

METRIC

MIL-STD-613

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MILITARY STANDARD  
INORGANIC BASES AND BASIC ANHYDRIDES, REAGENT GRADE  
(INCLUDING ACS AND USP-NF COMPOUNDS) (METRIC)



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FSC 6810

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MIL-STD-613

DEPARTMENT OF DEFENSE  
Washington, DC 20301

Inorganic Bases and Basic Anhydrides, Reagent Grade (Including ACS and USP-NF Compounds)

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1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.
2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, U.S. Army Chemical Research, Development and Engineering Center, Attn: SMCCR-SPD-TS, Aberdeen Proving Ground, MD 21010-5423, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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### FOREWORD

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

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## 1. SCOPE

1.1 Coverage. This standard is a presentation of nomenclature, formulas, physical and chemical properties, specification requirements, military and typical commercial uses, safety information, storage information and disposal information for inorganic bases and basic anhydrides, reagent grade (including ACS and USP-NF Compounds). This standard does not include all of the items represented by the title or all those items which are commercially available. It does contain items preferred for use in the selection of inorganic bases and basic anhydrides, reagent grade (including ACS and USP-NF compounds) for application by the Department of Defense.

1.2 Application. Inorganic bases and basic anhydrides, reagent grade (including ACS and USP-NF compounds) are used in analytical Chemistry, Chromatography and in pharmaceuticals.

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

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## 2. REFERENCED DOCUMENTS

2.1 Government documents.

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

## SPECIFICATIONS

## FEDERAL

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

## 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

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

## CODE OF FEDERAL REGULATIONS (CFR)

- Title 29 - Department Of Labor, Occupational Safety And Health Agency; General Industry Standards And Interpretations
- Title 40 - Environmental Protection Agency; Hazardous Waste And Consolidated Permit Regulations
- Title 49 - Department Of Transportation; Hazardous Materials Regulations

- 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
- (DLAM 1000.2) Respiratory Protection Program
- TB MED 506 - Occupational And Environmental Health
- Occupational Vision
- TM 38-250 - Packaging, Materials Handling - Preparation Of Hazardous Materials For Military Air Shipment



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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

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

(Copies of specifications, standards, handbooks, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following document(s) form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of DODISS specified in the solicitation. The issues of documents which have not been adopted shall be those in effect on the date of the cited DODISS.

AMERICAN CONFERENCE OF GOVERNMENT INDUSTRIAL HYGIENISTS (ACGIH)

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

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

ASTM

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

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

National Fire Codes

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

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

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

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## 3. DEFINITIONS

3.1 Explosive limits - The minimum concentration of a flammable gas or vapor in air below which a substance does not burn by means of flame propagation, when exposed to an ignition source, is called the lower explosive limit. The maximum concentration of the substance in air above which ignition does not occur is called the upper explosive limit. The lower and upper explosive limits are expressed as percent by volume of vapor in air.

3.2 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.

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## 4. GENERAL REQUIREMENTS

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

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

4.3 Safety.

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

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

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

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

4.3.1.4 Training. Training shall be provided to ensure that employees know potential hazards of the chemicals with which they come in contact and the symptoms of over-exposure as well as how these chemicals affect the body and bodily functions. A person or persons shall be adequately trained to render first aid.

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

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

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

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

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

\*Refers only to materials that have become waste materials.

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

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

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

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

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

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

#### 4.4 Pollution and disposal.

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

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

\*Refers only to materials that have become waste materials.



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

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

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

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

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

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## 5. DETAIL REQUIREMENTS

- 5.1 Name. AMMONIUM HYDROXIDE, ANALYTICAL REAGENT  $\text{NH}_4\text{OH}$  FW 35.05  
 Aqua ammonia  
 Ammoniacal liquor

5.1.1 Technical Description. Ammonium hydroxide is formed by dissolving ammonia in water. It exists as a colorless liquid having a pungent odor. It is soluble in cold water.

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

5.1.3 Requirements. The Federal Specification requirements for ammonium hydroxide, analytical reagent is shown in Table I.

TABLE I. Ammonium hydroxide, analytical reagent - requirements (ACS).

Appearance	colorless and free from suspended matter or sediment
Assay (as $\text{NH}_3$ ) min-max, % by wt	28.0 - 30.0
Maximum Limits of Impurities (% by wt)	
Residue after ignition	0.002
Carbon dioxide ( $\text{CO}_2$ )	0.002
Substances reducing permanganate	to pass test
Maximum Limits of Impurities (ppm)	
Chloride ( $\text{Cl}$ )	0.5
Phosphate ( $\text{PO}_4$ )	2.0
Total sulfur ( $\text{SO}_4$ )	2.0
Heavy metals (as Pb)	0.5
Iron (Fe)	0.2

5.1.4 Use. Ammonium hydroxide, analytical reagent is used as a reagent in analytical chemistry.

5.1.5 Safety. Aqueous ammonia is a corrosive liquid. It exerts a local irritant action; strong solutions cause tissue destruction on contact, whether acting on eyes, skin, mucous membrane, gastro-intestinal mucosa, or pulmonary tissue. Concentrated solutions of ammonia remaining in contact with the eye for even a short time may cause serious ocular damage, which may result in prolonged, severe visual disturbance or permanent scarring of the cornea. The consequences of skin contact with ammonia water vary from a relatively mild dermatitis to severe burns, depending upon the strength of the solution, length of contact, and individual skin sensitivity. Inhalation of vapors and mists shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Ammonia hydroxide shall be used with adequate ventilation. Evolved ammonia has a lower explosive limit of 16% and an upper explosive limit of 25% in air. The TLV for ammonia is 25 ppm ( $18 \text{ mg/m}^3$ ). The PEL is 50 ppm ( $35 \text{ mg/m}^3$ ). For personal protective measures, refer to section 4.3.1.



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When concentrated solutions of ammonia are mixed rapidly with inorganic acids, the mixture becomes boiling hot instantly and may result in an explosion.

5.1.6 Storage. Ammonium hydroxide shall be stored in strong glass or plastic, tightly closed containers in a cool, well-ventilated place. Containers shall not be completely filled. Refer to section 4.3.2.

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

Ammonium hydroxide has an EPA Hazardous Waste Classification - Corrosive; Waste Number D002.

5.2 Name. BARIUM HYDROXIDE, ANALYTICAL REAGENT  $\text{Ba(OH)}_2$  FW 171.38

5.2.1 Technical description. Barium hydroxide (pure) exists as monoclinic crystals. It has a density of  $4.495 \text{ g/cm}^3$ , and a melting point of  $408^\circ\text{C}$ . Its solubility in water is  $4.29 \text{ g/100cm}^3$  at  $25^\circ\text{C}$  and  $101.4 \text{ g/100cm}^3$  at  $80^\circ\text{C}$ .

5.2.2 Specification. None

5.2.3 Requirements. Barium hydroxide, analytical reagent is commercially available with requirements as shown in Table II.

TABLE II. Barium hydroxide, analytical reagent - requirements.

Assay, $\text{Ba(OH)}_2$ , min., % by wt	95.0
Maximum Limits of Impurities (% by wt)	
Insoluble in dilute hydrochloric acid	0.010
Chloride (Cl)	0.01
Calcium and alkalies	1.30
Sulfides (S)	0.001
Heavy metal (as Pb)	0.001
Iron (Fe)	0.005

5.2.4 Use. Barium hydroxide, analytical reagent is used as a reagent in analytical chemistry. It is also used for deproteinizing blood.

5.2.5 Safety. Barium hydroxide is toxic by inhalation. Barium hydroxide aqueous solutions are alkaline and are irritating to the eyes, skin and mucous membranes. Inhalation of dust or mists shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Barium hydroxide shall be used with adequate ventilation. The TLV for barium, soluble compounds, as Ba is  $0.5 \text{ mg/m}^3$ . The PEL is the same. For personal protective measures, refer to section 4.3.1.

5.2.6 Storage. Barium hydroxide shall be stored in a cool, dry place in tightly closed containers. Refer to section 4.3.2.

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

Barium hydroxide has an EPA Hazardous Waste Classification - EP Toxic; Waste Number D005.

5.3 Name. BARIUM HYDROXIDE, OCTAHYDRATE, ANALYTICAL REAGENT.  
 Barium hydrate  $\text{Ba(OH)}_2 \cdot 8\text{H}_2\text{O}$  FW 315.48  
 Caustic baryta

5.3.1 Technical description. Barium hydroxide, octahydrate (pure) exists as colorless monoclinic crystals with a refractive indices of 1.471, 1.502 and 1.50 and a density of  $2.18 \text{ g/cm}^3$  at  $16^\circ\text{C}$ . Its melting point is  $78^\circ\text{C}$  and boiling point is  $780^\circ\text{C}$  with a loss of eight (8) molecules of water. Its solubility in water is  $5.6 \text{ g/100cm}^3$  at  $15^\circ\text{C}$  and  $94.7 \text{ g/100cm}^3$  at  $78^\circ\text{C}$ . It is slightly soluble in alcohol and insoluble in acetone..

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

5.3.3 Requirements. The Federal Specification requirements for barium hydroxide, octahydrate, analytical reagent is shown in Table III.

TABLE III. Barium hydroxide, octahydrate, analytical reagent - requirements (ACS).

Assay, $(\text{Ba(OH)}_2 \cdot 8\text{H}_2\text{O})$ min., % by wt	98.0
Maximum Limits of Impurities (% by wt)	
Carbonate (as $\text{Ba CO}_3$ )	2.0
Insoluble in dilute hydrochloric acid	0.01
Chloride (Cl)	0.001
Sulfides (S)	To pass test (limit about 0.001%)
Substances not precipitated by sulfuric acid	0.2
Calcium (Ca)	0.05
Iron (Fe)	0.001
Strontium (Sr)	To pass test (limit about 0.8%)
Maximum Limits of Impurities (ppm)	
Heavy metals (as Pb)	5.0

5.3.4 Use. Barium hydroxide, octahydrate, analytical reagent is used as a reagent in analytical chemistry.

5.3.5 Safety. Barium hydroxide, octahydrate is highly toxic and irritating to the eyes, skin and mucous membranes. Inhalation of dust or mists shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Barium hydroxide, octahydrate shall be used with adequate ventilation. The TLV for soluble barium compounds (as Ba) is  $0.5 \text{ mg/m}^3$ . The PEL is the same. For personal protective measures, refer to section 4.3.1.

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5.3.6 Storage. Barium hydroxide, octahydrate shall be stored in a cool, dry place in tightly closed containers. Refer to section 4.3.2.

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

Barium hydroxide, octahydrate has an EPA Hazardous Waste Classification - EP Toxic; Waste Number D005.

5.4 Name. BARIUM OXIDE, ANALYTICAL REAGENT. BaO FW 153.34  
Barium monoxide  
Barium protoxide

5.4.1 Technical description. Barium oxide (pure) exists as a white to yellowish-white powder with a density of 5.72 g/cm<sup>3</sup>. Its melting point is 1923°C and boiling point is approximately 2000°C. Its solubility in water is 3.48 g/100cm<sup>3</sup> at 20°C and 90.8 g/100cm<sup>3</sup> at 100°C. It is soluble in dilute acid and alcohol and insoluble in acetone and ammonia.

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

5.4.3 Requirements. The Federal Specification requirements for barium oxide, analytical reagent is shown in Table IV.

TABLE IV. Barium oxide, analytical reagent - requirements (USP).

Melting temperature, (°C)	About 1920
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Barium oxide, analytical reagent is also commercially available with requirements as shown in Table V.

TABLE V. Barium oxide, analytical reagent - requirements.

Assay, % by wt	>97.0
Maximum Limits of Impurities, % by wt	
Chloride (Cl)	< 0.02
Copper (Cu)	< 0.005
Lead (Pb)	< 0.01
Iron (Fe)	< 0.02
Zinc (Zn)	< 0.005
Cadmium (Cd)	

5.4.4 Use. Barium oxide, analytical reagent is used as a reagent in analytical chemistry.

5.4.5 Safety. Barium oxide is toxic if ingested or inhaled. It is irritating to the eyes, skin and mucous membranes. Inhalation of dust shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Barium oxide shall be used with adequate ventilation. The TLV for soluble barium compounds (as Ba) is 0.5 mg/m<sup>3</sup>. The PEL is the same. For personal protective measures, refer to section 4.3.1.

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On contact with water, barium oxide evolves much heat.

5.4.6 Storage. Barium oxide shall be stored in a cool, dry place in tightly closed containers. Refer to section 4.3.2.

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

Barium oxide has an EPA Hazardous Waste Classification - EP Toxic; Waste Number D005.

5.5 Name. CALCIUM HYDROXIDE, ANALYTICAL REAGENT.  $\text{Ca(OH)}_2$  FW 74.09  
Hydrated lime  
Slaked lime  
Calcium hydrate

5.5.1 Technical description. Calcium hydroxide (pure) exists as colorless hexagonal crystals with a density of  $2.24 \text{ g/cm}^3$ . It loses water at  $580^\circ\text{C}$  and decomposes on boiling. Its solubility in water is  $0.185 \text{ g/100cm}^3$  at  $0^\circ\text{C}$  and  $0.077 \text{ g/100cm}^3$  at  $100^\circ\text{C}$ . It is soluble in  $\text{NH}_4$  salts and insoluble in alcohol. Calcium hydroxide is unstable if subjected to  $\text{CO}_2$  in moist air and acids.

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

5.5.3 Requirements. The Federal Specification requirements for calcium hydroxide, analytical reagent is shown in Table VI.

TABLE VI. Calcium hydroxide, analytical reagent - requirements (ACS).

Maximum Limits of Impurities (% by wt)	
Insoluble in hydrochloric acid	0.03
Chloride (Cl)	0.005
Sulfur compounds (as $\text{SO}_4$ )	0.1
Heavy metals (as Pb)	0.003
Iron (Fe)	0.05
Magnesium and alkali salts (as sulfates)	1.0

Calcium hydroxide, analytical reagent is commercially available with a minimum purity of 95.0% by weight.

5.5.4 Use. Calcium hydroxide, analytical reagent is used in thin layer chromatography. It is also used in medicine.

5.5.5 Safety. Calcium hydroxide is irritating to the eyes, skin and mucous membranes. Eyes and open cuts are particularly vulnerable. Inhalation of dust shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Calcium hydroxide shall be used with adequate ventilation. The TLV for calcium hydroxide is  $5 \text{ mg/m}^3$ . For personal protective measures, refer to section 4.3.1.

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Calcium hydroxide is incombustible and, unlike calcium oxide it will not generate heat when in contact with water.

5.5.6 Storage. Calcium hydroxide shall be stored in cool, dry place in tightly closed containers away from acids and acid fumes. Avoid dusting. Refer to section 4.3.2.

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

5.6 Name. CALCIUM OXIDE, ANALYTICAL REAGENT. CaO FW 56.08  
Unslaked lime  
Quicklime  
Burnt lime

5.6.1 Technical description. Calcium oxide (pure) exists as colorless, cubic crystals with a density of 3.25 - 3.38 g/cm<sup>3</sup>. Its melting point is 2580°C and boiling point is 2850°C. Its solubility in water is 0.131 g/100 cm<sup>3</sup> at 10°C and 0.07 g/100cm<sup>3</sup> at 80°C with decomposition. It is soluble in glycerol and insoluble in alcohol. On exposure to air it absorbs CO<sub>2</sub> and water and becomes air-slaked. With a little water calcium oxide develops much heat and is converted into Ca(OH)<sub>2</sub>.

5.6.2 Specification. None.

5.6.3 Requirements. Calcium oxide, analytical reagent is commercially available with requirements as shown in Table VII.

TABLE VII. Calcium oxide, analytical reagent - requirements.

Assay (CaO), % by wt	>98.0
Maximum Limits of Impurities (% by wt)	
Chloride (Cl)	< 0.05
Sulfate (SO <sub>4</sub> )	< 0.1
Copper (Cu)	< 0.005
Lead (Pb)	< 0.01
Iron (Fe)	< 0.05
Zinc (Zn)	< 0.005
Cadmium (Cd)	< 0.005

5.6.4 Use. Calcium oxide, analytical reagent is used in preparation of pharmaceuticals. It is also used in chromatography.

5.6.5 Safety. Calcium oxide is noncombustible. It is a strong caustic and may cause severe burns to the eyes, skin and mucous membranes. Inhalation of dust shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Calcium oxide shall be used with adequate ventilation. The TLV for calcium oxide is 2 mg/m<sup>3</sup>. The PEL is 5 mg/m<sup>3</sup>. For personal protective measures, refer to section 4.3.1.

On contact with water or moisture, calcium oxide may generate sufficient heat to ignite combustible materials. It swells when moist and may burst container. It is not compatible with acids.



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5.7.6 Storage. Calcium oxide shall be stored in cool, dry place in tightly closed containers away from acids and combustible materials. Protect containers against physical damage. Refer to section 4.3.2.

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

5.8 Name. LITHIUM HYDROXIDE, MONOHYDRATE, ANALYTICAL REAGENT.  
 $\text{LiOH} \cdot \text{H}_2\text{O}$  FW 56.08

5.8.1 Technical description. Lithium hydroxide, monohydrate (pure) exists as white monoclinic crystals with refractive indices of 1.460 and 1.524 and a density of  $1.51 \text{ g/cm}^3$ . Its solubility in water is  $22.3 \text{ g/100 cm}^3$  at  $10^\circ\text{C}$  and  $26.8 \text{ g/100 cm}^3$  at  $80^\circ\text{C}$ . It is slightly soluble in alcohol and insoluble in ether. pH of a 1.0 normal solution is about 14.

5.8.2 Specification. None.

5.8.3 Requirements. Lithium hydroxide, monohydrate, analytical reagent is commercially available with requirements as shown in Table IX.

TABLE IX. Lithium hydroxide, monohydrate, analytical reagent - requirements.

Assay ( $\text{LiOH} \cdot \text{H}_2\text{O}$ )(by acid-base titration)	
min, % by wt	98.0
Maximum Limits of Impurities (% by wt)	
Insoluble matter	0.01
Chloride (Cl)	0.01
Sulfur compounds (as $\text{SO}_4$ )	0.05
Heavy metals (as Pb)	0.002
Iron	0.002

5.8.4 Use. Lithium hydroxide, monohydrate, analytical reagent is used in the preparation of pharmaceuticals.

5.8.5 Safety. Lithium hydroxide, monohydrate, is noncombustible. It is a strong base and its solutions are very caustic. The fact that lithium hydroxide is a caustic material is the chief hazard. It is irritating to the eyes, skin and mucous membranes. Inhalation of dust or mist shall be avoided. Inhalation of dust or mist can cause damage to the upper respiratory tract and to lung tissue depending on the severity of the exposure. Contact with the eyes, skin and clothing shall be avoided. Lithium hydroxide, monohydrate shall be used with adequate ventilation. For personal protective measures, refer to section 4.3.1.

5.8.6 Storage. Lithium hydroxide, monohydrate shall be stored in cool, dry, well-ventilated place in tightly closed containers. Refer to section 4.3.2.

5.8.7 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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Lithium hydroxide, monohydrate, has an EPA Hazardous Waste Classification - Corrosive, Waste Number D002.

- 5.9 Name. MAGNESIUM HYDROXIDE, ANALYTICAL REAGENT. Mg(OH)<sub>2</sub> FW 56.08  
 Magnesia Magma  
 Magnesium hydrate

5.9.1 Technical description. Magnesium hydroxide (pure) exists as colorless hexagonal plates with a density of 2.36 g/cm<sup>3</sup>. It decomposes at 350°C. Its water solubility is 0.0009 g/100cm<sup>3</sup> at 18°C and 0.0004 g/100cm<sup>3</sup> at 100°C. It is soluble in NH<sub>4</sub> salts.

5.9.2 Specification. None.

5.9.3 Requirements. Magnesium hydroxide, analytical reagent is commercially available with requirements as shown in Table X.

TABLE X. Magnesium hydroxide, analytical reagent - requirements.

Assay (Mg (OH) <sub>2</sub> ), % by wt	95.0
Maximum Limits of Impurities (% by wt)	
Calcium oxide (CaO)	0.5
Carbonate	To pass test
Heavy Metals (as Pb)	0.005
Loss on drying	2.0
Loss on ignition	30 - 33
Maximum Limits of Impurities (ppm)	
Arsentic (As)	2.0

5.9.4 Use. Magnesium hydroxide, analytical reagent is used in pharmaceuticals. It is also used as a general laboratory reagent.

5.9.5 Safety. Magnesium hydroxide imparts a slightly alkaline reaction in water. Magnesium compound are mild irritants to the conjunctiva and nasal mucosa, but are not specifically toxic. Inhalation of dust shall be avoided. Contact with the eyes shall be avoided. Magnesium hydroxide shall be used with adequate ventilation. For personal protective measures, refer to section 4.3.1.

5.9.6 Storage. Magnesium hydroxide shall be stored in cool, dry place in tightly closed containers. Refer to section 4.3.2.

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

- 5.10 Name. MAGNESIUM OXIDE, ANALYTICAL REAGENT. MgO FW 40.31  
 Magnesia  
 Calcined magnesia  
 Magnesia usta  
 Magcal  
 Maglite



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5.10.1 Technical description. Magnesium oxide (pure) exists as colorless cubic crystals with a density of  $3.58 \text{ g/cm}^3$  at  $25^\circ\text{C}$ . Its melting point is  $2800^\circ\text{C}$  and boiling point is  $3600^\circ\text{C}$ . It is very slightly soluble in pure water, solubility increased by  $\text{CO}_2$ . It is soluble in dilute acids; insoluble in alcohol.

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

5.10.3 Requirements. The federal specification requirements for magnesium oxide, analytical reagent is shown in Table XI.

TABLE XI. Magnesium oxide, analytical reagent - requirements (ACS).

Maximum Limits of Impurities (% by wt)	
Insoluble in dilute hydrochloric acid	0.02
Soluble in water	0.4
Loss on ignition	2.0
Ammonium hydroxide precipitate	0.02
Chloride (Cl)	0.01
Nitrate ( $\text{NO}_3$ )	0.005
Sulfate and sulfite (as $\text{SO}_4$ )	0.02
Barium (Ba)	0.005
Calcium (Ca)	0.05
Heavy metals (as Pb)	0.0003
Iron (Fe)	0.1
Potassium (K)	0.005
Sodium (Na)	0.5
Strontium (Sr)	0.005
Maximum Limits of Impurities (ppm)	
Manganese (Mn)	5.0

Magnesium oxide, analytical reagent is commercially available with a minimum purity of 98.0% by weight.

NOTE: Magnesium oxide is commercially available in two forms, one a light fluffy material prepared by a relatively low temperature dehydration of the hydroxide, the other a dense material made by high temperature furnacing of the oxide after it has been formed from the carbonate or hydroxide. Both forms are commercially available with the same requirements as shown in Table XII.

TABLE XII. Magnesium oxide, light and heavy, analytical reagent - requirements.

Assay ( $\text{MgO}$ ) min, % by weight	96.0
Maximum Limits of Impurities (% by wt)	
Acid-insoluble substances	0.1
Calcium oxide ( $\text{CaO}$ )	1.5
Carbonate ( $\text{CO}_3$ )	to pass test
Description	to pass test
Free alkali and soluble salts	2.0
Identification	to pass test
Loss on ignition	10.0

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TABLE XII. Magnesium oxide, light and heavy, analytical reagent - requirements - Continued.

Solubility	to pass test
Maximum Limits of Impurities (ppm)	
Arsenic (As)	12.5
Heavy metals (as Pb)	40.0
Iron (Fe)	500.0

5.10.4 Use. Magnesium oxide, analytical reagent is used as a reagent in analytical chemistry including chromatography.

5.10.5 Safety. Magnesium oxide is noncombustible. Exposure to magnesium oxide dust can cause slight eye and nose irritation. The inhalation of finely divided magnesium oxide fumes produces febrile reaction and leukocytosis. Thus, exposure shall be minimized. Magnesium oxide shall be used with adequate ventilation. The TLV for magnesium oxide fume is 10 mg/m<sup>3</sup>. The PEL is 15 mg/m<sup>3</sup>. For personal protective measures, refer to section 4.3.1.

5.10.6 Storage. Magnesium oxide shall be stored in cool, dry place in tightly closed containers. Exposure to moisture may cause caking. Refer to section 4.3.2.

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

5.11 Name. POTASSIUM HYDROXIDE, ANALYTICAL REAGENT.  
Caustic potash KOH FW 56.11  
Potassium hydrate

5.11.1 Technical description. Potassium hydroxide (pure) exists as white, rhombic, deliquescent crystals with a density of 2.044 g/cm<sup>3</sup>. It has a melting point of 360.4°C+0.7°C and a boiling point of 1320-1324°C. Its solubility in water is 107 g/100cm<sup>3</sup> at 15°C and 178 g/100cm<sup>3</sup> at 100°C. It is very soluble in alcohol and insoluble in ether and ammonia.

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

5.11.3 Requirements. The federal specification requirements for potassium hydroxide, analytical reagent is shown in Table XIII.

TABLE XIII. Potassium hydroxide, analytical reagent - requirements (ACS).

Assay (KOH), min, % by wt	85.0
Maximum Limits of Impurities (% by wt)	
Potassium carbonate (K <sub>2</sub> CO <sub>3</sub> )	2.0
Chloride (Cl)	0.01
Nitrogen compounds (as N)	0.001
Sulfate (SO <sub>4</sub> )	0.003
Ammonium hydroxide precipitate	0.02
Heavy Metals (as Ag)	0.001

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TABLE XIII. Potassium hydroxide, analytical reagent - requirements (ACS).  
- Continued.

Iron (Fe)	0.001
Nickel (Ni)	0.001
Sodium (Na)	0.05
Maximum Limits of Impurities (ppm)	
Phosphate (PO <sub>4</sub> )	5.0

NOTE: Reagent potassium hydroxide normally contains 10 to 15% water.

5.11.4 Use. Potassium hydroxide, analytical reagent is used as a reagent in analytical chemistry. It is also used in medicine.

5.11.5 Safety. Potassium hydroxide is a corrosive solid and a primary irritant. It is nonflammable. Solid caustic and concentrated solutions are irritating to eyes, skin and mucous membranes. Inhalation of dust or mist can cause injury to the entire respiratory tract. Inhalation of dust or mists shall be avoided. Contact with the eyes, skin and clothing shall be avoided. In case of dilute solutions, symptoms of irritation may not be apparent until some time has passed. A chronic dermatitis may follow repeated skin contact. Potassium hydroxide shall be used with adequate ventilation. The TLV (ceiling limit) for potassium hydroxide is 2.0 mg/m<sup>3</sup>. For personal protective measures, refer to section 4.3.1.

5.11.6 Storage. Potassium hydroxide shall be stored in cool, dry place in tightly closed containers. Refer to section 4.3.2.

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

Potassium hydroxide has an EPA Hazardous Waste Classification - Corrosive, Waste Number D002.

5.12 Name. SODIUM HYDROXIDE, ANALYTICAL REAGENT. NaOH FW 40.00  
Caustic soda  
Sodium hydrate  
White caustic

5.12.1 Technical description. Sodium hydroxide (pure) exists as white, deliquescent crystals with a density of 2.130 g/cm<sup>3</sup>. It has a melting point of 318.4°C and a boiling point of 1390.0°C. Its water solubility is 42.0 g/100cm<sup>3</sup> at 0°C and 347.0 g/100cm<sup>3</sup> at 100°C. It is very soluble in alcohol and glycerine and insoluble in acetone and ether.

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

5.12.3 Requirements. The federal specification requirements for sodium hydroxide, analytical reagent is shown in Table XIV.

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TABLE XIV. Sodium hydroxide, analytical reagent - requirements (ACS).

Assay (NaOH), min, % by wt	97.0
Maximum Limits of Impurities (% by wt)	
Sodium carbonate (Na <sub>2</sub> CO <sub>3</sub> )	1.0
Chloride (Cl)	0.0005
Nitrogen compounds (as N)	0.001
Phosphate (PO <sub>4</sub> )	0.001
Sulfate (SO <sub>4</sub> )	0.003
Ammonium hydroxide precipitate	0.02
Heavy Metals (as Ag)	0.002
Iron (Fe)	0.001
Mercury (Hg)	0.1
Nickel (Ni)	0.001
Potassium (K)	0.02

5.12.4 Use. Sodium hydroxide, analytical reagent is used as a reagent in analytical chemistry. It is also used in medicine.

5.12.5 Safety. Sodium hydroxide is nonflammable and corrosive. Tissue exposed to sodium hydroxide results in burns and frequently deep ulceration. It causes rapid destruction of any tissue contacted. Inhalation of dust or mist shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Sodium hydroxide shall be used with adequate ventilation. The TLV (ceiling limit) for sodium hydroxide is 2.0 mg/m<sup>3</sup>. The PEL is 2.0 mg/m<sup>3</sup>. For personal protective measures, refer to section 4.3.1.

Sodium hydroxide will react with water and acids to generate considerable heat; boiling and spattering of hot sodium hydroxide solution may result. Sufficient heat may be generated to ignite combustible materials. Sodium hydroxide solutions can react with some metals, such as aluminum and zinc, to form flammable hydrogen gas.

5.12.6 Storage. Sodium hydroxide shall be stored in cool, dry place in tightly closed containers protected against moisture and water and separated from acids and easily ignitable materials. Protect containers against physical damage. Refer to section 4.3.2.

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

Sodium hydroxide has an EPA Hazardous Waste Classification - Corrosive, Waste Number D002.

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6. NOTES

6.1 Subject term (key word) listing.

Exposure limits, hazardous chemicals  
Ammonium hydroxide, analytical reagent  
Barium hydroxide, analytical reagent  
Barium hydroxide, octahydrate, analytical reagent  
Barium oxide, analytical reagent  
Calcium hydroxide, analytical reagent  
Calcium oxide, analytical reagent  
Calcium oxide, reagent  
Hazardous wastes, disposal and storage of  
Information, hazardous chemicals  
Lithium hydroxide, monohydrate, analytical reagent  
Magnesium hydroxide, analytical reagent  
Magnesium oxide, analytical reagent  
Potassium hydroxide, analytical reagent  
Sodium hydroxide, analytical reagent  
Safety, hazardous chemicals

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Preparing activity: Army - EA

Project Number 6810-B541

Custodians:

Army - EA

Navy - SH

Air Force - 68

Review activities:

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Navy - AS, SA

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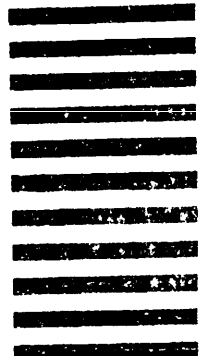
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