METRIC

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MILITARY STANDARD

INORGANIC BASES AND BASIC ANHYDRIDES, TECHNICAL GRADE (METRIC)

AMSC N/A

FSC 6810

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DEPARTMENT OF DEFENSE
Washington, DC 20301

Inorganic Bases and Basic Anhydrides, Technical Grade

MIL-STD-612B

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.

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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TABLES

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, technical grade. 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, technical grade, for application by the Department of Defense.

1.2 Application. Inorganic bases and basic anhydrides, technical grade, are used mainly as cleaning agents, in neutralizing acid wastes, water treatment, dehydrating agent, electroplating, gas absorption and as anti-fouling agents and in pyrotechnic compositions. Inorganic bases and basic anhydrides are also used as chemical intermediates for the manufacture of other chemical compounds and the formulation of chemical products for a variety of applications.

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

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-A-451 - Ammonium Hydroxide, Technical
O-C-110 - Calcium Hydroxide, Technical
O-P-566 - Potassium Hydroxide, Technical
O-S-598 - Sodium Hydroxide, Technical
PPP-C-2020 - Chemicals, Liquid, Dry and Paste, Packaging of

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MIL-P-11751 - Potassium Hydroxide, Solution
MIL-C-12056 - Calcium Oxide, Technical (Metric)
MIL-C-13600 - Cupric Oxide
MIL-L-20213 - Lithium Hydroxide (LiOH), Technical
MIL-S-50005 - Stannic Oxide, Technical

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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 Defense Disposal Manual
DOD 6050.5-LR - DOD Hazardous Materials Information System, Hazardous Item Listing
TB MED 502 (DLAM 1000.2) - Occupational And Environmental Health 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

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

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

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

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

AMERICAN CONFERENCE OF GOVERNMENT INDUSTRIAL HYGIENISTS (ACGIH)

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

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

ASTM

ASTM D 456 - Standard Specification for Caustic Soda (Anhydrous)
ASTM E 11 - Standard Specification for Wire-Cloth Sieves For Testing Purposes
ASTM E 291 - Standard Methods for Chemical Analysis Of Caustic Soda And Caustic Potash (Sodium Hydroxide And Potassium Hydroxide)

ASTM E 323 - Standard Specification For Perforated - Plate 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.

3. DEFINITIONS

3.1 Definitions of Technical Terms.

3.1.1 Baumé

For liquids lighter than water:

$$°\text{Baume} = \left[\frac{140}{\text{Specific gravity } 60°F/60°F}\right] - 130$$

For liquids heavier than water:

$$°\text{Baume} = 145 - \left[\frac{145}{\text{Specific gravity } 60°F/60°F}\right]$$

Specific gravity 60°F/60°F = Ratio of density of liquid at 60°F to density of distilled water at 60°F.

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 abbreviation is as follows: FW - Formula weight

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.

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 must be stored in a manner to prevent ignition and combustion. Easily ignitable substances, such as reducing agents, must be kept away from strong oxidizing agents. All containers must 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 must 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 must be stored in well-ventilated, cool, dry areas. All containers must 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 must be waterproof, located on high ground, and separated from other storage areas.

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

*Refers only to materials that have become waste materials.

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 must 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.

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 must 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 must 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, must 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 must be maintained and recorded in accordance with Part 262 of the above reference. Transportation of the waste must 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 Contigency 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 must 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

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

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

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

5. DETAILED REQUIREMENTS

5.1 Name. AMMONIUM HYDROXIDE, TECHNICAL NH_4OH FW 35.05
Aqua ammonia
Ammoniacal liquor
Ammonium hydrate
ammonia water

5.1.1 Technical Description. Ammonium hydroxide (pure) exists only in solution at ordinary temperature. It is a colorless liquid having a strong pungent odor. Its melting point is -77°C. It is soluble in cold water.

5.1.2 Specification. Federal, O-A-451, Ammonium Hydroxide, Technical.

This specification covers four types of ammonium hydroxide, technical:

Type I - 26° Baumé (27 to 30 percent as NH_3)
Type II - 21° Baumé (19 to 21 percent as NH_3)
Type III - 16° Baumé (9 to 10 percent as NH_3)
Type IV - 14° Baumé (6 to 7 percent as NH_3)

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

TABLE I. Ammonium hydroxide, technical - requirements.

Requirements	Type I	Type II	Type III	Type IV
Assay (as NH_3), % by wt, max	27-30	19-21	9-10	6-7
Specific gravity at 60°/ 60°F, max	0.904	0.929	0.936	0.974
Maximum Limit of Impurities, % by wt				
Residue after ignition	0.03	0.03	0.03	0.03
Nonvolatile matter	0.05	0.05	0.05	0.05

Ammonium hydroxide (26° Baumé) is commercially available with a maximum density of 0.8974 for 29.4% NH_3 at 15.5°C(60°F).

5.1.4 Use. Ammonium hydroxide, technical, is intended for military use as a cleaning agent, an accelerator in vulcanization, a dry diazo print developer for white print machines and as a laboratory reagent, when this grade is suitable. Commercially, it is used in textiles, fertilizer, plastics, pharmaceuticals and lubricants. It is also used in fireproofing wood, ink manufacture, explosives, ceramics, ammonium compounds, saponifying fats and oils, glues, tanning leather and metal industries.

5.1.5 Safety. Aqueous ammonia exerts a local irritant action; strong solutions cause tissue destruction on contact, whether acting on eyes, skin, mucous membranes, gastrointestinal mucosa, or pulmonary tissue. Concentrated solutions of ammonia remaining in contact with the eyes for even a short time may cause serious ocular damage, which may result in prolonged, severe visual disturbances 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.

Ammonia gas causes irritation of the eyes, respiratory tract and throat at concentrations as low as 0.05 percent to 0.1 percent. A concentration of 0.2 percent produces convulsive coughing and may be fatal after a short exposure, i.e., less than half an hour. The maximum concentration tolerated by the skin for more than a few seconds is 2.0 percent. Ammonium hydroxide shall be used with adequate ventilation. Inhalation of vapors or mist shall be avoided. Contact with the eyes, skin and clothing shall be avoided. (Refer to 4.3.1)

When concentrated solutions of ammonia are mixed rapidly with sulfuric acid or other strong mineral acids, the mixture becomes boiling hot instantly and may result in an explosion. Mixing with hypochlorites (chlorine bleach), other halogens and sodium hydroxide shall also be avoided. Avoid contact with metals. Heating shall also be avoided. Ammonia decomposes to hydrogen and nitrogen gases above 450°C (842°F) and has a flash point of 140°F (closed cup). Ammonia has a Threshold Limit Value (TLV) of 25 ppm (18 mg/m^3). The Permissible Exposure Limit (PEL) is 50 ppm (35 mg/m^3). Evolved ammonia has a lower explosive limit (LEL) of 16% and an upper explosive limit (UEL) of 25% in air.

5.1.6 Storage. Ammonium hydroxide shall be stored in a cool, well ventilated place in tightly closed strong glass or plastic containers. (Refer to 4.3.2)

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

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

5.2 Name. BARIUM HYDROXIDE, TECHNICAL $Ba(OH)_2$ FW 171.35
Caustic baryta

5.2.1 Technical Description. Barium hydroxide (pure) exists as monoclinic crystals with a density of 4.495 g/cm^3, and a melting point of 408°C. Its solubility in water is 4.29 g/100 cm^3 at 25°C and 101.4 g/100 cm^3 at 80°C.

5.2.2 Specification. Manufacturer's requirements (No government specification).

5.2.3 Requirements. Barium hydroxide, technical grade is commercially available with a typical analysis range as shown in Table II

TABLE II. Barium hydroxide, technical - typical analysis range.

Requirements	% by wt Typical Analysis Range
Barium hydroxide [$Ba(OH_2)$]	94.0 - 98.0
Limits of Impurities	
Barium carbonate ($BaCO_3$)	2.0 - 6.0
Insoluble, max	0.1
Iron (Fe)	0.2

TABLE II. Barium hydroxide, technical - typical analysis range (Continued).

Requirements	% by wt Typical Analysis Range
Strontium (Sr)	0.1 - 1.2
Sodium (Na) max	0.2
Calcium (Ca) max	0.2
Silica (Si)	Trace
Chloride (Cl)	0.01
Loss in wt (12 hrs at 105°C)	1.0
Tap density, g/cm^3	1.0 - 1.6

5.2.4 Use. Barium hydroxide, technical is used as an oil and grease additive, barium soaps, alkalizing agent in water, sulfate removal agent in treatment of water and brine, boiler scale removal and purifying agent for caustic soda.

5.2.5 Safety. Barium hydroxide is toxic by inhalation. Barium hydroxide aqueous solutions are strongly alkaline and therefore irritating to the eyes, skin and mucous membranes. Prolonged contact with solution of barium hydroxide has a destructive effect on tissue. Contact with the eyes, either in solid or solution form, can cause damage to the delicate tissue. Inhalation of the dust or mist can cause damage to the upper respiratory tract and to lung tissue depending on length of exposure. Inhalation of dust or mist 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 mg/m^3. The PEL is the same. (Refer to 4.3.1)

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

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

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

5.3 Name. BARIUM OXIDE, TECHNICAL BaO FW 153.34
Barium monoxide
Barium protoxide
Calcined baryta

5.3.1 Technical Description. Barium oxide (pure) exists as colorless cubic crystals or white to yellowish powder with a refractive index of 1.98 and density of 5.72 g/cm^3. Its melting point is 1923°C and boiling point about 2000°C. Its solubility in water is 3.48 g/100 cm^3 at 20°C and 90.8 g/cm^3 at 100°C forming barium hydroxide. It is soluble in alcohol forming barium alcoholate. It is soluble in dilute acids. It is insoluble in acetone.

5.3.2 Specification. Manufacturer's requirements (No government specification).

5.3.3 Requirements. Barium oxide, technical grade is commercially available with a typical analysis as shown in Table III.

TABLE III. Barium oxide, technical - typical analysis.

Requirement	% by wt
Assay (BaO) min-max	88 - 92
Maximum Limits of Impurities	
Barium carbonate ($BaCO_3$), min-max	7 - 11
Insoluble in HCl	0.45
Iron (as Fe)	0.017
Sodium (as Na)	0.032
Sulfur (as S)	0.03
Silicon dioxide (SiO_2)	0.670
Aluminum (as Al)	0.05

5.3.4 Use. Barium oxide, technical is used as a dehydrating agent.

5.3.5 Safety. Barium oxide is toxic if ingested or by inhalation. 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^3. The PEL is the same. (Refer to 4.3.1)

On contact with water, barium oxides evolves much heat.

5.3.6 Storage. Barium oxide shall be stored in a cool, dry place in tightly closed containers. (Refer to 4.3.2)

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

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

5.4 Name. CALCIUM HYDROXIDE, TECHNICAL Ca(OH) FW 74.09
Hydrate lime
Slaked lime
Calcium hydrate

5.4.1 Technical Description. Calcium hydroxide (pure) exists as colorless hexagonal crystals with a density of 2.24 g/cm^3. It loses water at 580°C and decomposes on boiling. Its solubility in water is 0.185 g/100 cm^3 at 0°C and 0.077 g/100 cm^3 at 100°C. It is soluble in NH_4 salts and insoluble in alcohol. Calcium hydroxide is unstable if subjected to CO_2 in moist air and acids.

5.4.2 Specification. Federal, O-C-110, Calcium Hydroxide, Technical.

5.4.3 Requirements. The Federal Specification chemical and physical requirements for calcium hydroxide, technical are shown in Table IV and Table V.

TABLE IV. Calcium hydroxide, technical - chemical requirement.

Requirement	% by wt
Assay [$Ca(OH)_2$], min	90.0

TABLE V. Calcium hydroxide, technical - granulation requirements.

U S Standard Sieve 1/	% by wt
Thru 600 micrometer (No. 30)	99.5
Thru 75 micrometer (No. 200)	98.0

1/ Standard sieve designation in accordance with ASTM E 11.

5.4.3.1 Appearance. Calcium hydroxide shall be white, dry, finely powdered, and free from lumps or any foreign material that might interfere with the operation of dry-feed equipment.

5.4.4 Use. Calcium hydroxide, technical is intended for use in the treatment of sewage, industrial water and potable water, as well as for general use. It is not intended for structural use such as in the manufacture of mortar or plaster.

5.4.5 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. calcium hydroxide shall be used with adequate ventilation. Dusting shall be avoided. The TLV for calcium hydroxide is 5 mg/m^3. There is no PEL referenced for calcium hydroxide. (Refer to 4.3.1)

5.4.6 Storage. Calcium hydroxide shall be stored in a cool, dry, well ventilated place in tightly closed containers away from acids. (Refer to 4.3.2)

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

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

5.5 Name. CALCIUM OXIDE, TECHNICAL CaO FW 56.08
Unslaked lime
Quicklime
Burnt lime

5.5.1 Technical Description. Calcium oxide (pure) exists as colorless, cubic crystals with an index of refraction of 1.838 and a density of 3.25 - 3.38 g/cm^3. Its melting point is 2580°C and boiling point is 2850°C. Its solubility in water is 0.131 g/100 cm^3 at 10°C and 0.07 g/100 cm^3 at 80°C with decomposition.

5.5.2 Specification. Military, MIL-C-12056, Calcium Oxide, Technical (Metric).

This specification covers two grades of calcium oxide, technical:

Grade A - 90 percent purity
Grade B - 95 percent purity

5.5.3 Requirements. The Military Specification requirements for calcium oxide, technical are shown in Table VI and Table VII.

TABLE VI. Calcium oxide, technical - chemical requirements.

Requirement	% by Wt			
	Grade A		Grade B	
	Min	Max	Min	Max
Nonvolatile matter	94	--	98	--
Calcium oxide 1/	90	--	95	--
Magnesium oxide 1/	--	--	--	1.0
Iron and aluminum oxides 1/	--	--	--	1.0
Silicon oxide 1/	--	--	--	1.0

1/ On nonvolatile basis

TABLE VII. Calcium oxide, technical - granulation requirements.

Particle Size 1/	% by Wt			
	Grade A		Grade B	
	Min	Max	Min	Max
Retained on 38.1 millimeter (1 1/2 inch) square opening	-	0.0	-	-
Retained on 25.4 millimeter (1 inch) square opening	-	8.0	-	-
Retained on 3.35 millimeter (1/8 inch) round opening	95.0	-	-	-
Retained on 5.6 millimeter (0.223 inch) (No. 3 1/2 standard sieve)	-	-	-	0.0
Retained on 1.70 millimeter (0.0661 inch) (No. 12 standard sieve)	-	-	95.0	-

1/ Standard sieve designation in accordance with ASTM E 11 and ASTM E 323 as applicable.

5.5.4 Use. Calcium oxide, technical is intended for use in steel furnace fluxing, in neutralizing acidic wastes, and in manufacturing bleaching materials.

5.5.5 Safety. Calcium oxide 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. Calcium oxide shall be used with adequate ventilation. The TLV for calcium oxide is 2.0 mg/m^3. The PEL is 5.0 mg/m^3 (Refer to 4.3.1)

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

5.5.6 Storage. Calcium oxide shall be stored in a dry place in tightly closed containers away from acids and acid fumes. (Refer to 4.3.2)

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

Calcium oxide has an EPA Hazardous Waste Classification - Corrosive, Waste Number D002.

5.6 Name. CUPRIC OXIDE, TECHNICAL CuO FW 79.54
Natural tenorite
Black copper oxide
Copper (II) oxide

5.6.1 Technical Description. Cupric oxide (pure) exists as black monoclinic crystals with a density of 6.3 - 6.49 g/cm^3. Its melting point is 1328°C. It is soluble in dilute acids, alkaline cyanides, ammonium carbonate solution, slowly soluble in ammonia, more readily if NH_4Cl is present. It is insoluble in hot or cold water.

5.6.2 Specification. Military, MIL-C-13600, Cupric Oxide.

5.6.3 Requirements. The Military Specification chemical and granulation requirements for cupric oxide, technical are shown in Table VIII and Table IX.

TABLE VIII. Cupric oxide, technical - chemical requirements.

Requirement	% by wt
Assay (CuO), min	95.0
Moisture content, max	0.2
Acid insoluble matter, max	0.5

TABLE IX. Cupric oxide, technical - granulation requirement.

U S Standard Sieve 1/	% by wt
Thru 75 micrometer (No. 200) min	95

1/ Standard sieve designation in accordance with ASTM E 11.

5.6.4 Use. Cupric oxide, technical is intended for use in pyrotechnic compositions.

5.6.5 Safety. Cupric oxide is irritating to the eyes and upper respiratory tract. Inhalation of dust shall be avoided. Contact with the eyes shall be avoided. Cupric oxide shall be used with adequate ventilation. The TLV for copper fume is 0.2 mg/m^3 and for dust and mists, as Cu, is 1 mg/m^3. The PEL for copper fume is 0.1 mg/m^3 and for dust and mist it is 1 mg/m^3. (Refer to 4.3.1)

5.6.6 Storage. Cupric oxide shall be stored in a dry, cool place in tightly closed containers. (Refer to 4.3.2)

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

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

5.7 Name. LITHIUM HYDROXIDE, MONOHYDRATE, TECHNICAL

$LiOH \cdot H_2O$ FW 41.96

5.7.1 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 g/cm^3. Its solubility in water is 22.3 g/100 cm^3 at 10°C and 26.8 g/100 cm^3 at 80°C. It is slightly soluble in alcohol and insoluble in ether. Its heat of formation -188.9 K cal/mole at 25°C. Its heat of formation is -0.867 K cal/mole at 25°C and its specific heat is 0.453 cal/g/°C at 25°C. Its loses water at 100 - 110°C.

5.7.2 Specification. Manufacturer's requirements (No government specification).

5.7.3 Requirements. Lithium hydroxide, monohydrate, technical, free flowing grade is commercially available with typical chemical analysis and specification as shown in Table X and granulation requirements as shown in Table XI.

TABLE X. Lithium hydroxide, monohydrate, technical - typical chemical analysis and specification requirements.

Requirement	% by Wt	
	Typical Analysis	Specification
Lithium hydroxide, monohydrate, free flowing grade, (as LiOH)	57.2	56.5
Limits of Impurities		
Carbon dioxide (CO_2)	0.28	0.35 (max)
Chloride (Cl)	0.001	0.003 (max)
Sulfates (SO_4)	0.01	0.05 (max)
Calcium oxide (CaO)	0.01	0.03 (max)
Iron oxide (as FeO_3)	0.001	0.003 (max)
Sodium hydroxide (NaOH)	0.01	0.05 (max)
Insolubles	0.002	0.005 (max)

TABLE XI. Lithium hydroxide, monohydrate, technical - granulation requirements.

U S Standard Sieve 1/	% by wt
Thru 850 micrometer (No. 20)	100
Thru 180 micrometer (No. 80)	20
Thru 150 micrometer (No. 100)	10

1/ Standard sieve designation in accordance with ASTM E 11

5.7.4 Use. Lithium hydroxide, monohydrate, technical, is used in the production of multi-purpose lubricating grease, additive to the KOH electrolyte of alkaline type storage batteries, preparation of anhydrous lithium hydroxide used as an absorbent for CO_2 in the air purification systems of

submarines and space capsules, alkaline reagent for corrosion inhibition in steam boilers and starting material in industrial chemical manufacturing. It is also used in water-base alkyd resin paints using lithium hydroxide dispersing agent, stabilizer in "single powder" photographic developers, photographic compositions, products and processes and a component of copper electroplating baths.

5.7.5 Safety. Lithium hydroxide, monohydrate, is noncombustible and relatively nontoxic. It is caustic and therefore corrosive. The fact that lithium hydroxide monohydrate is a caustic material is the chief hazard. Its action on tissue can cause burns with possible ulceration and ultimate scarring. Prolonged contact with solutions of lithium hydroxide, monohydrate has a destructive effect on tissue. Contact with the eyes, either in solid or solution form, can cause damage to the delicate tissue. Inhalation of the dust or mist can cause damage to the upper respiratory tract and to lung tissue depending on the length of the exposure. Inhalation of dust or mist shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Lithium hydroxide, monohydrate shall be used with adequate ventilation. There is no TLV or PEL referenced for lithium hydroxide, monohydrate. (Refer to 4.3.1)

Avoid contact of lithium hydroxide, monohydrate with concentrated acids. Concentrated acids react with the evolution of heat and spattering.

5.7.6 Storage. Lithium hydroxide, monohydrate shall be stored in a cool, dry, well ventilated place in tightly closed containers away from acids. (Refer to 4.3.2)

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

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

5.8 Name. LITHIUM HYDROXIDE, TECHNICAL LiOH FW 23.95
Lithium hydrate

5.8.1 Technical Description. Lithium hydroxide (pure) exists as white tetragonal crystals with refractive indices of 1.464 and 1.452 and a density of 1.46 g/cm^3. Its melting point is 450°C and its boiling point is 924°C with decomposition. Its solubility in water is 12.8 g/100 cm^3 at 20°C and 17.5 g/100 cm^3 at 100°C. It is slightly soluble in alcohol and insoluble in ether.

5.8.2 Specification. Military, MIL-L-20213, Lithium Hydroxide (LiOH), Technical.

5.8.3 Requirements. The Military Specification chemical and granulation requirements for lithium hydroxide, technical are shown in Table XII and Table XIII.

TABLE XII. Lithium hydroxide, technical - chemical requirements.

Requirement	% by wt
Assay (LiOH), min	97.6
Moisture content, max	0.50
Maximum Limits of Impurities	
Sulfates and carbonates (as Li_2SO_4 or Li_2CO_3)	1.94 (total)
Calcium oxide (CaO)	0.20
Heavy metals	0.002
Chlorides	Trace
Sodium and potassium (Na and K)	0.20 (total)

TABLE XIII. Lithium hydroxide, technical - granulation requirements.

U S Standard Sieve 1/	Material Retained % by Wt
4.75 millimeter (No. 4)	0 to 5
3.35 millimeter (No. 6)	25 to 70
2.36 millimeter (No. 8)	20 to 65
1.40 millimeter (No. 14)	5 to 45
1.18 millimeter (No. 16)	0 to 3
125 micrometer (No. 120)	0 to 1.5
Pan	0 to 0.5

1/ Standard sieve designation in accordance with ASTM E 11

5.8.4.1 Qualification. The lithium hydroxide furnished under this specification shall be products which are listed, or are qualified for listing on the applicable qualified products list at the time set for opening of bids.

5.8.4.2 Materials. The lithium hydroxide shall be manufactured from lithium hydroxide monohydrate.

5.8.4.3 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and shall be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

5.8.4.4 Solubility. Lithium hydroxide shall be completely soluble, giving a clear colorless solution without any sediment when tested as specified.

5.8.4.5 Apparent density. The apparent density of the lithium hydroxide shall not be less than 0.38 g/cm^3 when tested as specified.

5.8.4.6 Hardness. Lithium hydroxide shall not be less than No. 95 hardness and the amount retained on the No. 14 U S Standard Sieve screen at the end of the test shall not be less than 45 g when tested as specified.

5.8.4.7 Absorption. Initial breakthrough of detectable carbon dioxide in sample effluent must not occur for a minimum of 30 minutes when tested as specified. The absorption of carbon dioxide shall be not less than 0.70 g of carbon dioxide per gram of lithium hydroxide at an absorption efficiency of 50 percent determined as specified.

5.8.4 Use. Lithium hydroxide, technical is intended for military use as a carbon dioxide absorbent on nuclear powdered submarines. Its use is primarily as a back-up system for emergency absorbent requirements. It is also used in organic synthesis, catalyst in making alkyd resins and in esterification reactions and as a stabilizer in "single powder" photographic developers.

5.8.5 Safety. Lithium hydroxide is noncombustible and relatively nontoxic. It is caustic and therefore corrosive. The fact that lithium hydroxide is a caustic material is the chief hazard. Its action on tissue can cause burns with possible ulceration and ultimate scarring. Prolonged contact with solution has a destructive effect on tissue. Contact with the eyes, either in solid or solution form, can cause damage to the delicate tissue. Inhalation of the dust or mist can cause damage to the upper respiratory tract and to lung tissue depending on the severity of the exposure. Inhalation of dust or mist shall be avoided. Contact with the eyes, skin and clothing shall be avoided. lithium hydroxide shall be used with adequate ventilation. There is no TLV or PEL referenced for lithium hydroxide. (Refer to 4.3.1)

Avoid contact of lithium hydroxide with concentrated acids. Concentrated acids react with the evolution of heat and spattering.

5.8.6 Storage. Lithium hydroxide shall be stored in a cool, dry, well ventilated place in tightly closed containers away from acids. (Refer to 4.3.2)

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

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

5.9 Name. POTASSIUM HYDROXIDE, SOLUTION, TECHNICAL
Caustic potash, liquid

5.9.1 Technical Description. Potassium hydroxide solution (30%, 34% and 50% solution) is a colorless to pale yellow liquid. A 30% solution has a specific gravity of 1.2836 (H_2O=1). A 34% solution has a specific gravity of 1.3254 (H_2O=1) and a 50% solution has a specific gravity of 1.5050 (H_2O=1). The solubility of potassium hydroxide in water is 107 g/100 cm^3 at 15°C and 178 g/100 cm^3 at 100°C. The solute has a molecular weight of 56.11 g/mol.

5.9.2 Specification. Military, MIL-P-11751, Potassium Hydroxide Solution.

This specification covers three classes of potassium hydroxide solution as follows:

Class 1 - 34 percent solution
Class 2 - 50 percent solution
Class 3 - 30 percent solution

5.9.3 Requirements. The Military Specification requirements for the three classes of potassium hydroxide, solutions are as shown in Table XIV, Table XV, and Table XVI.

TABLE XIV. Potassium hydroxide, solution (class 1 - 34% solution) - chemical requirements.

Requirement	% by Wt	
	Min	Max
Potassium hydroxide (KOH)	32.0	36.0
Potassium carbonate (K_2CO_3)	--	3.0

TABLE XV. Potassium hydroxide, solution (class 2 - 50% solution) - chemical and physical requirements.

Requirement	% by Wt	
	Min	Max
Potassium hydroxide (KOH)	45.0	50.0
Potassium carbonate (K_2CO_3)	--	3.0
Specific gravity at $15^{\circ}/4^{\circ}C$	1.455	1.515

TABLE XVI. Potassium hydroxide, solution (class 3 - 30% solution) - chemical requirements.

Requirement	% by Wt	
	Min	Max
Potassium hydroxide (KOH)	29.5	30.5
Potassium carbonate (K_2CO_3)	---	0.90
Chloride (Cl)	---	0.005
Nitrogen compounds (as N)	---	0.001
Phosphate (PO_4)	---	0.0005
Sulfate (SO_4)	---	0.002
Ammonium hydroxide precipitate	---	0.01
Heavy metals	---	0.002
Iron (Fe)	---	0.0005
Sodium (Na)	---	0.02

Potassium hydroxide solution, technical is also available commercially in standard grade and mercury cell grade solutions of 45.0% and 50.0%. The standard method for chemical analysis of potassium hydroxide (caustic potash) 45% liquor is given in ASTM E 291.

5.9.4 Use. Potassium hydroxide solutions are intended for military use as desired by the procuring service. Commercially, it is used in producing

soap, glass, textiles, dyes, organic and inorganic potassium compounds, electroplating and alkaline storage batteries.

5.9.5 Safety. Potassium hydroxide solutions are corrosive and a primary irritant. Concentrated solutions are strongly alkaline and are irritating to the eyes, skin and mucous membranes. Inhalation of mist can cause injury to the entire respiratory tract. 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. Inhalation of mist shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Potassium hydroxide solutions shall be used with adequate ventilation. The TLV (ceiling limit) for potassium hydroxide solution is 2 mg/m^3 as KOH. (Refer to 4.3.1)

5.9.6 Storage. Potassium hydroxide solution shall be stored in a cool, dry place in tightly closed containers away from acids and easily ignitable materials. (Refer to 4.3.2)

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

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

5.10 Name. POTASSIUM HYDROXIDE, TECHNICAL KOH FW 56.11
Caustic potash
Potassium hydrate

5.10.1 Technical Description. Potassium hydroxide (pure) exists as white, rhombic, deliquescent crystals with a density of 2.044 g/cm^3. 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/100 cm^3 at 15°C and 178 g/100 cm^3 at 100°C. It is very soluble in alcohol and insoluble in ether and ammonia.

5.10.2 Specification. Federal, O-P-566, Potassium Hydroxide, Technical.

This specification covers four classes of potassium hydroxide, technical as follows:

Class 1 - Flakes
Class 2 - Lumps
Class 3 - Pellets
Class 4 - Sticks

5.10.3 Requirements. The Federal Specification chemical and form requirements for potassium hydroxide, technical are as shown in Table XVII.

TABLE XVII. Potassium hydroxide, technical - chemical requirements.

Requirement	% by wt
Potassium hydroxide (KOH), min	85
Carbonate (as K_2CO_3), max	3

TABLE XVIII. Potassium hydroxide, technical - form requirements.

Class	Form	Dimensions
1	Flakes	----------
2	Lumps	Larger than 12.5 millimeter (1/2-inch) and smaller than 50 millimeter (2 inches).
3	Pellets	6.3 millimeter (1/4-inch) maximum for any dimension.
4	Sticks	12.5 millimeter (1/2-inch) maximum diameter

5.10.3.1 Manufacture. Potassium hydroxide shall be manufactured by the electrolytic method. The contractor shall certify that this requirement has been met.

5.10.3.2 Color, form and contamination. Potassium hydroxide shall be visibly free from foreign matter, shall have a white or pale yellow color, and shall have a form conforming to Table XVIII.

5.10.4 Use. Potassium hydroxide, technical is intended for use in gas absorption and electroplating.

5.10.5 Safety. Potassium hydroxide is a corrosive solid and a primary irritant. It is nonflammable. Solid caustic and concentrated solutions are strongly alkaline and are irritating to the eyes, skin and mucous membranes. Inhalation of dust or mist can cause injury to the entire respiratory tract. 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. Inhalation of dust or mist shall be avoided. Potassium hydroxide shall be used with adequate ventilation. The TLV (ceiling limit) for potassium hydroxide is 2.0 mg/m^3. (Refer to 4.3.1)

5.10.6 Storage. Potassium hydroxide shall be stored in a cool, dry place in tightly closed containers. (Refer to 4.3.2)

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

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

5.11 Name. SODIUM HYDROXIDE, SOLUTION, TECHNICAL
Caustic soda

5.11.1 Technical Description. Sodium hydroxide, solution (50%) is a colorless liquid. It has a boiling point of 142° - 148°C (288° - 298°F), a specific gravity of 1.525 at 20°C (68°F) (H_2O=1) and is miscible with water in all proportions. The solute has a molecular weight of 40.00 g/mol.

5.11.2 Specification. Manufacturer's requirements (No government specification).

5.11.3 Requirements. Sodium hydroxide, solution, technical grade is commercially available as a 50% commercial grade and 50% and 73% rayon grade. The specification requirements of the 50% commercial grade are as shown in Table XIX. The specifications and typical analysis for 50% and 73% rayon grade are as shown in Table XX and Table XXI.

TABLE XIX. Sodium hydroxide (50% solution) technical - specification requirements.

Requirements	% by wt
Sodium hydroxide (NaOH), min-max	49.0-52.0
Maximum Limits of Impurities	
Sodium oxide (Na_2O), min-max	38.0-40.4
Sodium carbonate (Na_2CO_3)	0.2
Sodium chloride (NaCl)	1.1
Iron (Fe)	0.0007
Sodium chlorate ($NaClO_3$)	0.4
Sodium sulfate (Na_2SO_4)	0.02
Silicon dioxide (SiO_2)	0.04
Aluminum oxide (Al_2O_3)	0.004
Calcium oxide (CaO)	0.006
Magnesium oxide (MgO)	0.002
Manganese (Mn)	0.0001
Nickel (Ni)	0.0002
Copper (Cu)	0.0002
Mercury (Hg)	0.00005

Appearance. Colorless to hazy liquid
Density. At 38°C - approximately 1510 Kg/m^3
(At 100°F - approximately 12.6 lbs/gal)
Melting point. Approximately 55°F (13°C)

TABLE XX. Sodium hydroxide (50% solution - rayon grade), technical - typical analysis and specification requirements.

Requirements	% by Wt	
	Typical Analysis	Specification
Sodium hydroxide (NaOH),	50.8	5.0-52.0 (min-max)
Maximum Limits of Impurities		
Sodium oxide (Na_2O)	39.4	38.7-40.3 (min-max)
Sodium carbonate (Na_2CO_3)	0.02	0.06
Sodium chloride (NaCl)	0.0006	0.003
Iron (Fe)	0.0008	0.0002
Sodium chlorate ($NaClO_3$)	0.00005	0.0001
Sodium sulfate (Na_2SO_4)	0.0005	0.002
Silicon dioxide (SiO_2)	0.0009	0.002
Aluminum oxide (Al_2O_3)	0.0001	0.0006
Calcium oxide (CaO)	0.001	0.002
Magnesium oxide (MgO)	0.0000	0.0002
Manganese (Mn)	0.00002	0.00004
Nickel (Ni)	0.00001	0.00003
Copper (Cu)	0.00000	0.00005
Mercury (Hg)	0.00002	0.00005

Appearance. Colorless liquid

Density. At 38°C - approximately 1510 Kg/m^3
(At 100°F - approximately 12.6 lbs/gal)
Melting point. Approximately 55°F (13°C)

TABLE XXI. Sodium hydroxide (73% solution - rayon grade), technical - typical analysis and specification requirements.

Requirements	% by Wt	
	Typical Analysis	Specification
Sodium hydroxide (NaOH),	72.70	72.0-74.0 min-max
Maximum Limits of Impurities		
Sodium oxide (Na_2O)	56.35	55.83-57.35 min-max
Sodium carbonate (Na_2CO_3)	0.02	0.06
Sodium chloride (NaCl)	0.0010	0.004
Iron (Fe)	0.00013	0.00035
Sodium sulfate (Na_2SO_4)	0.0005	0.0020
Silicon dioxide (SiO_2)	0.001	0.0025
Aluminum oxide (Al_2O_3)	0.0002	0.0005
Calcium oxide (CaO)	0.0020	0.003
Magnesium oxide (MgO)	0.000	0.0003
Manganese (Mn)	0.00003	0.00004
Nickel (Ni)	0.00004	0.00005
Copper (Cu)	0.00000	0.00007

Appearance. Colorless liquid
Density. At 176°F (80°C) - approximately 1712 Kg/m^3
Melting point. Approximately 143°F (61.5°C)

The standard method for chemical analysis of sodium hydroxide (caustic soda) is given in ASTM E 291.

5.11.4 Use. Sodium hydroxide, solution, technical, is an inexpensive alkali used in many chemical industries; effluent neutralization for pollution control in the treatment of metals, production of alumina from bauxite. It is used as a reagent in paper production, the reclaiming of rubber and the manufacture of soap and synthetic detergents. It is also used as a reagent in the processing of rayon, mercerized cotton and synthetic fibers and in the decarbonizing of wool.

5.11.5 Safety. Sodium hydroxide solutions are corrosive and a primary irritant. Concentrated solutions are strongly alkaline and are irritating to the eyes, skin and mucous membranes. Inhalation of mist can cause injury to the entire respiratory tract. in case of dilute solutions, symptoms may not be apparent until some time has passed. A chronic dermatitis may follow repeated skin contact. Inhalation of mist shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Sodium hydroxide solutions shall be used with adequate ventilation. The TLV (ceiling limit) for sodium hydroxide solution is 2 mg/m^3. (Refer to 4.3.1)

Sodium hydroxide solution will react with water and acids to generate a considerable amount of heat; boiling and spattering of hot sodium hydroxide solution may result. The solution can react violently or explosively with many organic chemicals. Sodium hydroxide solution can react with some metals to form flammable hydrogen gas.

5.11.6 Storage. Sodium hydroxide solution shall be stored in a cool, dry, well ventilated place in tightly closed container away from acids. (Refer to 4.3.2)

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

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

5.12 Name. SODIUM HYDROXIDE, TECHNICAL NaOH FW 40.00
Caustic soda
Sodium hydrate
White caustic
Lye

5.12.1 Technical Description. Sodium hydroxide (pure) exists as white, deliquescent crystals with an index of refraction of 1.3576 and a density of 2.130 g/cm^3. Its melting point is 318.4°C and boiling point is 1390°C. Its solubility in water is 42.0 g/100 cm^3 at 0°C and 347.0 g/100 cm^3 at 100°C. It is very soluble in alcohol and glycerine and insoluble in acetone and ether.

5.12.2 Specification. Federal, O-S-598, Sodium Hydroxide, Technical

This specification covers four types of sodium hydroxide, technical grade as follows:

Type I - Flake
Type II - Lump
Type III - Powder
Type IV - Bead

5.12.3 Requirements. The Federal Specification requirements for sodium hydroxide, technical are as shown in Table XXII.

TABLE XXII. Sodium hydroxide, technical - chemical requirements.

Requirements	% by wt
Assay (as NaOH), min	96.0
Maximum Limits of Impurities	
Carbonate (as Na_2CO_3), max	2.0
Total alkalinity (as Na_2O), min	75.0

Form. Sodium hydroxide shall be flakes, lumps, powder or beads in accordance with the type of material specified.

Sodium hydroxide is also covered by ASTM D 456, Standard Specification for Caustic Soda (Anhydrous). The chemical requirements as specified are the same as those given in Table XXII.

Sodium hydroxide, technical is commercially available in several grades and forms. it is available from one manufacturer in granular (regu-

lar and fine), and flake form. The specifications and typical granulation requirements are shown in Table XXIII and Table XXIV.

TABLE XXIII. Sodium hydroxide, technical - specification requirements.

Requirements	% by wt
Assay (as NaOH), min	97.0
Maximum Limits of Impurities	
Sodium oxide (Na_2O), min	75.1
Sodium carbonate (as Na_2CO_3), max	1.0
Sodium chloride (NaCl), max	1.0
Iron (Fe), max	0.003

TABLE XXIV. Sodium hydroxide, technical - typical granulation requirements.

	% by Wt Retained		
U S Standard Sieve 1/	Granular	Fine Granular	Flake
50 millimeter (2 inch) max	---	---	5.0
3.35 millimeter (No. 6) max	0.5	0.0	---
2.36 millimeter (No. 8) min	---	---	85.0
2.00 millimeter (No. 10) max	---	10.0	---
1.70 millimeter (No. 12) min	70.0	---	95.0
850 micrometer (No. 20) min	99.0	---	99.0
300 micrometer (No. 40) min	99.5	99.0	---

1/ Standard sieve designation in accordance with ASTM E 11.

Sodium hydroxide, technical (rayon grade) is commercially available in granular (regular and fine), and flake form. The specification requirements are shown in Table XXV. The typical granulation requirements are the same as shown in Table XXIV.

TABLE XXV. Sodium hydroxide, (rayon grade), technical - specification requirements.

Requirement	% by wt
Assay (as NaOH), min	98.0
Limits of Impurities	
Sodium oxide (Na_2O), min	75.9
Sodium carbonate (Na_2CO_3), max	0.5
Sodium sulfate (Na_2SO_4), max	0.1
Sodium chloride (NaCl), max	0.01
Sodium chlorate ($NaClO_3$)	<0.0001
Iron (Fe), max	0.002

Sodium hydroxide (reactor grade) is commercially available in course granules and thick plate - type flake form. The specification requirements for the course granules and thick plate - type flake are the same as those given in Table XXV.

The typical granulation requirement are as shown in Table XXVI.

TABLE XXVI. Sodium hydroxide, (reactor grade), technical-typical granulation requirements.

U S Standard Sieve 1/	% by Wt Retained	
	Flake	Granular
50 millimeter (2 inch) max	5.0	---
3.35 millimeter (No. 6) max	---	0.5
2.36 millimeter (No. 8) min	85.0	---
1.70 millimeter (No. 12) min	95.0	70.0
850 micrometer (No. 20) min	99.0	99.0
300 micrometer (No. 40) min	---	99.5
Particle thickness, millimeter (in.)	1.52(0.06)	1.52(0.06)

1/ Standard sieve designation in accordance with ASTM E 11.

Sodium hydroxide, technical (standard grade) is commercially available in flake, granular and beaded form. The specification requirements are shown in Table XXVII. The typical granulation requirements are shown in Table XXVIII.

TABLE XXVII. Sodium hydroxide (standard grade), technical - specification requirements.

Requirement	% by Wt	
	Flake and Granular	Beads
Sodium hydroxide (equiv)(NaOH), min	96.0	96.0
Sodium oxide (equiv)(Na_2O), min	75.0	74.4
Maximum Limits of Impurities		
Sodium carbonate (Na_2CO_3)	3.0	1.60
Sodium chloride (NaCl)	1.7	2.20
Sodium sulfate (Na_2SO_4)	0.10	0.035 1/
Sodium chlorate ($NaClO_3$)	None	0.02
Silicon (Si)	0.02	0.003 1/
Iron (Fe)	0.0025	0.002
Calcium (Ca)	0.0015	0.0010 1/
Magnesium (Mg)	0.002	0.0010 1/
Aluminum (Al)	0.001	0.0006 1/
Manganese (Mn)	0.0005	0.0004 1/
Copper (Cu)	0.0001	0.0002
Nickel (Ni)	0.0001	0.0004

1/ No specification. Represents typical data for beads.

TABLE XXVIII. Sodium hydroxide (standard grade), technical - typical granulation requirements.

U S Standard Sieve 1/	% By Wt Retained		
	Flake	Granular	Beads
9.5 millimeter (3/8 inch)	1.0	--	--
6.3 millimeter (1/4 inch)	5.0	--	--
4.75 millimeter (No. 4)	15.0	0.0	--
2.36 millimeter (No. 8)	75.0	12.0	--
2.00 millimeter (No. 10)	--	27.0	0.0
1.40 millimeter (No. 14)	4.0	38.0	--
1.18 millimeter (No. 16)	0.0	10.0	--

TABLE XXVIII. Sodium hydroxide (standard grade), technical - typical granulation requirements (Continued).

U S Standard Sieve 1/	% By Wt Retained		
	Flake	Granular	Beads
850 micrometer (No. 20)	--	9.0	10.0-25.0
600 micrometer (No. 30)	--	4.0	--
300 micrometer (No. 40)	--	--	50.0-70.0
250 micrometer (No. 60)	--	--	10.0-15.0
Thru 250 micrometer (No. 60)	--	--	1.0-10.0
Pan	--	Trace	--

1/ Standard sieve designation in accordance with ASTM E 11.

5.12.4 Use. Sodium hydroxide is intended for use in various cleaning, washing, and scouring processes, with or without soap, as conditions demand, and where a strongly alkaline material is desired.

5.12.5 Safety. Sodium hydroxide, both solid and in solution has a markedly corrosive action upon all body tissue. Its corrosive action on tissue causes burns and frequently deep ulceration. Mists, vapors and dust of sodium hydroxide causes burns and contact with the eyes either in solid or solution form, rapidly cause severe damage to the delicate tissue. Inhalation of the dust or concentrated mists can cause damage to the upper respiratory tract and to lung tissue, depending upon the severity of the exposure. Inhalation of dust or mists 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 mg/m^3. (Refer to 4.3.1)

Sodium hydroxide will react with water and acids to generate a considerable amount of heat; boiling and spattering of hot sodium hydroxide solution may result.

5.12.6 Storage. Sodium hydroxide shall be stored in a cool, dry, well ventilated place in tightly closed containers away from acids. (Refer to 4.3.2)

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

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

5.13 Name. STANNIC OXIDE, TECHNICAL SnO_2 FW 150.69
Tin (IV) oxide
Tin dioxide
Stannic anhydride

5.13.1 Technical Description. Stannic oxide (pure) exists as white tetragonal (also hexagonal or rhombic crystals with refractive indices of 1.997 and 2.093 and density of 6.95 g/cm^3. Its melting point is 1127°C and sublimes at 1800°-1900°C. It is soluble in concentrated sulfuric acid and hydrochloric acid. It is insoluble in hot and cold water.

5.13.2 Specification. Military, MIL-S-50005, Stannic Oxide, Technical.

This specification covers two classes of stannic oxide, technical:

Class 1
Class 2

5.13.3 Requirements. The Military Specification chemical and granulation requirements for stannic oxide, technical is shown in Table XXIX and XXX.

TABLE XXIX. Stannic oxide, technical - chemical requirements.

Assay (as SnO_2 on a dry basis) min	98.2
Maximum Limits of Impurities	
Volatile content	0.50
Acidity (as H_2SO_4)	0.01

TABLE XXX. Stannic oxide, technical - granulation requirements.

	% by Wt	
U S Standard Sieve 1/	Class 1	Class 2
Thru 75 micrometer (No. 200) min	95	95
Thru 45 micrometer (No. 325) min	85	90

1/ Standard sieve designation in accordance with ASTM E 11.

5.13.4 Use. Stannic oxide, technical is intended for use as an antifouling agent.

5.13.5 Safety. Stannic oxide has a low toxicity and is nonflammable. Inhalation of dust or fumes of inorganic tin is known to cause a benign pneumoconiosis. It produces distinctive progressive X-ray changes of the lungs as long as exposure persists, but there is no distinctive fibrosis, no evidence of disability and no special complicating factors. Inorganic tin compounds may cause mild irritation to the skin and mucous membranes . inhalation of dust shall be avoided. Contact with the eyes, skin and clothing shall be avoided. Stannic oxide shall be used with adequate ventilation. The TLV for tin oxide and inorganic compounds as Sn in 2 mg/m^3. There is no PEL. (Refer to 4.3.1)

5.13.6 Storage. Stannic oxide shall be stored in a cool, dry, well ventilated place in tightly closed containers. (Refer to 4.3.2)

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

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

6. NOTES

6.1 Subject term (key word) listing.

Exposure limits, hazardous chemicals
Ammonium hydroxide
Barium hydroxide
Barium oxide
Calcium hydroxide
Calcium oxide
Cupric oxide
Lithium hydroxide
Lithium hydroxide, monohydrate
Potassium hydroxide
Potassium hydroxide, solution
Sodium hydroxide
Sodium hydroxide, solution
Stannic oxide
Safety, hazardous chemicals

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.

Preparing activity: Army - EA Project Number 6810-B567

Custodians:
Army - EA
Navy - YD
Air Force - 68

Review activities:
DLA - CT, GS
Army - GL, MD, ME
Navy - AS, SA

User activities:
Army - AT
Navy - MS

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3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
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5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
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