METRIC

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MILITARY STANDARD

INORGANIC SALTS AND COMPOUNDS, TECHNICAL GRADE (ALUMINUM CHLORIDE THROUGH BORON NITRIDE)

AMSC N/A

FSC 6810

FOREWORD

1. 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.

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 and Development Center, Attn: SMCCR-PET-S, 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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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 salts and compounds, technical grade (aluminum chloride through boron nitride). 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 salts and compounds, technical grade (aluminum chloride through boron nitride), for application by the Department of Defense.

1.2 Application. Inorganic salts and compounds, technical grade (aluminum chloride through boron nitride) are used in formulating products such as pyrotechnics, propellants, explosives, metal cleaners, battery electrolytes, and water treatment chemicals. They are also used as chemical intermediates.

1.3 Classification. The items in this standard are classified on the basis of chemical composition as inorganic salts and compounds.

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-429	Aluminum Sulfate, Technical
O-A-491	Ammonium Chloride, Technical
PPP-C-2020	Chemicals, Liquid, Dry and Paste; Packaging of

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MIL-A-159	Antimony Sulfide
MIL-B-162	Barium Nitrate
MIL-A-175	Ammonium Nitrate, Technical
MIL-A-192	Ammonium Perchlorate, Technical
MIL-B-550	Barium Chromate
MIL-B-624	Barium Carbonate (For Use in Ammunition)
MIL-B-47208	Boron Nitride Powder
MIL-A-47240	Ammonium Nitrate (Uncoated)
MIL-A-50460	Ammonium Nitrate, Prilled (For Use in Ammunition)
MIL-A-63471	Aluminum Chloride (Anhydrous) (For Use in Ammunition)
MIL-A-82667	Ammonium Perchlorate, General Specification for
MIL-A-82667/1	Ammonium Perchlorate, High Purity
MIL-A-82667/2	Ammonium Perchlorate, Conditioned

STANDARDS

FEDERAL

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

MILITARY

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

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

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

DEPARTMENT OF DEFENSE (DOD)

DODISS	Department of Defense Index of Specifications and Standards

DOD 4145.19-R-1	Storage and Materials Handling
DOD 4160.21-M	Defense Utilization and 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

(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.

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.)

CODE OF FEDERAL REGULATIONS (CFR)

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

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.)

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

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence.

3. GLOSSARY

3.1 Definitions.

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

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

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

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

4.3 Safety.

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

4.3.1.1 Respiratory protection. Respirators, approved by the National Institute for Occupational Safety and Health (NIOSH) or the Mine Safety and Health Administration (MSHA) 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 within 50 feet of where there is a potential for direct contact with harmful chemicals. When transferring chemicals, eye lavages and emergency showers shall be within 50 feet of the transfer point. Eye lavages must be able to provide at least 15 minutes of flushing capability. Emergency showers shall be equipped with a valve that will fully open with one pull and deliver 30 gallons of water per minute.

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

4.3.1.4 Training. Employers shall provide employees with training and information including MSDS on all chemical items in their work area, in accordance with 29 CFR 1910.1200(h), to ensure that employees know potential hazards of the chemicals with which they come in contact and the symptoms of exposure as well as how these chemicals affect the body and bodily functions. Employees shall be adequately trained to render first aid.

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

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

4.3.2.1 Flammable, combustible, pyrophoric and ignitable materials. A flammable material is generally any solid, liquid, vapor or gas that ignites easily and burns rapidly. Combustible materials are generally those that are difficult to ignite and burn slowly. The DOT, in Part 173, Subpart D, Section 173.115 of 49 CFR, defines a flammable liquid as one having a closed cup flash point below 100°F (37.8°C). A combustible liquid is defined, by DOT in the above reference, as one having a closed cup flash point at or above 100°F and below 200°F (93.3°C). A pyrophoric liquid is defined, by DOT in the above reference, as one that ignites spontaneously in dry or moist air at or below 130°F (54.4°C). Materials with flash points of 200°F or higher are not considered to be nonflammable or noncombustible, but are to be considered as burnable. The Environmental Protection Agency (EPA), in Part 261, Subpart C, Section 261.21 of 40 CFR (refers only to materials that have become waste materials), designates the criteria for flammable and combustible materials and oxidizers that exhibit the characteristic of ignitability (I). Liquids with closed cup flash points of less than 140°F (60°C) are defined by EPA as ignitable. The autoignition point (temperature) of a substance is generally defined as the minimum temperature required to initiate or cause self-sustained combustion in the absence of a spark or flame. Materials that ignite easily under normal industrial conditions are considered to be dangerous fire hazards. Such Materials shall be stored in a manner to prevent ignition and combustion. Easily ignitable substances, such as reducing agents, shall be kept away from strong oxidizing agents. All containers shall be tightly sealed. It is important to provide adequate ventilation in storage areas, and to locate the storage areas of these items away from fire hazards. Ample fire control equipment shall be easily accessible. Storage buildings, rooms and cabinets shall comply with provisions of the National Fire Codes. The building shall be electrically grounded and signs posted to prevent the lighting of matches or smoking in the area. Flammable storage areas shall be equipped with smoke or fire detection equipment.

4.3.2.2 Water-sensitive fire and explosive hazardous materials. These are materials that react on contact with water or steam to ignite or evolve heat or explosive gases. Such materials exhibit the characteristic of reactivity (R) as designated by the EPA in Section 261.23 of the above reference. (Refers only to materials that have become waste materials.) These materials shall be stored in well-ventilated, cool, dry areas. All containers shall be tightly sealed. These materials are a fire hazard in contact with water or moisture; therefore, it is essential that no sprinkler be used. Otherwise, the building shall conform to

that required for storage of flammable materials. The building shall be waterproof, located on high ground, and separated from other storage areas.

4.3.2.3 Incompatible materials. Materials that are chemically incompatible shall be segregated in the storage of both serviceable and unserviceable items. The degree of segregation will depend upon DOD 4145.19-R-1 and local supplementary requirements that insure safe storage conditions. Hazardous storage compatibility codes are provided in the HMIS referred to in 4.2.

4.3.3 Chemical hazardous exposure limits. Chemical hazardous exposure limits for airborne concentrations of substances are obtained from the current TLVs• Threshold Limit Values for Chemical Substances 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 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 261.119(a)(3) of 40 CFR. (Refers only to materials that have become waste materials.) Some commercial chemical products are listed as toxic under Subpart D, Section 261.33(f).

4.3.4.2 EPA acute hazardous toxicity (H). Some chemical compounds have been designated by the EPA as acute hazardous (H) in toxicity in accordance with the criteria shown in Subpart B, Section 261.11(a)(2) of the above reference, which refers only to materials that have become waste materials. Some commercial chemical products are listed as acute hazardous in toxicity under Subpart D, Section 261.33(e).

4.4 Pollution and disposal.

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

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

4.4.3 Disposal and storage of hazardous wastes. Items are classified and managed as hazardous wastes as defined by the Resource Conservation and Recovery Act (RCRA) (Public Law 94-580). Items have been identified as meeting the characteristics (i.e., ignitable, corrosive, reactive or 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 4.4.3.4.2, 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 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.

4.5 U.S. Sieve Numbers. U.S. Sieve Numbers are defined in ASTM E 11, Standard Specification for Wire Cloth Sieves for Testing Purposes, see 2.2.

5. DETAILED REQUIREMENTS

5.1 Name. ALUMINUM CHLORIDE, ANHYDROUS, TECHNICAL $AlCl_3$ FW 133.34

5.1.1 Technical description. Anhydrous aluminum chloride (pure) is in the form of white to colorless hexagonal crystals with the physical properties shown in Table I. It is very soluble in alcohol, and soluble in ethyl chloride, ether, acetonitrile and pyridine. It is very slightly soluble in benzene.

TABLE I. Aluminum chloride, anhydrous - physical properties.

Characteristic	Value
Density (25°C), g/cm^3	2.44
Density of liquid (200°C), g/cm^3	1.31
Sublimation point (760 mm Hg), °C	178
Melting point (2.5 atm), °C	190
Boiling point (752 mm Hg), °C	183
Solubility in absolute alcohol (12.5°C), g/100 cm^3	100
Solubility in ethyl ether (25°C) g/100 cm^3	5

Anhydrous aluminum chloride, in the solid form, is a continuous network with the formula $AlCl_3$. It also exists as the dimer, Al_2Cl_6, in the liquid and vapor state up to 400°C. It decomposes in water with a violent exothermic reaction to generate steam and hydrogen chloride fumes which form hydrochloric acid.

5.1.2 Specification. MIL-A-63471 Aluminum Chloride (Anhydrous) (For Use in Ammunition).

The military specification requirements for anhydrous aluminum chloride are shown in Table II.

TABLE II. Anhydrous aluminum chloride - specification requirements.

Characteristics	Requirements	
	Max	Min
Aluminum chloride, % by wt	---	99.0
Water-insoluble material, % by wt	0.3	---
Water, % by wt	0.8	---
Iron, ppm	200	---
Free aluminum, ppm	100	---

Anhydrous aluminum chloride, technical grade, is commercially available in several types with minimum purities of 98.5 percent and 99.25 percent by weight or more.

5.1.3 Use. Anhydrous aluminum chloride is intended for military use in thionyl chloride reserve type lithium batteries. Commercial uses are as a primary catalyst for Friedel-Crafts reactions such as alkylation, olefin polymerization, and addition. Non-catalytic uses include metal refining, plating, and the nucleation of titanium chloride for the manufacture of titanium dioxide.

5.1.4 Packaging. Refer to 4.1.

5.1.5 Safety precautions.

5.1.5.1 Health hazard. Anhydrous aluminum chloride is a strong irritant to the eyes, skin and mucous membranes. It can cause burns by reaction with moisture. There is no PEL or TLV for anhydrous aluminum chloride. For personal protective measures, refer to 4.3.1.

5.1.5.2 Fire and explosion hazard. Anhydrous aluminum chloride is not burnable.

5.1.5.3 Reactivity. Anhydrous aluminum chloride reacts violently with water to generate hydrogen chloride gas fumes which are irritating, corrosive and toxic. If the material is present in a fire, the use of water must be avoided. A dry chemical or CO_2 extinguisher is suitable.

5.1.6 Storage. Anhydrous aluminum chloride shall be stored in a cool, dry, well-ventilated space, without a sprinkler system, in tightly sealed, waterproof metal containers. Containers can develop pressure, by reaction of the compound with atmospheric moisture, and shall be vented cautiously prior to emptying. 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.

EPA Hazardous Waste Classification - Reactive; Waste Number D003.

5.2 Name. ALUMINUM SULFATE, HYDRATED, TECHNICAL FW 594.36 for $14H_2O$
$Al_2(SO_4)_3 \cdot xH_2O$ (x = approximately 14)
Cake alum
Filter alum
Sulfate of alumina

5.2.1 Technical description. Hydrated aluminum sulfate (pure) is in the form of the octadecahydrate, $Al_2(SO_4)_3 \cdot 18H_2O$, with the formula weight 666.43. It is in the form of colorless monoclinic crystals with the physical properties shown in Table III. It is soluble in water, and insoluble in alcohol. Solutions in water are acidic because of hydrolysis, and the pH of a 1% solution is approximately 3.5.

TABLE III. Aluminum sulfate, hydrated - physical properties.

Characteristic	Value
Density (17°C), g/cm^3	1.69
Refractive index	1.474, 1.467, 1.483
Dehydration start, °C	86.5
Anhydrous point, °C	250
Solubility in water, $g/100\ cm^3$	
(0°C)	86.9
(100°C)	1104

5.2.2 Specification. O-A-429 Aluminum Sulfate, Technical.

The federal specification covers two types and three classes of hydrated aluminum sulfate, technical grade, as follows:

Type I - Purified
Type II - Unpurified
Class 1 - Lump
Class 2 - Round
Class 3 - Rice ground

The chemical requirements for the two types are shown in Table IV.

TABLE IV. Aluminum sulfate, hydrated - chemical requirements.

Characteristics	Requirements	
	Type I	Type II
	% By Wt	% By Wt
Water-soluble alumina, as Al_2O_3, min	17.0	17.0
Basicity, as Al_2O_3, min	0.05	0.05
Iron, as Fe_2O_3, max	0.75	0.75
Water insoluble matter, max	0.5	10.0

The particle size requirements for the three classes are shown in Table V.

TABLE V. Aluminum sulfate, hydrated - particle size requirements.

Particle Size	Requirements			
	Class 1	Class 2	Class 3	
	Max	Max	Min	Max
	% By Wt	% By Wt	% By Wt	% By Wt
Retained on a 75 mm sieve	0	---	---	---
Passing a 19 mm sieve	0	---	---	---
Retained on a 4.75 mm sieve	---	0.0	---	0.0
Retained on a 2.00 mm sieve	---	10.0	---	---
Retained on a 850 μm sieve	---	---	80.0	---
Passing a 150 μm sieve	---	---	---	2.0

Technical grades of aluminum sulfate are not completely hydrated, and are pale-green to cream colored, powdered, granular or lump material. The iron-free grade is colorless or white. Hydrated aluminum sulfate, technical grade, is commercially available with water-soluble Al_2O_3 contents of 17.0 to 17.2 percent by weight, which corresponds approximately to the formula containing $14H_2O$.

5.2.3 Use. Aluminum sulfate is intended for military use in the treatment of water and sewage. Commercial uses include water treatment, in the manufacture of paper, alumino-silicate catalysts and aluminum soaps. Iron-free aluminum sulfate is used in the textile, paper, leather, rubber and food industries where the presence of iron would cause discoloring problems.

5.2.4 Packaging. Refer to 4.1.

5.2.5 Safety precautions.

5.2.5.1 Health hazard. Aluminum sulfate is an acidic compound and the dust can be irritating to the eyes and respiratory tract. The TLV for soluble salts of aluminum is 2 mg/m_3. Solutions of aluminum sulfate are also irritating to the eyes and skin. For personal protective measures, refer to 4.3.1.

5.2.5.2 Fire and explosion hazard. Aluminum sulfate is not burnable.

5.2.5.3 Reactivity. Aluminum sulfate is a stable compound.

5.2.6 Storage. Aluminum sulfate, hydrated, shall be stored in a cool, dry area in polyethylene-lined containers. It is slightly hygroscopic and is subject to caking if exposed to moisture. The acid resulting from hydrolysis, if exposed to moisture, can cause deterioration of metal containers or paper bags. 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.

EPA Hazardous Waste Classification - None.

5.3 Name. AMMONIUM BIFLUORIDE, TECHNICAL NH_4HF_2 FW 57.05
Ammonium acid fluoride
Ammonium hydrogen difluoride
Ammonium hydrogen fluoride

5.3.1 Technical description. Ammonium bifluoride is the salt of the dimer acid H_2F_2, which is a stronger acid that the monomer HF. Ammonium bifluoride (pure) is in the form of rhombic or tetragonal deliquescent crystals with the physical properties shown in Table VI. It is soluble in cold and hot water, and slightly soluble in alcohol. In aqueous solution, it releases 0.35 parts by weight of hydrofluoric acid per part of salt by hydrolysis.

TABLE VI. Ammonium bifluoride - physical properties.

Characteristic	Value
Density, g/cm^3 (solid state)	1.50
(liquid state)	1.35
Refractive index	1.390
Melting point, °C	126
Boiling point (760 mm Hg), °C	239.5
Solubility in water (20°C), g/100g	58.3

5.3.2 Specification. None.

Ammonium bifluoride, technical grade, is commercially available as white flakes with a minimum of NH_4HF_2 content of 98.0 percent by weight. These flakes are hygroscopic at 50% or more relative humidity. The molten salt dissolves metal oxides.

5.3.3 Use. Ammonium bifluoride, technical grade, is intended for military use in metal cleaning and in the preparation of anodic coatings for aluminum and magnesium. Commercial uses include cleaning, frosting and polishing glass, acidizing oil wells, and stain removal from textiles.

5.3.4 Packaging. Refer to 4.1.

5.3.5 Safety precautions.

5.3.5.1 Health hazard. Ammonium bifluoride is an acid salt, and the dust is highly irritating to the eyes, respiratory tract, and skin. Prolonged contact with dust or solutions can cause hydrofluoric acid burns of the eyes and skin. The PEL and TLV for fluorides, as F, is 2.5 mg/m^3. It is very toxic as a soluble fluoride. For personal protective measures, refer to 4.3.1.

5.3.5.2 Fire and explosion hazard. Ammonium bifluoride is not burnable, but can decompose at very high temperatures to produce highly irritating NH_3 and H_2F_2 fumes.

5.3.5.3 Reactivity. Ammonium bifluoride is a stable compound.

5.3.6 Storage. Ammonium bifluoride shall be stored in a cool, dry, space in tightly sealed containers that are lined to resist corrosion. 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.

EPA Hazardous Waste Classification - Dry compound, Toxic (T); Aqueous solutions, Corrosive (C) and Toxic (T).

5.4 Name. AMMONIUM CHLORIDE, TECHNICAL NH_4Cl FW 53.49
Ammonium muriate
Sal ammoniac

5.4.1 Technical description. Ammonium chloride (pure) is in the form of colorless cubic crystals with the physical properties shown in Table VII. It is soluble in water and glycerol, and very slightly soluble in alcohol. It is also soluble in liquid ammonia. Aqueous solutions of ammonium chloride are acidic, and the pH of a 1% solution is 5.5. Ammonium chloride ionizes completely in aqueous solutions to from NH_4^+ and Cl^- ions. The NH^+ ion reacts with water to form the acid hydronium ion, H_3O^+: $NH_4^+ + H_2O = NH_3 + H_3O^+$.

TABLE VII. Ammonium chloride - physical properties.

Characteristic	Value
Density, g/cm^3	1.527
Refractive index	1.642
Volatilization with dissociation, °C	340
Solubility in water, g/100 cm^3	
(0°C)	29.7
(100°C)	75.8

5.4.2 Specification. O-A-491 Ammonium Chloride, Technical.

The federal specification covers two types and two grades of ammonium chloride, technical grade, as follows:

Type I - Compressed bricks of 8 oz (227 g) and 16 oz (454 g)
Type II - Crystals of two grades
Grade A - White crystals
Grade B - Galvanizing crystals or granules

The chemical and physical requirements for the two types and grades are shown in Table VIII.

TABLE VIII. Ammonium chloride, technical - chemical and physical requirements.

Characteristics	Types I & II		Type II	
	Grade A		Grade B	
	Min	Max	Min	Max
Assay, as NH_4Cl, % by wt	99.0	---	95.0	---
Residue on ignition (dry basis), % by wt	---	0.8	---	3.0
Volatile matter, % by wt	---	1.0	---	1.0
Free acid	To pass test	To pass test	To pass test	To pass test
Heavy metals	To pass test	To pass test	---	---
Granulation (Type II only), % by wt				
Through US Sieve No. 4 (4.75 mm)	---	---	99.0	---
Through US Sieve No. 30 (600 μm)	90.0	---		10.0

Ammonium chloride, technical grade, is commercially available with a minimum purity of 99.0 percent by weight.

5.4.3 Use. Ammonium chloride bricks are intended for military use in the cleaning of soldering irons. The Grade A white crystals are intended for military use in batteries, and are also suitable for galvanizing. The Grade B material is intended for military use only for galvanizing. Commercial uses of ammonium chloride are as a flux for hot-dip galvanizing and the refining of zinc, in zinc-carbon dry-cell batteries, and in the manufacture of ammonium perchlorate. Additional uses are in brick manufacture, leather tanning, and as a curing agent for urea-formaldehyde resins.

5.4.4 Packaging. Refer to 4.1.

5.4.5 Safety precautions.

5.4.5.1 Health hazard. Ammonium chloride is an acidic compound and the dust can be irritating to the eyes and respiratory tract. Prolonged contact can cause irritation to the skin. The TLV for ammonium chloride fumes is 10 mg/m^3. For personal protective measures, refer to 4.3.1.

5.4.5.2 Fire and explosion hazard. Ammonium chloride is not burnable, but if heated to decomposition will release ammonia and hydrogen chloride fumes which are irritating and toxic.

5.4.5.3 Reactivity. Ammonium chloride is reactive with alkalies to produce ammonia fumes. It is reactive with concentrated sulfuric acid to produce hydrogen chloride fumes. It is reactive with strong oxidizing agents to produce chlorine.

5.4.6 Storage. Ammonium chloride shall be stored in a cool, dry place in tightly sealed containers. The compound is hygroscopic and pick-up of moisture should be avoided to prevent caking. 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.

EPA Hazardous Waste Classification - None.

5.5 Name. AMMONIUM NITRATE, TECHNICAL NH_4NO_3 FW 80.04
Norway saltpeter

5.5.1 Technical description. Ammonium nitrate (pure) is in the form of colorless rhombic or monoclinic crystals (above 32.1°C) with the physical properties shown in Table IX. It is very soluble in water, soluble in methyl alcohol and acetone, and slightly soluble in ethyl alcohol. It is also soluble in liquid ammonia. Aqueous solutions of ammonium nitrate are acidic. Ammonium nitrate can decompose endothermically and reversibly at lower temperatures as follows:

$$NH_4NO_3(s)=NH_3(g)+HNO_3(g)$$

It decomposes exothermically and irreversibly at higher temperatures as follows:

$$NH_4NO_3(s)\rightarrow N_2(g)+2H_2O(g)+1/2O_2(g)$$
$$NH_4NO_3(s)\rightarrow N_2O(g)+2H_2O(g)$$

Ammonium nitrate can explode, and, when used in explosives, the first exothermic reaction predominates.

TABLE IX. Ammonium nitrate - physical properties.

Characteristic	Value
Density (25°C), g/cm^3	1.725
Melting point, °C	169.6
Boiling point (11 mm Hg), °C	210
Solubility, g/100 cm^3	
in water, (0°C)	118.3
in water, (100°C)	871
in methyl alcohol (20°C)	17.1
in ethyl alcohol (20°C)	3.8

5.5.2 Specification. MIL-A-175, Ammonium Nitrate, Technical (Metric); MIL-A-47240, Ammonium Nitrate (Uncoated); MIL-A-50460, Ammonium Nitrate, Prilled (For Use In Ammunition).

The military specification, MIL-A-175, for ammonium nitrate, technical, covers two classes of material.

Class 1 - Medium grind
Class 3 - Coarse grind

The chemical requirements applicable to both classes are shown in Table X.

TABLE X. Ammonium nitrate, technical - chemical requirements.

Characteristics	Requirements	
	Min	Max
	% By Wt	% By Wt
Assay, as NH_4NO_3	99.0	---
Moisture	---	0.15
Ether-soluble material	---	0.10
Water-insoluble material	---	0.18
Insoluble material retained on a US Sieve No. 40 (425 μm)	---	0.01
Acidity, as HNO_3	---	0.02
Nitrites	---	To pass test
Sulfates	---	0.02
Chlorides	---	0.02

The granulation requirements are shown in Table XI.

TABLE XI. Ammonium nitrate, technical - granulation requirements.

U.S. Sieves	Requirements	
	Class 1	Class 3
	% By Wt	% By Wt
Through No. 10 (2 mm), min	99.0	---
Through 2.5 in (63 mm), min	---	99.9

Zinc oxide, 0.50 to 0.90 percent by weight, shall be added to the ammonium nitrate in the amount specified when required.

The military specification, MIL-A-47240, for ammonium nitrate (uncoated), covers one grade of material. The chemical requirements are shown in Table XII.

TABLE XII. Ammonium nitrate (uncoated) - chemical requirements.

Characteristics	Requirements	
	Min	Max
	% By Wt	% By Wt
Assay, as NH_4NO_3	99.0	---
Moisture	---	0.50
Ash	---	0.10
Ether-soluble material	---	0.10
Water-insoluble material	---	0.10
Soluble chlorides, as NH_4Cl	---	0.03
Acidity, as free HNO_3	---	0.02
Acidity, as pH	5	7

The military specification, MIL-A-50460, for ammonium nitrate, prilled, covers an uncoated high density phase-stabilized grade of material with the chemical requirements shown in Table XIII. The granulation requirements are shown in Table XIV.

TABLE XIII. Ammonium nitrate, prilled - chemical requirements.

Characteristics	Requirements	
	Min	Max
	% By Wt	% By Wt
Assay, as NH_4NO_3	98.5	---
Moisture	---	0.15
Ether-soluble material	---	0.05
Water-insoluble material (of ether extract)	---	0.10
Water insoluble material retained on:		
US Sieve No. 60 (250 μm)	---	0.00
US Sieve No. 120 (125 μm)	---	0.01
Acidity, as HNO_3	---	0.02
Nitrites	None	None
Chlorides, as NH_4Cl	---	0.02
Phosphates, as $(NH_4)_2HPO_4$	0.17	0.25
Sulfates, as $(NH_4)_2SO_4$	0.007	0.014
Boric acid	0.11	0.17
Density: Particle, g/cm^3	1.50	---
Bulk, lb/ft^3	50	---
pH	5.9	6.1

TABLE XIV. Ammonium nitrate, prilled - granulation requirements.

U.S. Sieves	Requirements	
	Min	Max
	% By Wt	% By Wt
Through No. 6 (3.35 mm)	99.0	---
Retained on No. 12 (1.70 mm)	50.0	85.0
Retained on No. 20 (850 μm)	97.0	---
Through No. 35 (500 μm)	---	0.5

Ammonium nitrate is commercially available as dense, free-flowing, spherical prill, fertilizer grade material; and as industrial grade spherical white prills with controlled internal porosity for maximum oil absorbency.

5.5.3 Use. Ammonium nitrate, technical grade, Class 1, is intended for military use in the manufacture of Amatol explosives, a mixture with trinitrotoluene; and Class 3 is intended for use as a nitrating agent in the manufacture of explosives. Ammonium nitrate (uncoated) is intended for military use as an ingredient in ammonium nitrate-base solid propellants. Ammonium nitrate, prilled, is intended for military use in Minol-2 explosives. Commercial uses include the blending of fertilizer grade in fertilizer mixtures; and the use of porous prills in mixtures with fuel oil, or other carbonaceous fuels, to make ANFO blasting agents. Other applications of ammonium nitrate include use in freezing mixtures, generation of nitrous oxide gas, and as an oxidizer in propellant mixtures.

5.5.4 Packaging. Refer to 4.1.

5.5.5 Safety precautions.

5.5.5.1 Health hazard. Ammonium nitrate is an acidic compound and the dust can be irritating to the eyes and respiratory tract. Prolonged contact can cause irritation to the skin. There is no PEL or TLV cited for ammonium nitrate. For personal protective measures, refer to 4.3.1.

5.5.5.2 Fire and explosion hazard. Pure ammonium nitrate is not burnable, but if heated to decomposition, will release toxic fumes of nitric acid and oxides of nitrogen. In order to detonate, it requires a combination of initiator and high explosive to provide a reinforced detonator. Ammonium nitrate can detonate by itself under certain conditions, such as shock, or exposure to heat or flame when confined. It also explodes more readily if contaminated. Ammonium nitrate in the vicinity of a fire must be cooled with large amounts of water to prevent decomposition and detonation.

5.5.5.3 Reactivity. Ammonium nitrate is reactive with alkalies to produce ammonia fumes. It is reactive with concentrated sulfuric acid to produce nitric acid fumes. Ammonium nitrate is an oxidizing agent. It supports combustion and can react vigorously with reducing materials. It can cause self-ignition of

easily oxidizable organic materials or finely divided metals at moderately elevated temperatures.

5.5.6 Storage. Ammonium nitrate shall be stored in a cool, dry, well-ventilated space away from fire hazards and oxidizable material and vapors. The salt is hygroscopic and absorption of moisture can cause caking. A change in crystalline state with expansion occurs at 32.1°C (89.8°F) which can damage storage containers. 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.

EPA Hazardous Waste Classification - Reactive; Waste Number D003.

5.6 Name. AMMONIUM PERCHLORATE NH_4ClO_4 FW 117.49
AP
APC

5.6.1 Technical description. Ammonium perchlorate (pure) is in the form of colorless rhombic crystals with the physical properties shown in Table XV. It is soluble in water and acetone, and slightly soluble in alcohol. Aqueous solutions of ammonium perchlorate are acidic. Perchloric acid salts are unreactive at room temperature, but are very reactive when hot. Pure ammonium perchlorate is stable below 65.6°C. When heated, it undergoes an endothermic decomposition reaction at 240°C followed by two exothermic steps at 275° and 470°C. Contamination of metallic salts, such as those of copper, chromium and iron, catalyzes the second decomposition step so that it occurs at progressively lower temperatures as the impurity concentrations are increased. Ammonium perchlorate is a strong oxidizing agent, and will violently ignite combustible material.

TABLE XV. Ammonium perchlorate - physical properties.

Characteristic	Value
Density, g/cm^3	1.95
Refractive index	1.482
Solubility in water, g/100 cm^3	
(0°C)	10.74
(85°C)	42.45

5.6.2 Specifications. MIL-A-192, Ammonium Perchlorate, Technical; MIL-A-82667, Ammonium Perchlorate, General Specification for; MIL-A-82667/1, Ammonium Perchlorate, High Purity; MIL-A-82667/2, Ammonium Perchlorate, Conditioned.

5.6.2.1 Ammonium perchlorate, technical. The military specification, MIL-A-192, for ammonium perchlorate, technical, covers three grades and seven classes of material.

a. Grades

A - Low moisture content
B - Extra low moisture content

C - Tricalcium phosphate conditioner added
D - Ammonium perchlorate, retained on a #200 (75 μm sieve)

b. Classes

1 - Through U.S. Sieve #40 (425 μm) and #50 (300 μm) sieve, retained on #200 (75 μm) sieve
2 - Through #50 (300 μm) sieve
3 - Through #100 (150μm) sieve
4 - Graduated sieving, between #18 (1.0 mm) and #325 (45 μm)
5 - Through #50 (300 μm) sieve, retained on #140 (106 μm) sieve
6 - Graduated sieving, between #50 (300 μm) and #140 (106 μm)
7 - Graduated sieving, between #12 (1.70 mm) and #50 (300 μm)

The chemical requirements for the three grades are shown in Table XVI. The granulation requirements for the seven classes are shown in Table XVII.

5.6.2.2 Ammonium perchlorate, high purity and conditioned. The military specification, MIL-A-82667, for ammonium perchlorate is a general specification referring to MIL-A-82667/1 for ammonium perchlorate, high purity, and MIL-A-82667/2 for ammonium perchlorate, conditioned.

5.6.2.2.1 Ammonium perchlorate, high purity. Military specification, MIL-A-82667/1, for ammonium perchlorate, high purity, covers two types with the chemical and physical properties shown in Table XVIII.

Type I - Whole crystals (200 μm)
Type II - Ground crystals (5 to 15 μm)

Type I shall be solid white crystalline nonspherical granular ammonium perchlorate with a nominal particle size of 200 μm. The Type II material shall be Type I ground to a particle size range of 5 to 15 μm. The particle size requirements for Type I material are shown in Table XIX.

TABLE XVI. Ammonium perchlorate technical - chemical requirements.

Characteristics	Percent by Weight					
	Grade A		Grade B		Grade C	
	Min	Max	Min	Max	Min	Max
Assay, NH_4ClO_4	99.0	---	99.0	---	98.8	---
Total moisture	---	0.08†	---	0.05	---	0.08†
Surface moisture	---	0.020	---	0.015	---	0.020
Water insoluble	---	0.03	---	0.01	---	0.25
Ash, sulfated	---	0.25	---	0.15	---	0.45
Chlorate, as NH_4ClO_3	---	0.02	---	0.02	---	0.02
Chloride, as NH_4Cl	---	0.15	---	0.10	---	0.15
Sodium and potassium	---	0.08	---	0.05	---	0.08
Tricalcium phosphate, as $Ca_3(PO_4)_2$	---	---	---	---	0.15	0.22
Iron as Fe_2O_3 (when specified)	---	0.0036	---	0.0036	---	0.0036
pH range	4.3	5.3	4.3	5.3	5.5	6.5

†Class 7 may be 0.13% maximum.

TABLE XVII. Ammonium perchlorate, technical - granulation requirements (percent passing through sieve).

U.S. Sieve No.	Standard Sieve Dimensions	Requirements by Class						
		1	2	3	4	5	6	7
12	1.70 mm	---	---	---	---	---	---	99.5 min
18	1.0 mm	---	---	---	99.5 min	---	---	---
30	600 µm	---	---	---	---	---	---	95 min
40	425 µm	99.5 min	---	---	---	---	---	45-65
50	300 µm	85-98	93 min	---	88-96	96 min	89-97	0-3
70	212 µm	---	---	---	50-70	---	---	---
100	150 µm	---	---	70 min	17-38	---	18-50	---
140	106 µm	---	---	---	2-15	1.0 max	2-15	---
200	75 µm	1-9	---	---	1-5	---	---	---
325	45 µm	---	---	---	2 max	---	---	---

TABLE XVIII. Ammonium perchlorate, high purity, Types I and II - chemical and physical requirements.

Characteristics	Requirements	
	Min	Max
Composition, % by wt		
Purity	99.3	---
Chloride, as NH_4Cl	---	0.03
Chlorate, as NH_4ClO_3	---	0.02
Bromate, as NH_4BrO_3	---	0.003
Chromate, as K_2CrO_4	---	0.015
Sulfate, as $(NH_4-)_2SO_4$	---	0.20
Sulfated ash, calculated as $NaClO_4$	---	0.25
Iron, as Fe_2O_3	---	0.001
Sodium and potassium	---	0.08
Nonalkali metals as oxide	---	0.04
Moisture, surface		
Type I	---	0.008
Type II	---	0.02
Moisture, total	---	0.05
Water insolubles	---	0.006
Ether soluble	---	0.01
Total volatiles	---	0.04
Stability, hr	3	---
Friability, % passing No. 100 sieve		
Type I	---	10.0

TABLE XIX. Ammonium perchlorate, high purity, type I - particle size requirements (percent passing through sieve).

U.S. Standard Sieve Number	Requirements	
	Min	Max
18 (1.00 mm)	100.0	---
20 (150 μm)	99.9	---
50 (300 μm)	90	96
70 (212 μm)	54	70
100 (150 μm)	18	30
140 (106 μm)	4	15
200 (75 μm)	2	5
325 (45 μm)	---	2

5.6.2.2.2 Ammonium perchlorate, conditioned. The military specification, MIL-A-82667/2, for ammonium perchlorate, conditioned, covers two types and three classes for Type I.

Type I: Class 1 - Whole crystals (200 μm)
Class 2 - Ground crystals (8 to 13 μm)
Class 3 - Ground crystals (5 to 6 μm)

Type II: Whole crystals (80 μm)

Type I, Class 1 shall be solid white crystalline ammonium perchlorate consisting essentially of whole crystals with rounded corners and edges. Type I, Class 2 shall be Type I ground to a particle size of 8 to 13 μm. Type I, Class 3 shall be Type I crystals ground to a particle size of 5 to 6 μm. The chemical and physical properties are shown in Table XX. The particle size requirements for Type I, Class 1 material are shown in Table XXI. The particle size requirements for Type II material are shown in Table XXII.

TABLE XX. Ammonium perchlorate, conditioned - chemical and physical requirements.

Characteristics	Percent By Weight			
	Type I		Type II	
	Min	Max	Min	Max
Purity	98.3	---	98.8	---
Chloride, as NH_4Cl	---	0.155	---	0.15
Chlorate, as NH_4ClO_3	---	0.020	---	0.02
Bromate, as NH_4BrO_3	---	0.004	---	---
Sulfated ash, as Na_2SO_4	---	---	---	0.45
Sulfated ash, calculated as $NaClO_4$	---	0.9	---	---
Iron, as Fe_2O_3	---	0.0036	---	0.0036
Sodium and potassium	---	---	---	0.08
Tricalcium phosphate, as $Ca_3(PO_4)_2$	0.10	0.25	0.15	0.22
Moisture, total	---	0.06	---	0.08
Moisture, surface	---	0.02	---	0.02
Water insolubles	---	---	---	0.25
Acid insolubles	---	0.04	---	---
pH	5.0	6.5	5.5	6.5

TABLE XXI. Ammonium perchlorate, conditioned, type I, class 1 - particle size requirements (percent passing through sieve).

U.S. Standard Sieve Number	Requirements	
	Min	Max
40 (425 μm)	96	---
50 (300 μm)	89	97
70 (212 μm)	57	87
100 (150 μm)	14	50
140 (106 μm)	2	15
200 (75 μm)	---	3

TABLE XXII. Ammonium perchlorate, conditioned, type II - particle size requirements (percent passing through sieve).

U.S. Standard Sieve Number	Requirements	
	Min	Max
100 (150 μm)	96	---
140 (106 μm)	92	---
230 (75 μm)	---	45

Ammonium perchlorate is commercially available from a manufacturer as ordnance and propellant grades with typical purities ranging from 99.1 to 99.7 percent by weight; in several particle size classifications and particle shapes; and with tricalcium phosphate conditioner as specified.

5.6.3 Use. Ammonium perchlorate is intended for military use as an oxidizer in solid rocket propellants for several applications, and in tracer ammunition. Commercial uses are as an etching and engraving agent.

5.6.4 Packaging. Refer to 4.1.

5.6.5 Safety precautions.

5.6.5.1 Health hazard. Ammonium perchlorate is an acidic compound and the dust can be irritating to the eyes and respiratory tract. Prolonged contact can cause irritation to the skin. There is no PEL or TLV cited for ammonium perchlorate. For personal protective measures, refer to 4.3.1.

5.6.5.2 Fire and explosion hazard. Ammonium perchlorate can release toxic fumes if heated to decomposition. Ammonium perchlorate can detonate under certain conditions such as shock or exposure to heat or flame. It also explodes more readily if contaminated by reducing materials. Contact with copper can spontaneously catalyze decomposition with heat. Ammonium perchlorate in the vicinity of a fire must be cooled with large amounts of water to prevent decompo-

sition and detonation. It is classified as a high explosive if 50% or more by weight of particles are 15 μm or smaller.

5.6.5.3 Reactivity. Ammonium perchlorate is reactive with alkalies to produce ammonia fumes. It is reactive with concentrated sulfuric acid to produce perchloric acid and its decomposition products. Ammonium perchlorate is an oxidizing agent. It support combustion and can react vigorously with reducing materials. It can cause self-ignition of easily oxidizable organic materials or finely divided metals at moderately elevated temperatures.

5.6.6 Storage. Ammonium perchlorate shall be stored in a cool, dry well-ventilated space away from fire hazards and oxidizable material and vapors. It must be kept in original containers, and containers must be kept tightly sealed when not in use. 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.

EPA Hazardous Waste Classification - Reactive; Waste Number D003.

5.7 Name. ANTIMONY SULFIDE Sb_2S_3 FW 339.69
Antimonous sulfide
Antimony trisulfide
Stibnite

5.7.1 Technical description. Antimony trisulfide (pure) exists naturally as black rhombic crystals. It can also be prepared as a yellow-red amorphous substance. The physical properties are shown in Table XXIII. It is almost insoluble in water. It is soluble in alcohol. It dissolves in ammonium hydrogen sulfide and potassium or sodium sulfide solutions to form thioantimonite ions. It is dissolved by concentrated hydrochloric acid with evolution of hydrogen sulfide and formation of tetrachloroantimonate ions.

TABLE XXIII. Antimony trisulfide - physical properties.

Characteristic	Value
Crystalline forms	
Density, g/cm^3	4.64
Refractive index	3.194
	4.064
	4.303
Amorphous form	
Density, g/cm^3	4.12
Melting point, °C	550
Boiling point, °C (ca)	1150
Solubility in water (18°C), g/100 cm^3	0.000175

5.7.2 Specification. MIL-A-159, Antimony Sulfide.

The military specification, MIL-A-159, for antimony sulfide, covers two

a. Types

I - 0.2 percent free sulfur, max
II - 0.02 percent free sulfur, max

b. Classes

1 - 100 mesh, nominal
2 - Fine
3 - 100 mesh, nominal, coarse
4 - Lump
5 - 140 mesh, nominal

The product shall have the characteristic needle-like structure steel gray color, and hardness of naturally occurring crystalline mineral. The chemical requirements are shown in Table XXIV. The granulation requirements are shown in Table XXV.

TABLE XXIV. Antimony sulfide - chemical requirements.

Characteristics	Requirements			
	Type I		Type II	
	Min	Max	Min	Max
	% By Wt	% By Wt	% By Wt	% By Wt
Antimony	70.5	---	70.5	---
Total sulfur	24.8	---	24.8	---
Insoluble material	---	1.0	---	1.0
Acidity, as H_2SO_4	---	0.01	---	0.01
Lead	---	0.15	---	0.15
Iron	---	0.5	---	0.5
Free sulfur	---	0.2	---	0.02
Arsenic	---	0.06	---	0.06
Moisture	---	0.20	---	0.20

TABLE XXV. Antimony sulfide - granulation requirements (percent by weight).

U.S. Sieve Number	Requirements by Class				
	1	2	3	4	5
Through No. 100 (150 μm)	95 min	---	95 min	---	---
Retained on No. 140 (106 μm)	30-50	---	70 min	---	---
Through No. 140	---	97 min	---	---	99 min
Retained on No. 200 (75 μm)	---	80-95	---	---	95 min
Through No. 200	20-30	---	20 max	---	---

5.7.3 Use. Antimony sulfide is intended for military use in priming and matchhead compositions. Commercial applications include use as a pigment in paints, in pyrotechnics and in matches.

5.7.4 Packaging. Refer to 4.1.

5.7.5 Safety precautions.

5.7.5.1 Health hazard. Antimony sulfide is a toxic material if inhaled. The dust is highly irritating to the eyes, respiratory tract and skin. The PEL and TLV for antimony compounds, as Sb, is 0.5 mg/m^3. For personal protective measures, refer to 4.3.1.

5.7.5.2 Fire and explosion hazard. Antimony sulfide is burnable, and the dust can form explosive mixtures in air. Burning in air or heating to decomposition in air liberates toxic fumes of hydrogen sulfide.

5.7.5.3 Reactivity. Antimony sulfide is reactive with oxidizing agents. It is reactive with steam to produce toxic and flammable vapors. It is reactive with acids to produce toxic fumes of hydrogen sulfide.

5.7.6 Storage. Antimony sulfide shall be stored in a cool, dry, well-ventilated space in sealed containers away from fire hazards. 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.

EPA Hazardous Waste Classification - Toxic (T).

5.8 Name. BARIUM CARBONATE $BaCO_3$ FW 197.35
Witherite (natural)

5.8.1 Technical description. Barium carbonate exists as three crystalline forms, α, ß, and γ. The α form consists of white hexagonal crystals, and the γ form consists of white rhombic crystals, with the physical properties shown in Table XXVI. The natural witherite is the γ form, which has a transition point of 811°C to the ß form. Barium carbonate decomposes to the metal oxide, BaO,

when heated to 1450°C, at which point an equilibrium pressure of one atmosphere of carbon dioxide is attained. Barium carbonate is practically insoluble in water. It is decomposed by mineral acids, or acidic salt solutions such as NH_4Cl. It is insoluble in alcohol.

TABLE XXVI. Barium carbonate - physical properties.

Characteristic	Value
Density, g/cm^3	4.43
Refractive index, γ form	1.529
	1.676
	1.677
Melting point (90 atm), °C	1740
Solubility in water, $g/100\ cm^3$	
α form (20°C)	0.002
α form (100°C)	0.006
β and γ forms (18°C)	0.0022
β and γ forms (100°C)	0.0065

5.8.2 Specification. MIL-B-624, Barium Carbonate (For Use in Ammunition).

Military specification, MIL-B-624, covers one grade of barium carbonate with the chemical and physical requirements shown in Table XXVII.

TABLE XXVII. Barium carbonate - chemical and physical requirements.

Characteristics	Requirements	
	Min	Max
	% By Wt	% By Wt
Barium, as Ba	68.0	---
Acid-insoluble matter	---	0.2
Alkalinity, as Na_2CO_3	---	0.5
Moisture	---	0.3
Apparent density, g/mL	2.2	---
Granulation, through US Sieves		
No. 50 (300 μm)	99	---
No. 200 (75 μm)	85	---

5.8.3 Use. Barium carbonate is intended for military use in inert loading of practice shell ammunition. Commercial uses include the production of barium oxide as an intermediate for the manufacture of barium peroxide and other barium compounds. Other applications include use as an additive to ceramics, paints, paper and rubber.

5.8.4 Packaging. Refer to 4.1.

5.8.5 Safety precautions.

5.8.5.1 Health hazard. Barium carbonate may be toxic if inhaled. It is irritating to the eyes, skin and respiratory tract. There is no PEL or TLV cited for barium carbonate as an insoluble compound. For personal protective measures, refer to 4.3.1.

5.8.5.2 Fire and explosion hazard. Barium carbonate is not burnable. If present in a fire, it can decompose to release carbon dioxide gas which would tend to extinguish the fire.

5.8.5.3 Reactivity. Barium carbonate is reactive with mineral acids and is decomposed with the release of carbon dioxide gas.

5.8.6 Storage. Barium carbonate shall be stored in tightly sealed containers in a cool, dry space. 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.

EPA Hazardous Waste Classification - EP Toxic; Waste No. D005.

5.9 Name. BARIUM CHLORATE $Ba(ClO_3)_2 \cdot H_2O$ FW 322.26

5.9.1 Technical description. Barium chlorate (pure) is in the form of colorless monoclinic crystals with the physical properties shown in Table XXVIII. It is soluble in water, and slightly soluble in alcohol and acetone. On heating, it loses oxygen at 250°C. It is decomposed by mineral acids, and chloric acid solutions can be obtained by the reaction of barium chlorate with sulfuric acid as follows:

$$Ba(ClO_3)_2 + H_2SO_4 \rightarrow BaSO_4\downarrow + 2HClO_3$$

The chloric acid cannot be isolated from solution in its free state because it decomposes. Chloric acid solution is strongly acidic and is a powerful oxidizing agent. Barium chlorate is reactive as an oxidizing agent.

TABLE XXVIII. Barium chlorate - physical properties.

Characteristic	Value
Density, g/cm^3	3.18
Refractive index	1.562
	1.577
	1.635
Dehydration point, °C	120
Loss of oxygen, °C	250
Melting point, °C	414
Solubility in water, g/100 cm^3	
(15°C)	27.4
(100°C)	111.2

5.9.2 Specification. None.

5.9.3 Use. Barium chlorate is intended for military use in pyrotechnics, such as flares and smoke munitions, to produce a green color. Commercial appli-

cations include the manufacture of other chlorates and chloric acid solutions, matches, and as a textile mordant for dyes.

5.9.4 Packaging. Refer to 4.1.

5.9.5 Safety precautions.

5.9.5.1 Health hazard. Barium chlorate is toxic if inhaled. It is irritating to the eyes, skin and respiratory tract. The PEL and TLV for soluble barium compounds, as Ba, is 0.5 mg/m^3. For personal protective measures, refer to 4.3.1.

5.9.5.2 Fire and explosion hazard. Barium chlorate is not burnable but is a fire and explosion hazard when mixed with oxidizable or combustible material and subjected to friction, heat or shock. If present in the vicinity of a fire, it must be cooled with large amounts of water to prevent decomposition.

5.9.5.3 Reactivity. Barium chlorate is reactive with strong acids to form chloric acid. Barium chlorate is an oxidizing agent and can react vigorously with reducing materials. It can cause self-ignition of easily oxidizable organic materials or finely divided metals at moderately elevated temperatures.

5.9.6 Storage. Barium chlorate shall be stored in tightly sealed containers in a cool, dry, well-ventilated space away from fire hazards and oxidizable material. 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.

EPA Hazardous Waste Classification - EP Toxic; Waste Number D005.

5.10 Name. BARIUM CHROMATE $BaCrO_4$ FW 253.33
Baryta yellow

5.10.1 Technical description. Barium chromate (pure) is in the form of yellow rhombic crystals with the physical properties shown in Table XXIX. It is almost insoluble in water. It is decomposed and dissolved by mineral acids. Barium chromate is reactive as an oxidizing agent.

TABLE XXIX. Barium chromate - physical properties.

Characteristic	Value
Density (15°C), g/cm^3	4.498
Solubility in water, g/100 cm^3	
(16°C)	0.00034
(28°C)	0.00044

5.10.2 Specification. MIL-B-550, Barium Chromate.

The military specification, MIL-B-550, for barium chromate, covers three grades of material: Grade A, Grade B and Grade C. The chemical and physical requirements for these grades are shown in Table XXX.

TABLE XXX. Barium chromate - chemical and physical requirements.

Characteristics	Requirement by Grade					
	A		B		C	
	Min	Max	Min	Max	Min	Max
Assay, as $BaCrO_4$, % by wt	98.5	---	99.0	---	98.5	---
Volatile matter, % by wt	---	0.10	---	0.20	---	0.10
Chlorides, as Cl, % by wt	---	0.05	---	0.05	---	0.05
Sulfates, as SO_4, % by wt	---	---	---	---	---	0.04
Water soluble matter, % by wt	---	0.50	---	0.08	---	0.05
Moisture reabsorption, % by wt	---	---	---	0.20	---	---
Apparent density, g/mL	0.35	0.50	0.35	0.75	0.35	0.50
Average particle diameter, µm	---	2.0	---	3.5	0.50	1.50
Granulation, % by wt (through US Sieve)						
No. 100 (150 µm)	---	---	100.0	---	---	---
No. 200 (75 µm)	---	---	98.0	---	---	---
No. 325 (45 µm)	100.0	---	---	---	100.0	---

5.10.3 Use. Barium chromate is intended for military use in the manufacture of delay powder and other nongaseous powders, and in pyrotechnic mixtures. Commercial applications include use as a pigment for yellow paint, in safety matches, ceramics, glass, and pyrotechnics.

5.10.4 Packaging. Refer to 4.1.

5.10.5 Safety precautions.

5.10.5.1 Health hazard. Barium chromate particles are toxic by inhalation and ingestion after being trapped in the upper respiratory tract. As a chromate, it is a confirmed carcinogen. It is irritating to the eyes, skin and mucous membranes. The TLV for chromium (VI), as a water insoluble compound is 0.05 mg/m^3 as Cr. The PEL for chromium (VI) is 0.1 mg/m^3 as a ceiling value. For personal protective measures, refer to 4.3.1.

5.10.5.2 Fire and explosion hazard. Barium chromate is not burnable, but as an oxidizing agent can support a fire involving combustibles. If present in the vicinity of a fire, it must be kept cool with large amounts of water.

5.10.5.3 Reactivity. Barium chromate is reactive with strong mineral acids to form chromic acid. Barium chromate is an oxidizing agent and can react with reducing materials.

5.10.6 Storage. Barium chromate shall be stored in tightly sealed containers in a cool, dry, well-ventilated space away from fire hazards and oxidizable material. 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. EPA Hazardous Waste Classification - EP Toxic; Waste Number D007.

5.11 Name. BARIUM NITRATE, TECHNICAL $Ba(NO_3)_2$ FW 261.35
Nitrobarite

5.11.1 Technical description. Barium nitrate (pure) is in the form of colorless cubic crystals with the physical properties shown in Table XXXI. It is soluble in water and insoluble in alcohol. It decomposes on heating above its melting point. Barium nitrate is reactive as an oxidizing agent.

TABLE XXXI. Barium nitrate - physical properties.

Characteristic	Value
Density, g/cm^3	3.24
Refractive index	1.574
Melting point, °C	592
Solubility in water, g/100 cm^3	
(20°C)	8.7
(100°C)	34.2

5.11.2 Specification. MIL-B-162, Barium Nitrate.

The military specification, MIL-B-162, for barium nitrate, covers six classes of material. The granulation requirements for these classes are shown in Table XXXII, and the chemical requirements are shown in Table XXXIII.

Class 1 - For use in the manufacture of priming compositions
Class 2 - For use in the manufacture of photoflash compositions
Class 3 - For use in the manufacture of propellants
Class 4 - For use in the manufacture of special compositions
Class 5 - For use in the manufacture of incendiary mixtures
Class 6 - For use in the manufacture of pyrotechnic compositions

TABLE XXXII. Barium nitrate - granulation requirements as minimum percent passing (except as noted).

U.S. Sieve No.	Requirements							
	Class 1		Class 2	Class 3	Class 4	Class 5	Class 6	
	Gran A	Gran B					Gran A	Gran B
30 (600 μm)	---	---	99.5	---	---	---	---	---
50 (300 μm)	---	---	---	98.0	---	---	99.0	---
60 (250 μm)	---	---	---	---	---	99.0	---	99.0
100 (150 μm)	99.9	99.9	---	80.0	---	75.0†	40.0	---
120 (125 μm)	---	---	---	---	98.0	---	---	---
140 (106 μm)	40.0	85.0	---	---	---	---	---	---
200 (75 μm)	25.0†	35.0±10.0	2.0†	---	---	5.0†	75.0†	---
230 (63 μm)	---	---	---	---	50.0±10.0	---	---	---
325 (45 μm)	---	20.0†	---	---	30.0†	---	---	---

†Maximum
Average Particle Diameter: Class 2 - 140±40 μm; Class 6, Gran B - 20 μm, max

TABLE XXXIII. Barium nitrate - chemical requirements.

Properties	Requirement by Class					
	1	2	3	4	5	6
Barium nitrate	99.7 min	99.0 min	99.5 min	99.5 min	98.5 min	99.5 min
Strontium, as Sr	0.6 max	---	0.6 max	---	---	0.6 max
Calcium, as Ca	0.05 max	---	0.05 max	---	---	0.05 max
Iron and aluminum, as oxides	---	0.50 max	---	0.02 max	---	0.02 max
Calcium and magnesium, as oxides	---	0.50 max	---	---	---	---
Sodium, as Na_2O	---	0.15 max	---	---	---	0.15 max
Chloride, as $BaCl_2$	0.0075 max	0.0075 max	0.0075 max	0.0075 max	---	0.0075 max
Grit	0.05 max	0.05 max	0.05 max	0.05 max	---	0.05 max
Heavy metals	0.05 max	---	---	---	---	---
Moisture	0.20 max	0.10 max	0.20 max	0.20 max	0.05 max	0.10 max
pH	5.0-8.0	5.0-8.0	5.0-8.0	---	5.0-8.0	5.0-9.0
Insoluble matter	0.10 max	0.10 max	0.10 max	0.10 max	0.10 max	0.10 max
Hygroscopicity	---	---	---	---	0.05 max	---

5.11.3 Use. Barium nitrate is intended for military use as described above for each class of material. Commercial applications include use in pyrotechnics and signal flares where a green color is required. Barium nitrate is used in the production of other barium compounds.

5.11.4 Packaging. Refer to 4.1.

5.11.5 Safety precautions.

5.11.5.1 Health hazard. Barium nitrate is toxic if inhaled. It is irritating to the eyes, skin and respiratory tract. The PEL and TLV for soluble barium compounds, as Ba, is 0.5 mg/m^3. For personal protective measures, refer to 4.3.1.

5.11.5.2 Fire and explosion hazard. Barium nitrate is not burnable, but is a fire and explosion hazard when mixed with oxidizable or combustible material and subjected to friction, heat or shock. If heated to decomposition, it can release toxic fumes of nitric oxides. If present in the vicinity of a fire, it must be cooled with large amounts of water.

5.11.5.3 Reactivity. Barium nitrate is reactive with sulfuric acid to release nitric acid. Barium nitrate is an oxidizing agent and can react with reducing materials.

5.11.6 Storage. Barium nitrate shall be stored in tightly sealed containers in a cool, dry, well-ventilated space away from fire hazards and oxidizable material. 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.

EPA Hazardous Waste Classification - EP Toxic; Waste No. D005.

5.12 Name. BORON NITRIDE BN FW 24.82

5.12.1 Technical description. Boron nitride (pure) is in the form of white hexagonal plate crystals with the physical properties shown in Table XXXIV. It is insoluble in cold water and decomposes slightly in hot water. Boron nitride is inert to most chemical reagents, but can be decomposed by fusion with alkalies. The crystalline structure of boron nitride is analagous to that of graphite. The layers of atoms in graphite and boron nitride are made up of hexagonal rings. Boron nitride is a high-resistance nonconductor of electricity.

TABLE XXXIV. Boron nitride - physical properties.

Characteristic	Value
Density, g/cm^3	2.25
Sublimation point, °C (ca)	3000
Melting point (under pressure), °C (ca)	3000

5.12.2 Specification. MIL-B-47208, Boron Nitride Powder.

The military specification, MIL-B-47208, for boron nitride powder, covers a high purity grade of material. The chemical and physical requirements are shown in Table XXXV.

TABLE XXXV. Boron nitride powder - chemical and physical requirements.

Characteristics	Requirements
	% By Wt
Purity	99.5 min
Particle size, passing through US Sieve No. 325 (45 μm)	100 min

5.12.3 Use. Boron nitride powder is intended for military use as a filler to improve the thermal conductivity of epoxy potting and encapsulating compounds. Commercial applications include use as a refractory in furnace insulation and crucibles, as a dielectric in electronic components, and in fabricating heat-resistant components for space vehicles.

5.12.4 Packaging. Refer to 4.1.

5.12.5 Safety precautions.

5.12.5.1 Health hazard. Boron nitride dust can be irritating to the eyes and respiratory tract. As an inert or nuisance dust, the PEL for the respirable fraction is 5 mg/m^3, and for total dust, it is 15 mg/m^3. For personal protective measures, refer to 4.3.1.

5.12.5.2 Fire and explosion hazard. Boron nitride powder does not present a fire and explosion hazard.

5.12.5.3 Reactivity. Boron nitride powder does not present a reactivity hazard.

5.12.6 Storage. Boron nitride powder shall be stored in sealed containers to prevent contamination by other materials. 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.

EPA Hazardous Waste Classification - None.

6. NOTES

6.1 Intended use. This standard is intended to cite nomenclature, formulas, physical and chemical properties, specification requirements, military and typical commercial uses, safety information, storage information and disposal information for Inorganic Salts and Compounds, Technical Grade (Aluminum Chloride through Boron Nitride) preferred for application by the Department of Defense.

6.2 Subject term (key word) listing.

Aluminum chloride, anhydrous, technical
Aluminum sulfate, hydrated, technical
Ammonium acid fluoride
Ammonium bifluoride, technical
Ammonium chloride, technical
Ammonium hydrogen difluoride
Ammonium hydrogen fluoride
Ammonium muriate
Ammonium nitrate, technical
Ammonium perchlorate
Antimonous sulfide
Antimony sulfide
Antimony trisulfide
AP
APC
Barium carbonate
Barium chlorate
Barium chromate
Barium nitrate, technical
Baryta yellow
Boron nitride
Cake alum
Exposure limits, hazardous chemicals
Filter alum
Hazardous wastes, disposal and storage of
Information, hazardous chemicals
Nitrobarite
Norway saltpeter
Safety, hazardous chemicals
Sal ammoniac
Stibnite
Sulfate of alumina
Witherite (natural)

6.3 Changes from previous issue. The changes from the previous issue include reformatting tables, a complete rewrite of Section 4 and the addition of Section 6.

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

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CONCLUDING MATERIAL

Lead Standardization Activity:

Defense General Supply Center - GS

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Navy - OS
Air Force - 68

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