leather. Tannic acid is a strong astringent. The material is extremely soluble in water, warm glycerol, acetone and alcohol, and insoluble in benzene, chloroform, petroleum ether, carbon tetrachloride and carbon disulfide. It decomposes at 210-215°C and the flash point is 198.9°C. It is incompatible with salts of heavy metals, alkaloids, gelating albumin, starch, oxidizing substances such as permanganates and chlorates, spirit nitrous ether and lime water. The tannic acid covered by this standard is a quebracho extract in powder form with a 65% minimum assay as tannic acid.

5.16.2 Specifications. None.

5.16.2.1 Requirements. Refer to 5.18.1.

5.16.3 Use. Tannic acid is intended for military use as a deodorizing agent of crude oil. Typical commercial applications for tannic acid include use as a denaturing agent in the tanning of leather; as a mordant in dyeing textiles; as a fermenting agent in the fermenting of wines; in the manufacture of medicines and pharmaceuticals, as a deodorizing agent in crude oil; in the manufacture of rubber substitutes, photographic chemicals, and stove polishing compounds.

5.16.4 Safety. Tannic acid is flammable, but nontoxic. Normal laboratory safety precautions are required when handling tannic acid. Tannic acid is considered a nuisance particulate with a TLV of 10 mg/m^3 of total dust. Tannic acid shall be used with adequate ventilation. LD_{50} in mice is 6.0 g/kg.

5.16.5 Storage. Tannic acid, technical is packaged for military use in 100-lb (45.4 kg) unit quantity bags. It should be stored in a cool, well ventilated area away from open flame, acute fire hazards, and powerful oxidizing agents. The shelf life is considered to be five years from date of manufacture.

5.16.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. (Refer to 4.4)

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

6. NOTES

6.1 Intended use. This standard is intended to cite nomenclature, formulas, physical and chemical properties, specification requirements, military and typical commercial uses, safety information, storage information, and disposal information for Organic Acids and Acid Anhydrides, Technical Grade preferred to application by the Department of Defense.

6.2 Subject term (key word) listing.

α-Methylacrylic acid
ACETIC ACID, GLACIAL
ACETIC ANHYDRIDE
Acetic oxide
Acetyl oxide
ADIPIC ACID
Allomaleic acid
B-Hydroxytricarballylic acid
Benzenecarboxylic acid
1,2,3-Benzenetriol
BENZOIC ACID
Boletic acid
1,4-Butanedicarboxylic acid
(E)-2-Butenedioic acid
Carbazotic acid
Chloroacetic acid
Chloroethanoic acid
CITRIC ACID, MONOHYDRATE
Cresol(s)
Cresylic acid
Cresylol
Digallic acid
Dracylic acid
Ethanedioic acid
Ethanoic acid
1,2-Ethylene dicarboxylic acid
2-ETHYLHEXANOIC ACID
2-Ethylhexoic acid
Exposure limits, hazardous chemicals
FORMIC ACID
FUMARIC ACID
Gallotannic acid
Gallotannin
Hazardous wastes, disposal and storage of
Hexanedioic acid
2-Hydroxy-1,2,3-propanetricarboxylic acid
2-Hydroxy-1,3,5-trinitrobenzene
Information, hazardous chemicals
MCA
METHACRYLIC ACID
Methane carboxylic acid
Methanoic acid
2-Methylpropenoic acid
MONOCHLOROACETIC ACID

N-Octadecylic acid
Nitroxanthic acid
Octadecanoic acid
Octoic acid
OXALIC ACID, DIHYDRATE
Phenol trinitrate
Phenylformic acid
PICRIC ACID
Picronitric acid
Pyrogallic acid
PYROGALLOL
Safety, hazardous chemicals
STEARIC ACID
Stearophanic acid
TANNIC ACID
Tannin
Trans-butenedioic acid
1,2,3-Trihydroxybenzene
Tricresol
Trinitrophenol
2,4,6-Trinitrophenol
Vinegar acid

6.3 Changes from previous issue. The changes include reformatting and updating tables and text in Section 5, a complete re-write of Section 4 and the addition of Section 6.

6.4 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.

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CONCLUDING MATERIAL

Lead Standardization Activity:

Defense Logistics Agency - GS

Custodians:

Army - EA
Navy - SH
Air Force - 68

Preparing Activity:

Army - EA
Project Number 6810-1249

Review Activities:

Army - None
Navy - None
Air Force - None

User Activities:

Army - MI, AR
Navy - AS, MC, YD