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MILITARY STANDARD

**INORGANIC ACIDS AND ACID ANHYDRIDES, REAGENT GRADE
(INCLUDING ACS AND USP-NF COMPOUNDS)**



AMSC N/A

FSC 6810

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FOREWORD

Inorganic Acids and Acid Anhydrides, 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 Technical Director, U.S. Army Edgewood Research, Development and Engineering Center, Attn: SCBRD-ENE (STD/SPECS/PKG), 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, symbols, physical and chemical properties and requirements, military and typical commercial uses, directions for use, packaging data, labeling, general safety precautions, storage information, and shelf life of all military standard reagent grade, inorganic acids and acid anhydrides. This standard does not necessarily include all classifications of the items represented by the title or those which are commercially available. It does contain items preferred for use in the selection of inorganic acids and acid anhydrides, reagent grade (including ACS and USP-NF compounds) for application by the Department of Defense.

1.2 Application. Inorganic acids and acid anhydrides, reagent grade (including ACS and USP-NF compounds) are used as reagents in analytical chemistry.

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

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2. APPLICABLE 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

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

MILITARY

- | | |
|-------------|---|
| MIL-C-51130 | - Chemicals, Reagent Grade, General Specification For |
| MIL-A-51313 | - Arsenic Pentoxide, Analyzed Reagent |

STANDARDS

FEDERAL

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

MILITARY

- | | |
|------------|---|
| MIL-STD-12 | Abbreviations For Use On Drawings, And In Specifications, Standards And Technical Documents |
|------------|---|

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the 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 - Environmental Protection Agency (EPA); Hazardous Waste And Consolidated Permit Regulations
- Title 49 - Department Of Transportation; Hazardous Materials Regulations (DOT)

DEPARTMENT OF DEFENSE PUBLICATIONS

- DOD 4145.19-R-1 - Storage and Materials Handling
- DOD 4160.21-M - Defense Utilization And Disposal Manual
- DOD 6050.5-LR - DOD Hazardous Materials Information System, Hazardous Item Listing
- TB MED 502 - Occupational And Environmental Health Respiratory
(DLAM 1000.2) Protection Program (under revision)
- TB MED 506 - Occupational And Environmental Health Occupational
Vision
- TM 38-250 - Packaging, Materials Handling-Preparation Of
Hazardous Materials For Military Air Shipment
- AR 11-34 - The Army Respiratory Protection Program

FEDERAL ACQUISITION REGULATION

Contractual acquisition of Material Safety Data Sheet information
(paragraph 52.223-3)

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

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

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

Public Law 94-580 Management of items classified as hazardous waste.

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(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.

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 GOVERNMENT INDUSTRIAL HYGIENISTS (ACGIH)

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

Volume 13: Transactions of ACGIH Activities 1985 Conference.

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z358.1-1990 for Emergency Eyewash and Shower Equipment.

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

AMERICAN SOCIETY FOR TESTING MATERIALS (ASTM)

ASTM E 11	-	Standard Specification for Wire-Cloth Sieves For Testing Purposes
ASTM E 380	-	Standard For Metric Practice

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- ASTM D 874 - Standard Test Method for Sulfated Ash From Lubricating Oils and Additives
- ASTM D 1209 - Color of Clear Liquids (Platinum-Cobalt Scale)

(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.

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

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

Dangerous Goods Regulations

(Application for copies should be addressed to the Publications Assistant, International Air Transport Association, 2000 Peel Street, Montreal, Quebec, Canada H3A 2R4.)

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO)

Technical Instructions for the Safe Transport of Dangerous Goods by Air, DOC 9284-AN/905.

(Application for copies should be addressed to the Document Sales Unit, International Civil Aviation Organization, 1000 Sherbrooke Street West, Suite 400, Montreal, Quebec, Canada H3A 2R2.)

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INTERNATIONAL MARITIME ORGANIZATION (IMO)

International Maritime Dangerous Goods Code (IMDG), Publication 200 89.10E, Vols. I-IV.

(Application for copies should be addressed to the International Maritime Organization, 4 Albert Embankment, London SE1 7SR.)

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.)

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 certified to meet 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 Decomposition - The chemical separation of a substance into two or more simpler substances, which differ from each other and from the original substance.

3.1.4 Explosive limits - When combustible vapor is mixed with air in the proper proportions, ignition will produce an explosion. This proper proportion is called the explosive range. The explosive range includes all concentrations of a mixture of flammable vapor or gas in air, in which a flash will occur or a flame will travel if the mixture is ignited. The lowest percentage at which this occurs is the lower explosive limit; and the highest percentage, the upper explosive limit. Explosive limits are expressed in percent by volume of vapor in air and, unless otherwise specified, under normal conditions of temperature and pressure.

3.1.5 Flash point - The temperature to which a substance must be heated under specific conditions to give off sufficient vapor to form a mixture with air that can be ignited momentarily by a specified flame.

3.1.6 Formula weight - The sum of the atomic weights of all the atoms appearing in a chemical formula. In this standard, it is computed according to international atomic weight values of 1961.

3.1.7 Hazardous substance - Any substance or mixture of substances which is (1) toxic; (2) corrosive; (3) an irritant; (4) a strong sensitizer; (5) flammable, or which (6) generates pressure through decomposition, heat or other means, if such substance or mixture of substances may cause substantial personal injury or substantial illness during or as a direct result of any customary or reasonably anticipated handling or use.

3.1.8 Melting point - The temperature at which the liquid and solid phases of a substance exist together in equilibrium, and transition from the solid to the liquid occurs.

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3.1.9 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.

3.1.10 pH - A numerical measure of the hydrogen ion concentration, indicating degree of acidity or alkalinity of a solution. It is expressed as $\text{pH} = -\log_{10}[\text{H}^+]$. At the neutral point, $\text{pH} = 7$. At a pH lower than 7, a solution is acidic. At a pH higher than 7, a solution is basic.

3.1.11 Reagent grade - Denotes reagent grade chemicals which do not bear a label 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.

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

3.1.13 Technical grade - Denotes a quality of chemicals which are generally used for industrial, solvent, and manufacturing applications. Generally, specific processes are not employed by the manufacturer to limit all the impurities, aside from the normal precautions which are taken in the manufacturing process. A technical grade chemical may be specially processed to reduce specific impurities so as to suit the chemical to a given industrial application. In such cases, the identification of the items must be further expanded to indicate the specific impurities limitation.

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
DRMO	- Defense Reutilization and Marketing Office
FW	- Formula Weight
HMIS	- Hazardous Materials Information System
MSDS	- Material Safety Data Sheet
MSHA	- Mine Safety and Health Administration
PEL	- Permissible Exposure Limit
TLV	- Threshold Limit Value

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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. When the commodity is a hazardous material, the shipping containers for domestic shipments using commercial carriers shall be labeled in accordance with current Department of Transportation (DOT) Hazardous Materials Regulations applicable to each chemical. Likewise, shipping containers for international shipments using commercial carriers shall be labeled in accordance with the International Hazardous Materials Regulations appropriate for the mode of shipment used (see Para. 2.2 herein). When shipping hazardous material by military aircraft, the requirements of TM 38-250 shall apply. Additionally, each item shall be packaged and labeled as specified in the applicable contract or order. All labels shall comply with Hazard Communication Standard, 29 CFR 1910.1200 (f) and the appropriate domestic or International Hazardous Materials Regulations.

4.2 Hazardous materials information. DOD 6050.5, DOD Hazardous Materials Information System (HMIS) acquires, reviews, stores, and disseminates Material Safety Data Sheet (MSDS) information for all hazardous materials used by DOD. The contractual acquisition of a MSDS is accomplished through use of Federal Acquisition Regulation, paragraph 52.223-3, Hazardous Material Identification and Material Safety Data. The MSDS is prepared in accordance with the instructions in FED-STD-313 and shall comply with the 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, non-routine exposure (i.e., not exceeding 1 hour/day for 1 day/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. Employees assigned to use respiratory protective

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equipment shall be included in a respiratory protection program that meets the minimal requirements as stipulated in AR 11-34, "The Army Respiratory Protection Program".

4.3.1.2 Skin protection. Personnel using these compounds shall be provided with and required to use impervious gloves, sleeves, aprons, and boots whenever indicated. Protective creams and ointments commonly known as "barrier creams" may be of value in certain cases. However, barrier creams shall not be used to replace protective clothing. During use, avoid contact with eyes, skin and clothing. Wash with soap and water after handling. When not in use, keep in a tightly closed container. In case of contact with the eyes, remove any contact lenses and irrigate with copious amounts of water for at least 20-30 minutes, and obtain medical attention. Eye lavages and emergency showers shall be located where there is a potential for direct contact with harmful chemicals. All emergency eyewashes and emergency showers shall be activated weekly to flush the line and to verify proper operation in accordance with ANSI standard Z-358-1-1990.

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

4.3.1.4 Training. Employers shall provide employees with training and information, including MSDSs, on all chemical items in their work area, in accordance with 29 CFR 1910.1200 (h) and, 49 CFR 172 Subpart H, as may be applicable, 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 that affect the body and bodily functions. Employees shall be adequately trained to render first aid. Additionally, any employee involved with the packaging, preparation, handling or causing a hazardous material to be shipped or transported, shall be provided with all of the training specified in 49 CFR 172 Subpart H.

4.3.1.5 Exercises. 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.

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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 49 CFR 173.115, defines a flammable liquid as one having a closed cup flash point below 37.8°C (100°F). In the DOT's Final Rule to Docket HM-181, the flash point for a flammable liquid was raised from below 37.8°C (100°F) to not more than 60.5°C (141°F). A combustible liquid is defined, by DOT in the above reference, as one having a closed cup flash point at or above 60.5°C (141°F) 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 (200°F) or higher are to be considered as burnable. The DOT has permitted, for domestic shipments only and except for shipments by air or water, that "...a flammable liquid with a flash point at or above 38°C (100°F)..." and which does not meet the definition of any other hazard class as defined in 49 CFR, may be re-classed as a combustible liquid. The Environmental Protection Agency (EPA), in 40 CFR 261.21, 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 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 materials include compounds that react violently or form explosive mixtures on contact with water or steam, or react with water to produce toxic gases. Such waste materials exhibit the characteristic of reactivity (R) as designated by the EPA in 40 CFR 261.23. 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.

^{*}Refers to materials that have become hazardous waste.

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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. Hazardous material storage compatibility may also be determined through use of the EPA Hazardous Materials Compatibility Chart. This chart determines reactions of most binary combinations of hazardous wastes by assigning Reactivity Group Numbers (RGNs) based on chemical classes and general chemical reactivities.

4.3.3 Chemical hazardous exposure limits. Chemical hazardous exposure limits for airborne concentrations of substances are obtained from the current TLVs in Threshold Limit Values for Chemical Substances in the Work Environment adopted by the American Conference of Governmental Industrial Hygienists (ACGIH); current Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL), 29 CFR 1910.1000; and NIOSH Recommendation for Environmental Exposure Limits. Such information is also shown in MSDSs and the HMIS referred to in 4.2.

Carcinogenic substances are listed by OSHA in Category I for confirmed carcinogens, and in Category II for suspected carcinogens. Category I substances have standard exposure limits set at the lowest possible levels. Category II substances have standard exposure limits set to prevent acute or chronic effects.

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

4.3.4.1 EPA Toxic (T). Some waste chemical compounds have been designated by the EPA as toxic wastes (T) in accordance with the criteria shown in 40 CFR 261.11(a)(3).* Some commercial chemical wastes are listed as toxic wastes under 40 CFR 261.33 (f).

4.3.4.2 EPA Acute Hazardous Toxicity (H). Some waste chemical compounds have been designated by the EPA as acute hazardous wastes (H) based on toxicity in accordance with the criteria shown in 40 CFR 261.11(a)(2).* Some commercial chemical wastes are listed as acutely hazardous in toxicity under 40 CFR 261.33(e).

4.3.4.3 EPA Toxicity Characteristic Leaching Procedure (TCLP). This procedure is used to determine the properties of a waste that are directly related to the potential of

*Refers to materials that have become hazardous waste.

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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 EPA as being a hazard to groundwater in a landfill environment. (See 40 CFR 261.24)*

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 of a hazardous waste (i.e., ignitable, corrosive, reactive or are subject to Toxicity Characteristic Leaching Procedure (TCLP); or they are listed (e.g., toxic or acute hazardous wastes) according to Identification and Listing of Hazardous Waste, 40 CFR Part 261, 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 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 40 CFR 262.34 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

*Refers to materials that have become hazardous waste.

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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 40 CFR Part 262. Transportation of the waste must be in accordance with Part 263 of the above reference, Standards Applicable to Transporters of Hazardous Waste. State and/or local regulations may be more stringent than Federal requirements. It is essential that the Installation Environmental Office review all disposal actions for compliance with all applicable regulations.

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 installation 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 wastes. It is imperative that the proper description of the waste accompany the packaged item at all times. Final disposal of the waste item shall be accomplished by reutilization, transfer, donation or sales by DRMO 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 (1-800-424-9300). 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

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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.** ARSENIC PENTOXIDE, ANALYZED REAGENT As_2O_5
 Arsenic anhydride FW 229.84
 Arsenic (V) oxide CAS 1303-28-2

5.1.1 **Technical Description.** Arsenic pentoxide (pure) exists as white amorphous, deliquescent crystals with a density of 4.32 g/cm^3 . It has a melting point of 315°C with decomposition. Its solubility in water is 150 g/cm^3 at 16°C and 76.7 g/cm^3 at 100°C with the formation of arsenic acid. It is soluble in alcohol.

5.1.2 **Specification.** Military, MIL-A-51313, Arsenic Pentoxide, Analyzed Reagent.

5.1.2.1 **Requirements.** The Military Specification requirements for arsenic pentoxide, analyzed reagent is shown in Table I.

TABLE I. Arsenic pentoxide, analyzed reagent - requirements.

Assay (as As_2O_5), min, % by wt	99.0
Maximum Limits of Impurities (% by wt)	
Arsenic trioxide (As_2O_3)	0.05
Chloride (Cl)	0.005
Heavy metals (as Pb)	0.010
Iron (Fe)	0.010
Nitrate (NO_3)	To pass color test

5.1.3 **Use.** Arsenic Pentoxide, analyzed reagent is intended for use as a laboratory reagent.

5.1.4. **Safety.** Arsenic pentoxide is highly toxic. Acute poisoning usually results from ingestion; chronic poisoning may result from either ingestion or inhalation. Acute poisoning results in marked irritation of the stomach and intestines with nausea, vomiting and diarrhea. Chronic poisoning, whether through ingestion or inhalation, may result in disturbances of the digestive system. Liver damage may also occur. Inhalation of dust or mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Wash thoroughly after handling. Arsenic pentoxide must be used with adequate ventilation. The TLV for arsenic and soluble compounds as As is 0.2 mg/m^3 . The PEL is 10 mg/m^3 . For personal protective measures, refer to section 4.3.1.

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TABLE II. Arsenic pentoxide, n-hydrate analyzed reagent - requirements.

Assay, (as As_2O_5)(dried basis) (by iodometry) min, % by wt	97.0
Maximum Limits of Impurities (% by wt)	
Loss on heating at 350°C	15.0
Insoluble in NH_4OH	0.05
Chloride (Cl)	0.002
Nitrate (NO_3)	0.005
Sulfides (S)	0.001
Arsenic trioxide (As_2O_3)	0.05
Iron (Fe) (by AAS)	0.05
Lead (Pb) (by AAS)	0.05

5.2.3 Use. Arsenic pentoxide, n-hydrate, analyzed reagent is intended for use as a laboratory reagent.

5.2.4 Safety. Arsenic pentoxide, n-hydrate is highly toxic. Acute poisoning usually results from ingestion; chronic poisoning from either ingestion or inhalation. Acute poisoning results in marked irritation of the stomach and intestines with nausea, vomiting and diarrhea. Chronic poisoning by any route may result in disturbances of the digestive system. Liver damage may also occur. Inhalation of dust or mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Wash thoroughly after handling. Arsenic pentoxide, n-hydrate must be used with adequate ventilation. Arsenic pentoxide, n-hydrate is a confirmed carcinogen. The TLV for arsenic and soluble compounds as As is 0.2 mg/m^3 . The PEL is 10 mg/m^3 . For personal protective measures, refer to section 4.3.1.

If heated to decomposition, arsenic pentoxide emits highly toxic fumes. It can form AsH_3 by reduction with zinc in acid solution or by reaction with hydrogen gas.

5.2.5 Storage. Arsenic pentoxide, n-hydrate must be stored in a cool, dry, well ventilated place in tightly closed containers away from fire hazards, acids, acid fumes and combustible materials. Refer to section 4.3.2.

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

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Arsenic is listed in 40 CFR 261.24, Table 1 for toxicity characteristics. Arsenic (V) oxide will exhibit the characteristic of toxicity for arsenic. Specific State and local regulations may treat arsenic (V) oxide as a corrosive waste. Designations of toxic and corrosive hazardous waste apply only to material declared as waste.

The EPA hazardous waste number for arsenic is D004. The hazardous waste code is E for toxicity characteristic waste.

5.3	<u>Name.</u> ARSENIC TRIOXIDE, ANALYZED REAGENT	FW 197.84
	White arsenic	CAS 1327-53-3
	Arsenous oxide	
	Arsenic III trioxide	

5.3.1 Technical description. Arsenic trioxide (pure) exists as amorphous or vitreous crystals with a density of 3.738 g/cm³. Its melting point is 315°C. Its solubility in water is 3.7 g/100cm³ at 20°C and 10.14 g/100cm³ at 100°C with the formation of arsenous acid. It sublimates at 193°C.

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

5.3.2.1 Requirements. The Federal Specification requirements for arsenic trioxide, analyzed reagent are shown in Table III.

TABLE III. Arsenic trioxide, analyzed reagent - requirements (ACS).

Maximum Limits of Impurities (% by wt)	
Residue after ignition	0.02
Insoluble in dilute hydrochloric acid	0.01
Chloride (Cl)	0.005
Sulfide (S), to pass color test, about	0.001
Antimony (Sb)	0.002
Lead (Pb)	0.001
Maximum Limits of Impurities (ppm)	
Iron (Fe)	5.0

Arsenic trioxide, analyzed reagent is commercially available with a minimum purity of 99.95%.

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5.3.4 **Safety.** Arsenic trioxide is highly toxic. The acute symptoms of exposure, headache, dizziness, garlic odor breath, numbness, chills and tingling of hands and feet, are usually latent for about two days. The chronic symptoms usually appear one to six weeks after onset of exposure. The skin becomes discolored, dry and scaly. Other symptoms may include edema of eyelids, corneal necrosis, nasal irritation and dryness of throat. The central nervous system and gastrointestinal tract may also be affected. Inhalation of dust and mist of arsenic trioxide must be avoided. Wash thoroughly after handling. Arsenic trioxide is a confirmed carcinogen. The TLV for arsenic and soluble compounds as As is 0.2 mg/m³. The PEL is 10 mg/m³. For personal protective measures, refer to section 4.3.1.

5.3.5 **Storage.** Arsenic trioxide must be stored in a cool, dry, well ventilated place in tightly closed containers away from food, food products and combustible materials. Protect container against physical damage. Refer to section 4.3.2.

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

Arsenic is listed in 40 CFR, 261.24, Table 1 for toxicity characteristics. Arsenic trioxide will exhibit the characteristic of toxicity for arsenic. Specific State and local regulations may treat arsenic trioxide as a corrosive waste. Designations of toxic and corrosive hazardous waste apply only to material declared as waste. The EPA hazardous waste number for arsenic is D004. The hazardous waste code is E for toxicity characteristic waste.

5.4.	Name. BORIC ACID, ANALYZED REAGENT	H ₃ BO ₃	FW 61.83
	Boracic acid		CAS 10043-35-3
	Orthoboric acid		

5.4.1 **Technical description.** Boric acid (pure) exists as colorless triclinic crystals with a density of 1.435 g/cm³. Its solubility in water is 6.35 g/100cm³ at 20°C and 27.6 g/100cm³ at 100°C. It is also soluble in glycerol (20 g/100cm³ at 25°C). Aqueous solutions of H₃BO₃ have approximately pHs of 5.4 at 0.5%, 5.1 at 1.0%, 4.6 at 2.0%, 4.2 at 3.0%, 3.9 at 4.0%, and 3.7 at 4.65% by weight concentrations. On heating to 169° to 175°C, H₃BO₃ loses water to form metaboric acid HBO₂. Further heating forms H₂B₄O₇ and the oxide B₂O₃.

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

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5.4.2.1 Requirements. The Federal Specification requirements for boric acid, analyzed reagent are shown in Table IV.

TABLE IV. Boric acid, analyzed reagent - requirements (ACS)

Maximum Limits of Impurities (% by wt)	
Insoluble in methanol	0.005
Nonvolatile with methanol	0.05
Chloride (Cl)	0.001
Phosphate (PO ₄)	0.001
Sulfate (SO ₄)	0.005
Calcium (Ca)	0.005
Heavy metals (as Pb)	0.001
Iron (Fe)	0.001
Maximum Limits of Impurities (ppm)	
Arsenic (As)	1.0

Boric acid, analyzed reagent is commercially available in granular and powdered forms with a minimum purity, as H₃BO₃, >99.5%.

5.4.3 Use. Boric acid, analyzed reagent is used in medicine.

5.4.4 Safety. Boric acid is not considered to be an industrial poison. It is not absorbed through intact skin, but it is absorbed through mucous membranes, burned or wounded skin area, or if ingested. Death has occurred for <5 gm in infants and from 5-20 gm in adults. Absorption will produce pathological changes. Inhalation of dust must be avoided. Contact with abraded skin must be avoided. For personal protective measures, refer to section 4.3.1.

5.4.5 Storage. Boric acid must be stored in a cool, dry place in tightly closed containers. Refer to section 4.3.2.

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

EPA Hazardous Waste Classification - None.

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5.5 **Name.** CHLOROSULFONIC ACID, REAGENT ClSO_3H FW 116.52
Chlorosulfuric acid CAS 7790-94-5

5.5.1 **Technical description.** Chlorosulfonic acid (pure) exists as a colorless fuming liquid with a specific gravity of 1.766 at 18°C. It has a melting point of -80°C and a boiling point of 158°C. It decomposes to H_2SO_4 and HCl in cold water and decomposes in alcohol. It is insoluble in CS_2 .

5.5.2 **Specification.** Military, MIL-C-51130, Chemicals, Reagent Grade, General Specification For.

5.5.2.1 **Requirements.** The Military Specification requirements for chlorosulfonic acid, reagent is shown in Table V.

TABLE V. Chlorosulfonic acid, reagent - requirements.

Boiling point, °C	150-153
Specific gravity, 20°/4°C	1.760

Chlorosulfonic acid, reagent is commercially available with a minimum purity of 99.0%.

5.5.3. **Use.** Chlorosulfonic acid, reagent is intended for use as a laboratory reagent.

5.5.4 **Safety.** Chlorosulfonic acid is toxic, corrosive and nonflammable. It can cause severe acid burns and is very irritating to the eyes, lungs and mucous membranes. It can cause acute toxic effects either in the liquid or vapor state. Inhalation of concentrated vapor may cause serious damage to lung tissue. Contact with eyes can cause severe burns. It also causes skin irritation due to its highly corrosive action. Inhalation of vapor or mist must be avoided. Wash thoroughly after handling. Chlorosulfonic acid must be used with adequate ventilation. For personal protective measures, refer to section 4.3.1.

Chlorosulfonic acid reacts violently with water. When exposed to the atmosphere, chlorosulfonic acid fumes release hydrochloric acid fumes and sulfuric acid mist by reacting with moisture in the air. Inhalation of these fumes or mist may also cause lung injury. The TLV (ceiling limit) for hydrogen chloride is 5 ppm ($7\text{mg}/\text{m}^3$). The TLV for sulfuric acid is $1\text{ mg}/\text{m}^3$. The PEL is the same. Chlorosulfonic acid undergoes a

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hazardous exothermic reaction with many organic and combustible materials, nitrates, chlorates, carbides, sulfides, cyanides and metallic powders.

5.5.5 Storage. Chlorosulfonic acid must be stored in a cool, dry, well ventilated place in tightly closed containers away from incompatible materials such as organic and combustible materials, nitrates, chlorates, carbides, sulfides, cyanides and metallic powders. Do not allow water to enter containers and do not wash out containers or use for other purposes. Refer to section 4.3.2.

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

Chlorosulfonic acid EPA Hazardous Waste Classifications are Corrosive, Waste Number D002; Reactive, Waste Number D003.

5.6	<u>Name</u> . CHROMIUM TRIOXIDE, ANALYTICAL REAGENT	CrO ₃
	Chromic trioxide	FW 99.99
	Chromic anhydride	CAS 1332-82-0
	Chromic acid	
	Chromium (VI) oxide	

5.6.1 Technical description. Chromium trioxide (pure) exists as red rhombic deliquescent crystals with a density of 2.70 g/cm³ and a melting point of 196°C. It decomposes to Cr₂O₃ and oxygen at 250°C. Chromium trioxide reacts with water in different proportions, forming chromic acid, H₂CrO₄, dichromic acid, H₂Cr₂O₇, and trichromic acid, H₂Cr₃O₁₀.

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

5.6.2.1 Requirements. The Federal Specification requirements for chromium trioxide, analyzed reagent are shown in Table VI.

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TABLE VI. Chromium trioxide, analyzed reagent - requirements (ACS).

Assay (CrO ₃), min, % by wt	98.000
Maximum Limits of Impurities (% by wt)	
Insoluble matter	0.010
Chloride (Cl)	0.005
Nitrate (NO ₃)	0.050
Sulfate (SO ₄)	0.005
Sodium (Na)	0.200
Iron, aluminum, barium	0.030

5.6.3 Use. Chromium trioxide, analyzed reagent is intended for use as a reagent in analytical chemistry.

5.6.4 Safety. Chromium trioxide is highly toxic and a strong oxidizer. It is an irritant to eyes, skin and mucous membranes. The lesions are confined to the exposed parts, affecting chiefly the skin of the hands and forearms and the mucous membranes of the septum. Inhalation of dust or mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Wash thoroughly after handling. Chromium trioxide must be used with adequate ventilation. Chromium trioxide is an OSHA Category I carcinogen. The TLV for chromium (VI) compounds as Cr is 0.05 mg/m³. For personal protective measures, refer to section 4.3.1.

Chromium trioxide decomposes when heated to 250°C, liberating oxygen to support combustion. It can cause violent reactions, ignition and explosion by contact with various organic materials or reducing materials especially, contact with acetic acid, analine, alcohol, acetone and grease. Containers may explode when involved in fire.

5.6.5. Storage. Chromium trioxide must be stored in a cool, dry, well ventilated place in tightly closed containers away from heat, sparks, open flame, combustible and easily oxidizable materials. Protect containers against physical damage. Refer to section 4.3.2.

5.6.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. In case of dry spills, gather up and place in nonreactive containers. In case of small solution spills, control with nonreactive absorbent. In case of large spills, dike to prevent spreading. Refer to section 4.4.

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Chromium is listed in 40 CFR 261.24, Table 1 for toxicity characteristics. Chromium trioxide will exhibit the characteristic of toxicity for chromium. Specific State and local regulations may treat chromium trioxide as a corrosive waste. Designations of toxic and corrosive hazardous waste apply only to material declared as waste.

The EPA hazardous waste number for arsenic is D004. The hazardous waste code is E for toxicity characteristic waste.

5.7 **Name.** HYDROBROMIC ACID (48%), ANALYZED REAGENT HBr
 Hydrogen bromide FW 80.91
 CAS 10035-10-6

5.7.1 **Technical description.** Hydrobromic acid is a clear, colorless gas or a pale yellow liquid. It has a molecular weight of 80.92 g/mol. The specific gravity of the liquid is 2.7 (H₂O=1) at 20/4°C. It has a melting point of -88.5°C and a boiling point of -67.0°C. Its water solubility is 221 g/100cm³ at 0°C and 130 g/100cm³ at 100°C. A constant boiling solution is formed with a specific gravity of 1.49 (H₂O=1) at 20/4°C containing 48% hydrobromic acid. It has a melting point of -11°C and a boiling point of 126°C.

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

5.7.2.1 **Requirements.** The Federal specification requirements for hydrobromic acid (48%), analyzed reagent are shown in Table VII.

TABLE VII. Hydrobromic acid (48%), analyzed reagent - requirements (ACS).

Assay, min-max, % by wt	47.0-49.0
Maximum Limits of Impurities (% by wt)	
Organic substance	To pass odor test
Residue after ignition	0.002
Chloride (Cl)	0.05
Iodide (I) to pass color test, about	0.003
Phosphate (PO ₄)	0.001
Sulfate and sulfite (as SO ₄)	0.003

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TABLE VII. Hydrobromic acid (48%), analyzed reagent - requirements (ACS) (continued).

Maximum Limits of Impurities (ppm)	
Arsenic (As)	0.5
Heavy metal (as Pb)	5
Iron (Fe)	1
Selenium (Se), to pass color test, about	0.01

5.7.3 Use. Hydrobromic acid (48%) analyzed reagent is intended for use as a reagent in analytical chemistry.

5.7.4 Safety. Hydrobromic acid solution is highly acidic and non-flammable. It is a strong irritant to the eyes, skin and mucous membranes and respiratory organs. Inhalation of vapors and mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Hydrobromic acid must be used with adequate ventilation. The TLV for hydrobromic acid is 3 ppm (10 mg/m³). The PEL is the same. For personal protective measures, refer to Section 4.3.1.

Hydrobromic acid itself is not flammable, but it will generate hydrogen gas, which is flammable when in contact with metals.

5.7.5 Storage. Hydrobromic acid (48%) must be stored in a cool, dry, well ventilated place in tightly closed containers away from oxidizing materials, metals, wood and textiles. Refer to Section 4.3.2.

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

Hydrobromic acid (48%) has an EPA Hazardous Waste Classification - Corrosive Hazardous Waste Number D002.

5.8	<u>Name</u> . HYDROCHLORIC ACID, ANALYZED REAGENT	HCl
	Chlorohydric acid	FW 36.46
	Hydrogen chloride	CAS 7647-01-0

5.8.1 Technical description. Hydrochloric acid (pure) exists as a colorless liquid with a melting point of -114.8°C and a boiling point of -84.9°C. Its water solubility is 82.3 g/100cm³ at 0° and 56.1 g/100 cm³ at 60°C. It is soluble in ether and benzene.

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

5.8.2.1 Requirements. The Federal specification requirements for hydrochloric acid, analyzed reagent are shown in Table VIII.

TABLE VIII. Hydrochloric acid, analyzed reagent - requirements (ACS).

Appearance	Free from suspended matter or sediment
Assay (HCl), min-max, % by wt	36.5-38.0
Color (APHA) ^{1/} , max	10.0
Maximum Limits of Impurities (% by wt)	
Bromide (Br)	0.005
Maximum Limits of Impurities (ppm)	
Residue after ignition	5
Sulfate (SO ₄)	1
Sulfite (SO ₃)	1
Extractable organic substances, to pass impurities test, about	5
Free chlorine (Cl), to pass color test, about	1
Ammonium (NH ₄)	3
Arsenic (As)	0.01
Heavy metals (as Pb)	1
Iron (Fe)	0.2

^{1/} APHA requirements are the same as platinum-cobalt scale used in ASTM, designation D 1209.

5.8.3 Use. Hydrochloric acid, analyzed reagent is intended for use as a reagent in analytical chemistry.

5.8.4 Safety. Hydrochloric acid is a corrosive liquid. It is irritating to the eye, skin, mucous membranes and respiratory tract. Inhalation of vapor and mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Hydrochloric acid must be used

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with adequate ventilation. The TLV (ceiling limit) for hydrochloric acid is 5 ppm (7 mg/m³). The PEL is the same. For personal protective measures, refer to section 4.3.1.

5.8.5 Storage. Hydrochloric acid must be stored in a cool, well ventilated place in tightly closed containers away from oxidizing materials. Protect containers against physical damage. Refer to section 4.3.2.

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

Hydrochloric acid has an EPA Hazardous Waste Classification - Corrosive, Hazardous Waste Number D002.

5.9	<u>Name</u> . HYDROFLUORIC ACID, ANALYZED REAGENT	HF
	Hydrogen fluoride	FW 20.01
	Fluorohydric acid	CAS 7664-39-3

5.9.1 Technical description. Hydrofluoric acid (pure) exists as a colorless, fuming liquid with a specific gravity of 0.987 at 13.6°C (H₂O=1). Its melting point is -83.1°C and boiling point is 19.5°C. It is infinitely soluble in cold water and very soluble in hot water.

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

5.9.2.1 Requirements. The Federal specification requirements for hydrofluoric acid, analyzed reagent are shown in Table IX.

TABLE IX. Hydrofluoric acid, analyzed reagent - requirements (ACS).

Assay (HF), min-max (% by wt)	48.0-51.0
Maximum Limits of Impurities (% by wt)	
Fluosilicic acid [H ₂ (SiF ₆)]	0.01

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TABLE IX. Hydrofluoric acid, analyzed reagent - requirements (ACS) (continued).

Maximum Limits of Impurities (ppm)	
Residue after ignition	5
Chloride (Cl)	5
Phosphate (PO ₄)	1
Sulfate and sulfite (as SO ₄)	5
Arsenic (As)	0.05
Copper (Cu)	0.1
Heavy metals (as Pb)	0.5
Iron (Fe)	1

5.9.3 Use. Hydrofluoric acid, analyzed reagent is intended for use as a reagent in analytical chemistry.

5.9.4 Safety. Hydrofluoric acid is a corrosive, noncombustible liquid. It is extremely irritating to the eyes, skin and mucous membranes. Inhalation of vapor or mist must be avoided. Inhalation of vapor or mist causes ulcers of the upper respiratory tract, and concentrations of 50 to 250 ppm are dangerous even for brief exposures. Contact with the eyes, skin, and clothing must be avoided. Hydrofluoric acid produces severe skin burns and may affect the subcutaneous tissues. Hydrofluoric acid must be used with adequate ventilation. The TLV (ceiling limit) for hydrogen fluoride (as F) is 3 ppm (2.5 mg/m³). For personal protective measures, refer to section 4.3.1.

Hydrofluoric acid is dangerous when heated, emitting corrosive fluoride fumes. It will react with steam to produce toxic and corrosive fumes. It is difficult to contain as it corrodes most substances except lead, wax, polyethylene and platinum.

5.9.5 Storage. Hydrofluoric acid must be stored in a cool, well ventilated place in tightly closed containers made of resistant material such as polyethylene, away from heat and sources of direct sunlight. Refer to section 4.3.2.

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

Hydrofluoric acid has an EPA Hazardous Waste Classification - Corrosive; Toxic, Waste Number U134.

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5.10 Name. IODIC ACID, ANALYZED REAGENT HIO_3 FW 175.91
CAS 7782-68-5

5.10.1 Technical description. Iodic acid (pure) exists as colorless or pale yellow crystalline powder or rhombic crystals with a density of 4.629 g/cm^3 . It decomposes at 110°C . Its solubility in water is 286 g/100cm^3 at 0°C and 473 g/100cm^3 at 80°C . It is very soluble in 87% alcohol, slightly soluble in HNO_3 and insoluble in absolute alcohol, ether and chloroform. It is sensitive to light.

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

5.10.2.1 Requirements. The Federal Specification requirements for iodic acid, analyzed reagent are shown in Table X.

TABLE X. Iodic acid, analyzed reagent - requirements (ACS).

Assay (HIO_3), min (% by wt)	99.50
Maximum Limits of Impurities (% by wt)	
Insoluble matter	0.01
Residue after ignition	0.02
Chloride and bromide (as Cl)	0.02
Iodide (I)	0.01
Nitrogen compounds (as N)	0.1
Sulfate (SO_4)	0.015
Heavy metals (as Pb)	0.001
Maximum Limits of Impurities (ppm)	
Iron (Fe)	5

5.10.3 Use. Iodic acid, analyzed reagent is intended for use as a reagent in analytical chemistry. It is also used in medicine.

5.10.4 Safety. Iodic acid is a strong oxidizer and irritating to the eyes, skin and mucous membranes. Inhalation of dust or mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Iodic acid must be used with adequate ventilation. For personal protective measures, refer to section 4.3.1.

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Iodic acid is a dangerous fire hazard in contact with combustible materials. If heated to decomposition, iodic acid can emit highly toxic fumes.

5.10.5 Storage. Iodic acid must be stored in a cool, dry, well ventilated place in tightly closed containers away from combustible materials. Protect from light. Refer to section 4.3.2.

5.10.6 Disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to section 4.4. Iodic acid is classified by the EPA as a hazardous waste. It satisfies the characteristic of ignitability, Hazardous Waste Number D001.

5.11 Name. IODIC PENTOXIDE, ANALYZED REAGENT I_2O_5 FW 333.81
Iodic anhydride CAS 12029-98-0
Iodine (V) oxide

5.11.1 Technical description. Iodic pentoxide (pure) exists as white trimetric hygroscopic crystals with a density of 4.799 g/cm³ at 25/4°C. It decomposes between 300-350°C. It has a solubility of 187.4 g/cm³ in water at 13°C and is very soluble in hot water. It is insoluble in alcohol, ether, chloroform and carbon disulfide. It is sensitive to light.

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

5.11.2.1 Requirements. The Federal specification requirements for iodic pentoxide, analyzed reagent are shown in Table XI.

TABLE XI. Iodic pentoxide, analyzed reagent - requirements (USP).

Assay (I_2O_5), min, % by wt	98.5
Maximum Limits of Impurities (% by wt)	
Residue on ignition	0.05
Heavy metals (as Pb)	0.001
Iron (Fe)	0.002

5.11.3 Use. Iodic pentoxide, analyzed reagent is intended for use as a reagent in analytical chemistry.

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5.11.4 **Safety.** Iodic pentoxide is an oxidizer and highly toxic. It is irritating to the eyes, skin and mucous membranes. Inhalation of vapor and dust must be avoided. Contact with the eyes, skin and clothing must be avoided. Iodic pentoxide must be used with adequate ventilation. Its vapor effect upon the body is similar to that of chlorine and bromine, but it is more irritating to the lungs. Signs and symptoms are irritation and burning of the eyes and lachrymation, cough, irritation of the nose and throat. For personal protective measures, refer to section 4.3.1.

Iodic pentoxide is a slight explosive hazard when exposed to heat or flame. There is a dangerous fire hazard from spontaneous chemical reaction. Iodine compound will react with steam to produce toxic fumes and can react vigorously with reducing materials.

5.11.5 **Storage.** Iodic pentoxide must be stored in a cool, dry, well ventilated place in tightly closed containers away from sources of heat and open flame and reducing materials. Protect from light. Refer to section 4.3.2.

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

Iodic pentoxide has an EPA Hazardous Waste Classification - Ignitable, Waste Number D001.

5.12	Name. MOLYBDENUM TRIOXIDE, ANALYZED REAGENT	MoO ₃
	Molybdic acid anhydride	FW 143.94
	Molybdenum (VI) oxide	CAS 1313-27-5

5.12.1 **Technical description.** Molybdenum trioxide (pure) exists as colorless or white-yellow rhombic crystals with a density of 4.692 g/cm³ at 21°C. Its melting point is 795°C and it sublimates at 1155°C at 760 mm Hg. Its solubility in water is 0.1066 g/100cm³ at 18°C and 2.055 g/cm³ at 70°C. It will precipitate in the presence of acids, and is soluble in bases.

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

5.12.2.1 **Requirements.** The Federal specification requirements for molybdenum trioxide, analyzed reagent are shown in Table XII.

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TABLE XII. Molybdenum trioxide, analyzed reagent - requirements (ACS).

Assay (MoO ₃), min, % by wt	99.5
Maximum Limits of Impurities (% by wt)	
Insoluble in dilute ammonium hydroxide	0.01
Chloride (Cl)	0.002
Nitrate (NO ₃) to pass color test, limit about	0.003
Arsenate, phosphate, and silicate (as SiO ₂)	0.001
Sulfate (SO ₄)	0.02
Ammonium (NH ₄)	0.002
Heavy metals	0.005
Maximum Limits of Impurities (ppm)	
Phosphate	5

5.12.3 Use. Molybdenum trioxide, analyzed reagent is intended for use as a reagent in analytical chemistry.

5.12.4 Safety. Molybdenum trioxide is relatively nontoxic. It may be irritating to the eyes, skin and mucous membranes. Inhalation of dust or mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Molybdenum trioxide must be used with adequate ventilation. The TLV for molybdenum trioxide is 10 mg/m³. The PEL is 15 mg/m³. For personal protective measures, refer to section 4.3.1.

5.12.5 Storage. Molybdenum trioxide must be stored in a cool, dry, well ventilated place in tightly closed containers. Refer to section 4.3.2.

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

5.13 Name. NITRIC ACID, ANALYZED REAGENT HNO₃ FW 63.01
 Aqua fortis (69%) CAS 7697-37-2
 Hydrogen nitrate (90%) CAS 52583-42-3
 Azotic acid

5.13.1 Technical description. Nitric acid (pure) exists as a colorless liquid with a density of 1.5027 g/cm³ at 25/4°C. It freezes to a white solid at -42°C and boils at 83°C. It is soluble in all proportions in both hot and cold water. It decomposes in alcohol and is

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soluble in ether. An aqueous solution containing 68% of the acid has a constant boiling point of 120.5°C.

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

NOTE: Nitric acid, meeting ACS Specifications for reagent chemical is available as 69% and 90% (sometimes referred to as fuming) concentrations.

5.13.2.1. Requirements. The Federal specification requirements for nitric acid (69%) analyzed reagent are shown in Table XIII.

TABLE XIII. Nitric acid (69%) analyzed reagent - requirements (ACS).

Appearance	Colorless and free from suspended matter or sediment
Assay (HNO ₃), min-max, % by wt	69.0-71.0
Maximum Limits of Impurities (ppm)	
Residue after ignition	5
Chloride (Cl)	0.5
Sulfate (SO ₄)	1
Arsenic (As)	0.01
Heavy metal (as Pb)	0.2
Iron (Fe)	0.2

The Federal specification requirements for nitric acid (90%) analyzed reagent are shown in Table XIV.

TABLE XIV. Nitric acid (90%) analyzed reagent - requirements (ACS).

Assay (HNO ₃), min, % by wt	90.0
Maximum Limits of Impurities (% by wt)	
Dilution test	to pass turbidity or precipitate test
Residue after ignition	0.002

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TABLE XIV. Nitric acid (90%) analyzed reagent - requirements (ACS) (continued).

Maximum Limits of Impurities (ppm)	
Dissolved oxides (as N ₂ O ₃), to pass test, limit about	0.1
Chloride (Cl)	0.7
Sulfate (SO ₄)	5
Arsenic (As)	0.3
Heavy metal (as Pb)	5
Iron (Fe)	2

5.13.3 Use. Nitric acid, analyzed reagent is intended for use as a reagent in analytical chemistry including the determination of trace metals.

5.13.4 Safety. Nitric acid is a strong oxidizer and corrosive. It is very irritating to the eyes, skin and mucous membranes. Inhalation of vapors or mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Nitric acid must be used with adequate ventilation. The TLV for nitric acid is 2 ppm (5 mg/m³). The PEL is the same. For personal protective measures, refer to section 4.3.1.

Nitric acid exhibits the properties of a strong acid and a strong oxidizing agent. Nitric acid is noncombustible but dangerously reactive with many materials. It can react violently with metallic powders, carbides, charcoal and hydrogen sulfide. It increases the flammability of combustible and readily oxidizable materials. It is a moderate fire hazard with reducing materials. When heated to decomposition it can emit toxic and corrosive oxides of nitrogen fumes.

5.13.5 Storage. Nitric acid must be stored in a cool, dry, well ventilated place in tightly closed acid resistant, nonreactive containers away from sources of heat, direct sunlight and oxidizable material. Protect container against physical damage. Refer to section 4.3.2.

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

Nitric acid has an EPA Hazardous Waste Classification - Ignitable, Waste Number D001; Corrosive, Waste Number D002.

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5.14 Name. PHOSPHOMOLYBDIC ACID, ANALYZED REAGENT

Molybdophosphoric acid $12\text{MoO}_3 \cdot \text{H}_3\text{PO}_4 \cdot x\text{H}_2\text{O}$ FW 1825.24+H₂O
 Phospho-12-molybdic acid CAS 51429-74-4

5.14.1 Technical description. Phosphomolybdic acid exists as yellow tetragonal crystals with a melting point of 78-90°C. It is soluble in hot and cold water. It is very soluble in alcohol and ether.

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

5.14.2.1 Requirements. The Federal specification requirements for phosphomolybdic acid, analyzed reagent are shown in Table XV.

TABLE XV. Phosphomolybdic acid, analyzed reagent - requirements (ACS).

Maximum Limits of Impurities (% by wt)	
Insoluble matter	0.01
Chloride (Cl)	0.02
Sulfate (SO ₄)	0.025
Ammonium (NH ₄)	0.01
Calcium (Ca)	0.02
Heavy metals (as Pb)	0.005
Iron (Fe)	0.005

5.14.3 Use. Phosphomolybdic acid, analyzed reagent is intended for use as a reagent in analytical chemistry for the determination of alkaloids and proteins. It is also used as a reagent in microscopy.

5.14.4 Safety. Phosphomolybdic acid is an oxidizer and corrosive solid. It is irritating to the eyes, skin and mucous membranes. Inhalation of dust or mist of phosphomolybdic acid must be avoided. Contact with the eyes, skin and clothing must be avoided. Phosphomolybdic acid must be used with adequate ventilation. The TLV for molybdenum soluble compounds (as Mo) is 5 mg/m³. The PEL is the same. For personal protective measures, refer to section 4.3.1.

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

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5.15 Name. PHOSPHORIC ACID (META), ANALYZED REAGENT HPO_3
 Glacial Phosphoric acid FW 79.98
 CAS 37267-86-0

5.15.1 Technical description. Phosphoric acid (meta) (pure) exists as colorless, deliquescent crystals with a density of 2.2-2.5 g/cm³. It sublimates on melting. It is very slowly soluble in cold water changing to H_3PO_4 , the change is hastened by heating. It is soluble in alcohol and insoluble in liquid CO_2 .

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

NOTE: This reagent contains as a stabilizer, a somewhat greater proportion of sodium metaphosphate than that corresponding to the empirical formula $\text{NaH}(\text{PO}_3)_2$.

5.15.2.1 Requirements. The Federal specification requirements for phosphoric acid (meta), analyzed reagent are shown in Table XVI.

TABLE XVI. Phosphoric acid (meta), analyzed reagent - requirements (ACS).

Assay (HPO_3), min-max, % by wt	34.0-36.0
Stabilizer, min-max, % by wt	58.0-62.0
Maximum Limits of Impurities (% by wt)	
Chloride (Cl)	0.001
Nitrate (NO_3)	0.001
Sulfate (SO_4)	0.005
Heavy metals (as Pb)	0.005
Iron (Fe)	0.005
Substances reducing permanganate (as H_3PO_3)	0.02
Maximum Limits of Impurities (ppm)	
Arsenic (As)	1

5.15.3 Use. Phosphoric acid (meta), analyzed reagent is intended for use as a reagent in analytical chemistry.

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5.15.4 Safety. Phosphoric acid (meta), is corrosive. It is irritating to the eyes, skin and mucous membranes. Inhalation of dust or mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Phosphoric acid (meta) must be used with adequate ventilation. The TLV for phosphoric acid (meta) is 1 mg/m³. The PEL is the same. For personal protective measures, refer to section 4.3.1.

If heated to decomposition, phosphoric acid (meta) emits toxic oxides of phosphorus fumes.

5.15.5 Storage. Phosphoric acid (meta) must be stored in a cool, dry, well ventilated place in tightly closed containers. Refer to section 4.3.2.

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

5.16 Name. PHOSPHORIC ACID (ORTHO) ANALYZED REAGENT FW 98.00
Phosphoric acid H₃PO₄ CAS 7664-38-2

5.16.1 Technical description. Phosphoric acid (ortho) (pure) exists as a colorless liquid or as rhombic, deliquescent crystals with a density of 1.834 g/cm³ at 18°C. Its melting point is 42.35°C. Its solubility in cold water is 548 g/100cm³ and it is very soluble in hot water. It is soluble in alcohol.

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

5.16.2.1 Requirements. The Federal specification requirements for phosphoric acid (ortho), analyzed reagent are shown in Table XVII.

TABLE XVII. Phosphoric acid (ortho), analyzed reagent - requirements (ACS).

Assay (H ₃ PO ₄), min, % by wt	85.0
Color (APHA), max	10.0

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TABLE XVII. Phosphoric acid (ortho), analyzed reagent - requirements (ACS) (continued).

Maximum Limits of Impurities (% by wt)	
Insoluble matter, calcium, magnesium and ammonium hydroxide precipitate	0.005
Sulfate (SO ₄)	0.003
Volatile acids (as CH ₃ COOH)	0.001
Heavy metals (as Pb)	0.001
Iron (Fe)	0.003
Potassium (K)	0.005
Sodium (Na)	0.025
Reducing substances	To pass color test
Maximum Limits of Impurities (ppm)	
Chloride (Cl)	3.000
Manganese (Mn)	0.5
Nitrate (NO ₃)	5.000
Arsenic (As)	1.000

5.16.3 Use. Phosphoric acid (ortho), analyzed reagent is intended for use as a reagent in analytical chemistry.

5.16.4 Safety. Phosphoric acid (ortho) is moderately toxic and irritating to eyes, skin and mucous membranes. Inhalation of dust or mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Phosphoric acid (ortho) must be used with adequate ventilation. The TLV for phosphoric acid is 1 mg/m³. The PEL is the same. For personal protective measures, refer to section 4.3.1.

If heated to decomposition, phosphoric acid (ortho) emits toxic oxides of phosphorus fumes.

5.16.5 Storage. Phosphoric acid (ortho) must be stored in a cool, dry, well ventilated place in tightly closed containers. Refer to section 4.3.2.

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

Phosphoric acid has an EPA Hazardous Waste Classification - Corrosive, Waste Number D002.

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5.17 Name. PHOSPHOROUS ACID (HYPO), (50%), ANALYZED REAGENT
 Phosphinic acid H_3PO FW 66.00
 CAS 6303-21-5

5.17.1 Technical description. Phosphorous acid (hypo) (pure) exists as a colorless, oily liquid or deliquescent crystals with a density of 1.493 g/cm^3 at 19°C . Its melting point is 26.5°C and it decomposes at 130°C . It is soluble in cold water and very soluble in hot water, alcohol and ether.

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

5.17.2.1 Requirements. The Federal specification requirements for phosphorous acid (hypo), 50% analyzed reagent are shown in Table XVIII.

TABLE XVIII. Phosphorous acid (hypo), 50%, analyzed reagent - requirements (USP).

Assay, (H_3PO_2), min, % by wt	48.0
Appearance	A colorless to faintly yellow liquid
Maximum Limits of Impurities (% by wt)	
Chloride (Cl), white, insoluble residue remaining	Negligible
Phosphate (PO_4), Precipitate formed	Slight
Sulfate (SO_4) max, (mg)	0.2

5.17.3 Use. Phosphorous acid (hypo), 50% analyzed reagent is intended for use as a reagent in analytical chemistry. It is also used in medicine.

5.17.4 Safety. Phosphorous acid (hypo), is corrosive and a strong reducing agent. It is irritating to the eyes, skin and mucous membranes. Inhalation of vapors, dust or mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Phosphorous acid (hypo) must be used with adequate ventilation. For personal protective measures, refer to section 4.3.1.

It is a dangerous fire and explosive risk in contact with oxidizing material. If heated to decomposition, it emits toxic oxides of phosphorous fumes.

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5.17.5 Storage. Phosphorous acid (hypo) must be stored in a cool, dry, well ventilated place in tightly closed acid resistant containers away from sources of heat and oxidizing materials. Refer to section 4.3.2.

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

Phosphorous acid (hypo) has an EPA Hazardous Waste Classification - Corrosive, Waste Number D002.

5.18 Name. PHOSPHOROUS ACID, ANALYZED REAGENT H₃PO₃
 Orthophosphorous acid FW 82.00
 CAS 13598-36-2

5.18.1 Technical description. Phosphorous acid (pure) exists as colorless to yellow deliquescent crystals with a specific gravity of 1.651 at 21°/4°C. Its melting point is 73.6°C and decomposes at 200°C. Its solubility in water is 309 g/100cm³ at 0°C and 649 g/100cm³ at 40°C. It is soluble in alcohol. It absorbs oxygen very readily with the formation of orthophosphoric acid (H₃PO₄).

5.18.2 Specification. Manufacturers requirement - No Government specification.

5.18.2.1 Requirements. The requirements for phosphorous acid, analyzed reagent are shown in Table XIX.

TABLE XIX. Phosphorous acid, analyzed reagent - requirements.

Assay (as H ₃ PO ₃), min, % by wt	98.00
Maximum Limits of Impurities (% by wt)	
Insoluble matter	0.005
Chloride (Cl)	0.003
Phosphate (PO ₄)	0.030
Sulfate (SO ₄)	0.002
Heavy metals (as Pb)	0.002

5.18.3 Use. Phosphorous acid, analyzed reagent is intended for use as a reagent in analytical chemistry.

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5.18.4 Safety. Phosphorous acid is corrosive and a strong reducing agent. It is irritating to the eyes, skin and mucous membranes. Inhalation of vapors, dust or mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Phosphorous acid must be used with adequate ventilation. For personal protective measures, refer to section 4.3.1.

Phosphorous acid is a dangerous fire and explosive risk in contact with oxidizing materials. If heated to decomposition, it emits toxic oxides of phosphorous fumes.

5.18.5. Storage. Phosphorous acid must be stored in a cool, well ventilated place in tightly closed acid resistant containers away from sources of heat and oxidizing materials. Refer to section 4.3.2.

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

Phosphorous acid has an EPA Hazardous Waste Classification - Corrosive, Waste Number D002.

5.19	<u>Name</u> . PHOSPHORUS PENTOXIDE, ANALYZED REAGENT	P_2O_5
	Phosphoric anhydride	FW 141.94
	Diphosphorus pentoxide	CAS 1314-56-3
	Phosphorus (V) oxide	

5.19.1 Technical description. Phosphorus pentoxide (pure) exists as white, deliquescent monoclinic crystals or powder with a density of 2.3 g/cm³. It has a melting point of 580-585°C and sublimates at 300°C. It reacts with cold water to produce H₃PO₄. It is soluble in H₂SO₄ and insoluble in acetone.

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

5.19.2.1 Requirements. The Federal specification requirements for phosphorus pentoxide, analyzed reagent are shown in Table XX.

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TABLE XX. Phosphorus pentoxide, analyzed reagent - requirements (ACS).

Assay (P ₂ O ₅), min, (% by wt)	98.0
Maximum Limits of Impurities (% by wt)	
Insoluble matter	0.2
Phosphorus trioxide (P ₂ O ₃)	0.02
Ammonium (NH ₄)	0.01
Heavy metals (as Pb)	0.01

5.19.3 Use. Phosphorus pentoxide, analyzed reagent is intended for use as a reagent in analytical chemistry. It is also used in pharmaceuticals and organic synthesis.

5.19.4 Safety. Phosphorus pentoxide is corrosive and nonflammable. It is irritating to the eyes, skin and mucous membranes. Inhalation of dust and mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Phosphorus pentoxide must be used with adequate ventilation. For personal protective measures, refer to section 4.3.1.

Phosphorus pentoxide reacts violently with water, evolving heat and acrid white fumes, forming phosphoric acid. The reaction with alcohol is similar. The TLV for phosphoric acid is 1 mg/m³. The PEL is the same.

5.19.5 Storage. Phosphorus pentoxide must be stored in a cool, dry, well ventilated place in tightly closed containers. Refer to section 4.3.2.

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

Phosphorus pentoxide has an EPA Hazardous Waste Classification - Reactive - Waste Number D003.

5.20 Name. SELENIOS ACID, ANALYZED REAGENT H₂SeO₃ FW 128.97
 Monohydrated selenium dioxide CAS 7783-00-8
 Selenious acid

5.20.1 Technical description. Selenious acid (pure) exists as colorless, hexagonal deliquescent crystals with a density of 3.004 g/cm³ at 15°/4°C. It gives off water upon heating and decomposes at 70°C. It has a solubility of 167 g/100cm³ water at 20°C and is very soluble in hot water. It is very soluble in alcohol and insoluble in ammonia. It is

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oxidized to selenic acid by strong oxidizing agents such as ozone, hydrogen peroxide and chlorine. It is reduced to selenium by most reducing agents including hydriotic acid, sulfurous acid, sodium hyposulfite and hypophosphorous acid.

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

5.20.2.1 Requirements. The Federal specification requirements for selenious acid, analyzed reagent are shown in Table XXI.

TABLE XXI. Selenious acid, analyzed reagent - requirements (USP).

Appearance	colorless or white crystals
Assay (H_2SeO_3), min, % by wt	93.0
Maximum Limits of Impurities (% by wt)	
Insoluble matter	The solution is clear and complete
Residue on ignition (% by wt)	0.01
Selenate and sulfate, turbidity or precipitate formed	none

5.20.3 Use. Selenious acid, analyzed reagent is intended for use as a reagent in analytical chemistry for determination of alkaloids.

5.20.4 Safety. Selenious acid is highly toxic by inhalation and moderately toxic by skin absorption. Inhalation of selenium compounds causes poisoning via rapid gut and lung absorption. It is most damaging to liver, kidneys, spleen, bone marrow and thyroid. It is irritating to the eyes, skin and mucous membranes. Inhalation of dust and mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Selenious acid must be used with adequate ventilation. Selenium is a suspected carcinogen. The TLV for selenium compounds (as Se) is 0.2 mg/m^3 . The PEL is the same. For personal protective measures, refer to section 4.3.1.

5.20.5 Storage. Selenious acid must be stored in a cool, dry, well ventilated place in tightly closed containers. Refer to section 4.3.2.

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

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Selenious acid has an EPA Hazardous Waste Classification - Toxic, Waste Number U204.

5.21 **Name.** SULFAMIC ACID, ANALYZED REAGENT $\text{NH}_2\text{SO}_3\text{H}$ FW 97.09
 Amidosulfonic acid CAS 5329-14-6
 Aminosulfonic acid

5.21.1 **Technical description.** Sulfamic acid (pure) exists as colorless rhombic crystals with a density of 2.126 g/cm^3 at 25°C . Its melting point is 200°C with decomposition. It also decomposes in hot water. Its solubility in cold water is 14.68 g/cm^3 and 47.08 g/cm^3 at 80°C . It is very slightly soluble in alcohol, ether and acetone. It is insoluble in carbon tetrachloride.

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

5.21.2.1 **Requirements.** The Federal specification requirements for sulfamic acid, analyzed reagent are shown in Table XXII.

TABLE XXII. Sulfamic acid, analyzed reagent - requirements (USP).

Appearance	colorless or white crystals
Assay ($\text{NH}_2\text{SO}_3\text{H}$), min, % by wt	98.5
Maximum Limits of Impurities (% by wt)	
Insoluble matter	0.01
Residue on ignition	0.01
Chloride (Cl)	0.001
Heavy metal (as Pb)	0.001
Iron (Fe)	0.0005
Sulfate (SO_4)	0.05

5.21.3 **Use.** Sulfamic acid, analyzed reagent is intended for use as a reagent in analytical chemistry including use as a standard in alkalimetry.

5.21.4 **Safety.** Sulfamic acid is a corrosive material and nonflammable. Its water solutions are strongly acidic. It is irritating to the eyes, skin, respiratory tract and mucous membranes. Inhalation of dust and mist must be avoided. Contact with the eyes, skin and

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clothing must be avoided. Sulfamic acid must be used with adequate ventilation. For personal protective measures, refer to section 4.3.1.

Sulfamic acid is stable when dry, but in solution, it slowly hydrolyzes forming ammonium bisulfate. Hazardous gases can be evolved; e.g., flammable hydrogen from contact with some metals, poisonous hydrogen cyanide from cyanide salts and poisonous hydrogen sulfide from sulfides. If heated to decomposition, sulfamic acid may emit toxic sulfur dioxide, sulfur trioxide and ammonia.

5.21.5 Storage. Sulfamic acid must be stored in a cool, dry, well ventilated place in tightly closed containers away from sources of heat and open flame and reducing materials. Protect from light. Refer to section 4.3.2.

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

5.22 Name. SULFURIC ACID, ANALYZED REAGENT H_2SO_4 , FW 98.08
Oil of vitriol CAS 7664-93-9

5.22.1 Technical description. Sulfuric acid (pure) exists as a clear, oily liquid with a specific gravity of 1.841 at 20°/4°C for 96-98% material. Its melting point is 10.36°C for 100% material. It is soluble in all proportions in cold water with the evolution of heat and soluble in all proportions in hot water. It decomposes when heated with a loss of SO_3 until an acid concentration of 98.33% is reached which boils at 338°C without further change in concentration. Sulfuric acid is a diprotic acid which ionizes in two stages. In dilute solution, primary ionization is complete, while the secondary ionization is less complete. It can form both normal and hydrogen sulfate salts. Hot concentrated sulfuric acid can act as an oxidizing agent depending on the strength of the reducing agent with which it acts.

5.22.2 Specification. Federal, O-C-265, Chemicals, Analytical; General Specification for.

5.22.2.1 Requirements. The Federal specification requirements for sulfuric acid, analyzed reagent are shown in Table XXIII.

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TABLE XXIII. Sulfuric acid, analyzed reagent - requirements (ACS).

Appearance	Free from suspended or insoluble matter as received and after dilution to 2N.
Assay (H ₂ SO ₄), min-max, % by wt	95.0-98.0
Color (APHA), as received and after dilution to 2N, max	10
Maximum Limits of Impurities (ppm)	
Residue after ignition	5
Chloride (Cl)	0.2
Nitrate (NO ₃)	0.5
Ammonium (NH ₄)	2
Substances reducing permanganate, to pass color test (as SO ₂)	2
Arsenic (As)	0.01
Heavy metals (as Pb)	0.5
Iron (Fe)	0.2
Mercury (Hg)	5

5.22.3 Use. Sulfuric acid, analyzed reagent is intended for use as a reagent in analytical chemistry. It is also used in metallurgy and as a alkylation catalyst.

5.22.4 Safety. Sulfuric acid is nonflammable, very reactive and corrosive. Contact with the body results in rapid destruction of tissue, causing severe burns. It is irritating to the eyes, skin and mucous membranes. Inhalation of vapors and mist must be avoided. Contact with the eyes, skin and clothing must be avoided. There are systemic effects secondary to tissue damage caused by contact. Repeated contact with dilute solutions can cause a dermatitis, and repeated or prolonged inhalation of the mist can cause an inflammation of the upper respiratory tract. Inhalation of concentrated vapor or mist from hot acid can cause rapid loss of consciousness with serious damage to lung tissue. Sulfuric acid must be used with adequate ventilation. The TLV for sulfuric acid is 1 mg/m³. The PEL is the same. For personal protective measures, refer to section 4.3.1.

Sulfuric acid, as an oxidizer, can cause ignition of combustibles. It can react with metals to emit flammable hydrogen gas. If heated, it can emit toxic fumes.

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5.22.5 Storage. Sulfuric acid must be stored in a cool, dry, well ventilated place in tightly closed, acid resistant containers away from reducing and combustible materials. Protect containers against physical damage. Refer to section 4.3.2.

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

Sulfuric acid has an EPA Hazardous Waste Classification - Corrosive, Waste Number D002; Reactive, Waste Number D003.

5.23	<u>Name</u> . SULFURIC ACID, 18N, ANALYZED REAGENT	FW 98.08
	oil of vitriol	CAS 7664-93-9
	H_2SO_4	

5.23.1 Technical description. Sulfuric acid (pure) exists as a clear, colorless, oily liquid with a specific gravity of 1.841 at 20°/4°C for 96-98% material. Its melting point is 10.36°C for 100% material. It is soluble in all proportions in cold water with the evolution of heat and soluble in all proportions in hot water. It decomposes in alcohol. Sulfuric acid decomposes when heated with a loss of SO_3 until a concentration of 98.33% is reached which boils at 338°C without further change in concentration. Sulfuric acid is a diprotic acid which ionizes in two stages. In dilute solution, primary ionization is complete, while the secondary ionization is less complete. It can form normal and hydrogen sulfate salts. Sulfuric acid can act as an oxidizing agent. Sulfuric acid, 18N, has a specific gravity of 1.5 at 20°/4°C.

5.23.2 Specification. Meets requirements for sulfuric acid, 18N, analyzed reagent used in Standard Test Method, ASTM 874.

5.23.2.1 Requirements. Sulfuric acid, 18N, analyzed reagent is commercially available with requirements as shown in Table XXIV.

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TABLE XXIV. Sulfuric acid, 18N, analyzed reagent - requirements.

Normality	17.5-18.5
Maximum Limits of Impurities (% by wt)	
Ammonium	0.0002
Arsenic	0.000001
Chloride	0.00002
Heavy metals	0.0001
Iron	0.00002
Nitrate	0.00005
Residue after ignition	0.0005
Substances reducing permanganate as SO ₂ , to pass test, limit about	0.0002

5.23.3 Use. Sulfuric acid, 18N, analyzed reagent is intended for use as a reagent for the determination of sulfated ash from lubricating oils and additives using the Standard Test Method, ASTM 874. It is also used where sulfuric acid must be added to aqueous media or diluted to make standard solutions because it is safer to handle than concentrated sulfuric acid.

5.23.4 Safety. Sulfuric acid is nonflammable, reactive and corrosive. Contact with the body results in rapid destruction of tissue, causing severe burns. It is irritating to the eyes, skin and mucous membranes. Inhalation of vapors and mist must be avoided. Contact with the eyes, skin and clothing must be avoided. There are systemic effects secondary to tissue damage caused by contact. Repeated contact with dilute solutions can cause a dermatitis, and repeated or prolonged inhalation of the mist can cause inflammation of the upper respiratory tract. Inhalation of concentrated vapor or mist from hot acid can cause rapid loss of consciousness with serious damage to lung tissue. Sulfuric acid must be used with adequate ventilation. The TLV for sulfuric acid is 1/mg/m³. The PEL is the same. For personal protective measures, refer to section 4.3.1.

Sulfuric acid, as an oxidizer, can cause ignition of combustibles. It can react with metals to emit flammable hydrogen gas. If heated, it can emit toxic fumes.

5.23.5 Storage. Sulfuric acid must be stored in a cool, dry, well ventilated place in tightly closed, acid resistant containers away from reducing and combustible materials. Protect container against physical damage. Refer to section 4.3.2.

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

Sulfuric acid has an EPA Hazardous Waste Classification - Corrosive, Waste Number D002; Reactive, Waste Number D003.

5.24 Name. SULFURIC ACID, FUMING, ANALYZED REAGENT $H_2S_2O_7$
 Oleum FW 178.14
 Pyrosulfuric acid CAS 8014-95-7

5.24.1 Technical description. Fuming sulfuric acid containing one mole of SO_3 /mole H_2SO_4 (pure) exists as colorless hygroscopic crystals with a density of 1.9 g/cm^3 at 20°C . Its melting point is 35°C . It decomposes in cold and hot water and alcohol.

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

NOTE: This specification applies to fuming sulfuric acid with nominal content of 15, 20, or 30% free SO_3 .

5.24.2.1 Requirements. The Federal specification requirements for sulfuric acid, fuming, analyzed reagent are shown in Table XXV.

TABLE XXV. Sulfuric acid, fuming, analyzed reagent - requirements (ACS).

Appearance	Colorless to very light brown color
Assay (free SO_3), min-max, % by wt	15.0-18.0 20.0-23.0 30.0-33.0
Maximum Limit of Impurities (% by wt)	
Residue after ignition	0.002
Maximum Limit of Impurities (ppm)	
Nitrate (NO_3)	1
Ammonium (NH_4)	3
Arsenic (As)	0.03
Iron (Fe)	2

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Sulfuric acid, fuming, analyzed reagent is also commercially available with requirements as shown in Table XXVI.

TABLE XXVI. Sulfuric acid, fuming, analyzed reagent - requirements.

Appearance	to pass test
Assay (free SO ₃), min-max, % by wt	12.0-17.0
	18.0-24.0
	27.0-33.0
Maximum Limit of Impurities (% by wt)	
Residue after ignition	0.002
Maximum Limit of Impurities (ppm)	
Nitrate (NO ₃)	0.1
Ammonium (NH ₄)	0.3
Arsenic (As)	0.03
Iron (Fe)	0.2

5.24.3 Use. Sulfuric acid, fuming, analyzed reagent is intended for use as a reagent in analytical chemistry.

5.24.4 Safety. Sulfuric acid, fuming, is corrosive and very reactive. Contact with the body results in rapid destruction of tissue, causing severe burns. It is irritating to the eyes, skin and mucous membranes. Inhalation of vapors and mist must be avoided. Contact with the eyes, skin and clothing must be avoided. There are systemic effects secondary to tissue damage caused by contact. Repeated contact with dilute solutions can cause a dermatitis, and repeated or prolonged inhalation of the mist can cause an inflammation of the upper respiratory tract. Inhalation of concentrated vapor or mist from hot acid can cause rapid loss of consciousness with serious damage to lung tissue. Sulfuric acid, fuming, must be used with adequate ventilation. For personal protective measures, refer to section 4.3.1.

Sulfuric acid, fuming, is dangerous by chemical reaction with reducing agents. If heated to decomposition, it emits toxic fumes and oxides of sulfur. It will react with water or steam to produce heat and toxic and corrosive fumes.

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5.24.5 Storage. Sulfuric acid, fuming, must be stored in a cool, dry, well ventilated place in tightly closed acid resistant containers away from combustible materials. Protect containers against physical damage. Refer to section 4.3.2.

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

Sulfuric acid, fuming, has an EPA Hazardous Waste Classification - Corrosive, Waste Number D002; Reactive, Waste Number D003.

5.25 Name. SULFUROUS ACID, ANALYZED REAGENT H_2SO_3 FW 82.08
A solution of SO_2 in water CAS 7782-99-2

5.25.1 Technical description. Sulfurous acid (pure) exists as a colorless solution of sulfur dioxide in water. It has a density of about 1.03. It is soluble in cold water, alcohol, ether and acetic acid. It has a suffocating odor of sulfur dioxide. It gradually oxidizes in air to sulfuric acid.

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

5.25.2.1 Requirements. The Federal specification requirements for sulfurous acid, analyzed reagent are shown in Table XXVII.

TABLE XXVII. Sulfurous acid, analyzed reagent - requirements (ACS).

Assay (SO_2), min, % by wt	6.0
Maximum Limits of Impurities (% by wt)	
Residue after ignition	0.005
Maximum Limits of Impurities (ppm)	
Chloride (Cl)	5
Arsenic (As)	0.5
Heavy metals (as Pb)	2
Iron (Fe)	5

5.25.3 Use. Sulfurous acid, analyzed reagent is intended for use as a reagent in analytical chemistry.

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5.25.4 Safety. Sulfurous acid is a corrosive liquid. It is irritating to the eyes, skin and mucous membranes. Inhalation of fumes or mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Sulfurous acid must be used with adequate ventilation. For personal protective measures, refer to section 4.3.1.

If heated to decomposition, sulfurous acid emits highly toxic fumes of SO₂.

5.25.5 Storage. Sulfurous acid must be stored in a cool, dry, well ventilated place in tightly closed containers. Refer to section 4.3.2.

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

Sulfurous acid has an EPA Hazardous Waste Classification - Corrosive, Waste Number D002.

5.26 Name. SULFUR TRIOXIDE, STABILIZED, ANALYZED REAGENT

Sulfuric anhydride

SO₃

FW 80.06

CAS 7446-11-9

5.26.1 Technical description. Sulfur trioxide (pure) exists as a colorless, clear liquid with a density of 1.970 (H₂O=1) at 20°/4°C. Its melting point is 16.8°C and boiling point is 44.8°C. It decomposes in hot and cold water, forming sulfuric acid.

5.26.2 Specification. Manufacturers requirements. No Government specification.

5.26.2.1 Requirements. Sulfuric trioxide, stabilized, analyzed reagent is commercially available with a typical analysis, as shown in Table XXVIII.

TABLE XXVIII. Sulfur trioxide, stabilized, analyzed reagent - typical analysis.

Sulfur trioxide (SO ₃), % by wt	99.6
Sulfuric acid (H ₂ SO ₄), % by wt	0.2
Stabilizer, % by wt	0.2
Iron (Fe), ppm	5

5.26.3 Use. Sulfur trioxide, stabilized reagent, is intended for use as a reagent for the sulfonation of organic compounds.

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5.26.4 Safety. Sulfur trioxide is highly toxic, a strong oxidizer and corrosive. It is irritating to the eyes, skin and mucous membranes. Inhalation of vapors and mist must be avoided. Contact with the eyes, skin and clothing must be avoided. Sulfur trioxide must be used with adequate ventilation. For personal protective measures, refer to section 4.3.1.

Absolutely dry sulfur trioxide is not corrosive to metals and shows no acid reaction. On exposure to air, it absorbs moisture rapidly, emitting dense white fumes. It combines with water with explosive violence, forming sulfuric acid. Due to its affinity for water sulfur trioxide chars many organic substance. On contact with some materials, the heat produced by dehydration is sufficient to cause fire.

5.26.5 Storage. Sulfur trioxide, stabilized, must be stored in cool, dry, well ventilated place in tightly closed containers away from reducing or flammable materials. Protect against physical damage. Refer to section 4.3.2.

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

Sulfur trioxide, stabilized, has an EPA Hazardous Waste Classification - Reactive, Waste Number D003.

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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. Subject term (key work) listing.

Arsenic pentoxide, analyzed reagent
Arsenic pentoxide, n-hydrate analyzed reagent
Arsenic trioxide, analyzed reagent
Boric acid, analyzed reagent
Chlorosulfonic acid, reagent
Chromium trioxide, analyzed reagent
Exposure limits, hazardous chemicals
Hazardous wastes, disposal and storage of
Hydrobromic acid (48%), analyzed reagent
Hydrochloric acid, analyzed reagent
Hydrofluoric acid, analyzed reagent
Information, hazardous chemicals
Iodic acid, analyzed reagent
Iodic pentoxide, analyzed reagent
Molybdenum trioxide, analyzed reagent
Nitric acid, analyzed reagent
Phosphomolybdic acid, analyzed reagent
Phosphoric acid (meta), analyzed reagent
Phosphoric acid (othro), analyzed reagent
Phosphorous acid (hypo), 50%, analyzed reagent
Phosphorous acid, analyzed reagent
Phosphorus pentoxide, analyzed reagent
Safety, hazardous chemicals
Selenious acid, analyzed reagent
Sulfamic acid, analyzed reagent
Sulfuric acid, analyzed reagent
Sulfuric acid, 18N, analyzed reagent
Sulfuric acid, fuming, analyzed reagent
Sulfurous acid, analyzed reagent
Sulfur trioxide, stabilized, analyzed reagent

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

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