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METRIC

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MILITARY STANDARD

INORGANIC SALTS AND COMPOUNDS, TECHNICAL GRADE

(FERRIC CHLORIDE THROUGH LITHIUM TETRAFLUOROBORATE)

AMSC N/A

FSC 6810

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1. SCOPE

1.1 Coverage. This standard is a presentation of nomenclature, Chemical Abstracts Service Registry Numbers, 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 (ferric chloride through lithium tetrafluoroborate). 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 (ferric chloride through lithium tetrafluoroborate), for application by the Department of Defense.

1.2 Application. Inorganic salts and compounds, technical grade (ferric chloride through lithium tetrafluoroborate) are used in formulating products such as pyrotechnics, propellants, explosives, and electrochemicals, and as 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.

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

FEDERAL

PPP-C-2020	Chemicals, Liquid, Dry and Paste, Packaging of

MILITARY

MIL-L-65	Lead Thiocyanate (Sulphocyanate)
MIL-F-279	Ferrous Sulfide, Technical
MIL-L-376	Lead Dioxide, Technical
JAN-L-488	Lead Chromate (For Use In Ammunition)
MIL-F-14580	Ferric Chloride, Anhydrous, Crystalline, Technical
MIL-L-18618	Lead Carbonate, Basic, Dry (For Ordnance Use)
MIL-L-20549	Lead Nitrate, Technical
MIL-L-47058	Lithium Chloride, Purified Grade
MIL-L-48765	Lithium Hexafluoroarsenate (For Use In Ammunition)
MIL-L-48766	Lithium Tetrafluoroborate (For Use In Ammunition)
MIL-L-63470	Lithium Chloride (For Use In Ammunition)
MIL-F-82655	Ferric Oxide, Technical

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

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(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Naval Publications and Forms Center, (ATTN: DODSSP), Customer Service, Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, 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 document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

CODE OF FEDERAL REGULATIONS (CFR)

Title 29 -	Department of Labor, Occupational Safety and Health Administration (OSHA); General Industry Standards And Interpretations
Title 40 -	Environmental Protection Agency (EPA); Hazardous Waste And Consolidated Permit Regulations
Title 49 -	Department Of Transportation (DOT); 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

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.)

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2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

AMERICAN CONFERENCE OF GOVERNMENT INDUSTRIAL HYGIENISTS (ACGIH)

Threshold Limit Values (TLVs) for Chemical Substances in the Work Environment Adopted by American Conference of Governmental 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 45211-4438.)

ASTM

ASTM E 11	- Standard Specification for Wire-Cloth Sieves For Testing Purposes
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.)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B 402 - Standard For Ferrous Sulfate

(Application for copies should be addressed to American Water Works Association, 6666 Quincy Avenue, Denver, CO 80235.)

CHEMICAL ABSTRACTS SERVICE REGISTRY

The Chemical Abstracts Service (CAS) Registry number provides a key to access the wealth of information available through CAS.

(For details on how to search the CAS files and database using the registry number, contact Chemical Abstracts Services, Customer Service, P.O. Box 3012, Columbus, OH 43210.)

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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 standard and the references cited herein, the text of this standard shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. DEFINITIONS

3.1 Definitions of Technical Terms.

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

3.1.2 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.

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

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

Additional abbreviations are as follows:

CAS	Chemical Abstracts Service Registry Number
DRMO	Defense Reutilization and Marketing Office
FW	Formula Weight
HMIS	Hazardous Materials Information System
PEL	Permissible Exposure Limit
TLV	Threshold Limit Value

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4. GENERAL REQUIREMENTS

4.1 Packaging data and labeling. All chemicals included in this standard shall be packaged in accordance with Federal Specification PPP-C-2020 and all applicable documents referenced therein. 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) requires 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.

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

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case of contact with the eyes, immediately irrigate with copious amounts of water for at least 20-30 minutes, and obtain medical attention. (Refer to TB MED 506.)

4.3.1.4 Training. Employers shall provide employees with training and information, including MSDSs, on all chemical items in their work area, in accordance with 29 CFR 1910.1200 (h), 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 Exercises. Participation in training exercises shall be stressed to demonstrate skills in the use of personal protective equipment and emergency response equipment.

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

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 37.8°C (100°F). A combustible liquid is defined, by DOT in the above reference, as one having a closed cup flash point at or above 37.8°C (100°F) and below 93.3°C (200°F). A pyrophoric liquid is defined, by DOT in the above reference, as one that ignites spontaneously in dry or moist air at or below 54.5°C (130°F). Materials with flash points of 93.3°C (200°F) or higher are not considered to be nonflammable or noncombustible, but are 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 60°C (140°F) are defined by EPA as ignitable. The autoignition point (temperature) of a substance is generally defined as the minimum temperature required to initiate or cause self-sustained combustion in the absence of a spark or flame. Materials that ignite easily under normal industrial conditions are considered to be dangerous fire hazards. Such materials shall be stored in a manner to prevent ignition and combustion. Easily ignitable substances, such as reducing agents, shall be kept away from strong oxidizing agents. All

*Refers only to materials that have become waste.

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containers shall be tightly sealed. It is important to provide adequate ventilation in storage areas, and to locate the storage areas of these items away from fire hazards. Ample fire-control equipment shall be easily accessible. Storage buildings, rooms and cabinets shall comply with provisions of the National Fire Codes. The building shall be electrically grounded and signs posted to prevent the lighting of matches or smoking in the area. Flammable storage areas shall be equipped with smoke or fire detection equipment.

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

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 in Threshold Limit Values for Chemical Substances in the Work Environment adopted by the American Conference of Governmental Industrial Hygienists (ACGIH); current Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL), 29 CFR, Part 1910, Section 1910.1000; and NIOSH Recommended 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 II 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.

*Refers only to materials that have become waste.

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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 acutely 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 acutely hazardous in toxicity under Subpart D, Section 261.33(e).

4.3.4.3 EPA Toxicity Characteristic Leaching Procedure (TCLP). This is a procedure used to determine the properties of a waste that are directly related to the potential of the waste to pose a hazard to groundwater when disposed of in a landfill environment. It replaces the EPA EP toxicity test. The TCLP procedure is contained in EPA Method No. 1311, SW-846. Some 40 chemical contaminants have been designated by the EPA as being a hazard to groundwater in a landfill environment (see Section 261.24 of 40 CFR.)

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 either having met the characteristics for ignitable, corrosive, or reactive waste or are subject to Toxicity Characteristic Leaching Procedure (TCLP); or have been listed as toxic or acutely hazardous according to Identification and Listing of Hazardous Waste,

*Refers only to materials that have become waste.

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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 disposed of as stated in 4.4.3.2 shall be stored under environmentally safe conditions until suitable methods of disposal are determined. Short-term storage (less than 90 days) requires proper containment (i.e., packaging and facilities) in accordance with Section 262.34, Part 262, of the above reference. Long-term storage (greater than 90 days) requires permitting by the EPA or by the state under Public Law 94-580 (RCRA), in compliance with the requirements of 40 CFR, Parts 264 and 265. Physical custody will be accomplished by the activity with conforming storage or most nearly conforming storage. When physical custody is in question, the Post Commander will make the final decision. In all cases where the wastes are to be collected, stored, transported and disposed of at a state or local permitted disposal facility, the identity and description of the waste shall be maintained and recorded in accordance with Part 262 of the above reference. Transportation of the waste must be in accordance with Part 263 of the above reference, Standards Applicable to Transporters of Hazardous Waste. State and/or local regulations may be more stringent than Federal requirements. It is essential that the installation Environmental Office review all disposal actions for Compliance with all applicable regulations.

4.4.3.1 Cleanup of liquid spills. To control the migration of spilled or leaking liquids, dike around the item with an inert, dry absorbent (e.g., clay, sawdust or vermiculite) or follow installation spill plans (Spill Prevention Control and Countermeasure Plan and Installations Spill Contingency Plan). Control entry to the spill site and segregate salvageable materials away from the spill area. Initiate waste cleanup operations immediately in accordance with local procedures. The residue shall be safely handled and transported to an approved or permitted disposal or storage facility. Packaging, labeling, transportation and record-keeping requirements for this waste material are determined by the appropriate Federal and State agencies and local procedures. It is recommended that all activities involving disposal preparation and transportation to commercial facilities be properly coordinated with the appropriate Federal and State agencies responsible for health and environmental aspects of hazardous 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 into the DRMO shall first be properly identified,

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containerized, and labeled. For large scale spills that grossly contaminate the environment, the Chemical Transportation Emergency Center (CHEMTREC) can be called for assistance (1-800-424-9300). Applicable procedures of the local spill control plan shall be followed. Necessary respiratory, eye, and skin protection measures are to be used while performing cleanup operations.

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

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

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5. DETAILED REQUIREMENTS

5.1 Name. FERRIC CHLORIDE, ANHYDROUS, CRYSTALLINE, TECHNICAL $FeCl_3$ FW 162.61
Iron(III)chloride
Iron trichloride CAS 7705-08-0
Molysite (natural)

5.1.1 Specification. MIL-F-14580 Ferric Chloride, Anhydrous, Crystalline, Technical.

5.1.2 Technical description. Anhydrous ferric chloride (pure) is in the form of reddish-brown to black hexagonal crystals with the physical properties shown in Table I. It is deliquescent, forming a yellow-brown liquid. When dissolved in water, much heat is liberated due to hydration of the Fe^{3+} ions. It is very soluble in water, ethyl alcohol, methyl alcohol, ether and acetone. Its aqueous solutions are acidic due to hydrolysis. It has a semicovalent structure which accounts for its solubility in nonpolar solvents. It is volatile, and in the gaseous state it exists as a dimer up to about 700°C. If heated in a vacuum, it decomposes with loss of chlorine to give iron(II)chloride.

Table I. Anhydrous ferric chloride -physical properties.

Density (25°C), g/cm^3	2.898
Melting point, °C	306
Boiling point (760 mm Hg), °C	315
Solubility in water, g/100 cm^3	
(0°C)	74.4
(100°C)	535.7
Solubility in acetone (18°C), g/100 cm^3	63

The military specification requirements for technical grade anhydrous crystalline ferric chloride are shown in Table II.

Table II. Ferric chloride, anhydrous, crystalline, technical - chemical requirements.

Ferric Chloride ($FeCl_3$), % by wt, min	95.5
Ferrous chloride ($FeCl_2$), % by wt, max	1.0
Water insolubles, as Fe_2O_3, % by wt, max	4.0

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Table II. Ferric chloride, anhydrous, crystalline, technical - chemical requirements (continued).

Deleterious ingredients, mg/L†	
Arsenic	0.025
Chromium, hexavalent	0.025
Copper	0.5
Fluoride	0.80
Lead	0.025
Selenium	0.005

†When 100 mg of $FeCl_3$ are added to 1L of water, the increase in the amount of deleterious ingredients shall not exceed the specified amounts.

5.1.3 Use. Anhydrous crystalline ferric chloride is intended for military use as a coagulant for water purification. Commercial uses include the treatment of sewage and industrial wastes, as an etching agent for engraving, in photography, and as a catalyst in organic synthesis.

5.1.4 Packaging. Refer to 4.1

5.1.5 Safety precautions.

a. Health hazard. Ferric chloride particles can be irritating to the eyes, skin and respiratory tract. The TLV, as a soluble iron salt, is 1 mg/m^3 as Fe. Solutions of ferric chloride are also irritating to the eyes and skin. For personal protective measures, refer to 4.3.1.

b. Fire and explosion hazard. Ferric chloride will not burn. If present in a fire and heated to decomposition, it can release toxic chlorine fumes.

c. Reactivity. Ferric chloride is reactive with water to form the hydrated compound, and the heat of hydration can cause release of irritating acidic fumes from solution.

5.1.6 Storage. Anhydrous ferric chloride shall be stored in a cool, dry, well-ventilated space in tightly sealed waterproof polyethylene-lined containers. The acid resulting from hydrolysis, if exposed to moisture, can cause deterioration of metal containers or paper bags. Refer to 4.3.2.

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5.1.7 Disposal. In case of spills, gather up the dry compound and place in containers for use or disposal. The spill area shall be flushed with water and neutralized with soda ash or lime if needed. For appropriate procedures, contact the Installation Environmental Office, the DRMO or Safety and Health Offices. Refer to 4.4.4. Ferric Chloride has been designated by the EPA as a hazardous substance.

5.2 Name. FERRIC OXIDE, TECHNICAL Fe_2O_3 FW 159.69
Hematite (natural)
Iron(III)oxide CAS 1309-37-1

5.2.1 Specification. MIL-F-82655 Ferric Oxide, Technical.

5.2.2 Technical description. Ferric oxide (pure) is in the form of reddish-brown to black trigonal crystals with the physical properties shown in Table III. It is insoluble in water. It is dissolved by hydrochloric acid and sulfuric acid to form the corresponding iron (III) salts. Treatment with alkali hydroxides or aqueous ammonia solutions results in formation of reddish-brown hydrous ferric oxide $Fe_2O_3 \cdot nH_2O$, a part of which is FeO(OH).

Table III. Ferric oxide - physical properties.

Density, g/cm^3	5.24
Melting point, °C	1565

Military specification MIL-F-82655 covers two classes of ferric oxide:

Class 1 - Fine
Class 2 - Extra fine

The chemical and physical requirements are shown in Table IV.

Table IV. Ferric oxide, technical - chemical and physical requirements.

Property	Class 1	Class 2
Iron, as Fe_2O_3 (calcined basis), wt %, min	98	98
Moisture, wt %, max	0.5	0.5
Calcination loss (dry basis), wt %, max	2.0	2.0
Acidity, as H_2SO_4, wt %, max	0.02	0.02
Weight mean diameter particle size, microns,		
min	4.5	2.0
max	6.0	3.0

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5.2.3 Use. Ferric oxide is intended for military use as an ingredient of solid propellants. Commercial applications include use as a thermite ingredient, and as a pigment and polishing agent.

5.2.4 Packaging. Refer to 4.1

5.2.5 Safety precautions.

a. Health hazard. Ferric oxide particles can be irritating to the eyes, skin and respiratory tract. The PEL for iron oxide fumes is 10 mg/m^3, and the TLV for iron oxide fumes, as Fe, is 5 mg/m^3. For personal protective measures, refer to 4.3.1.

b. Fire and explosion hazard. Ferric oxide is not burnable.

c. Reactivity. Ferric oxide is reactive with strong acids. Ferric oxide can react violently with active metal powders, such as aluminum, when the mixture is activated, resulting in very high temperatures.

5.2.6 Storage. Ferric oxide shall be stored in tightly sealed containers in a dry space away from acids. Refer to 4.3.2.

5.2.7 Disposal. In case of spills, gather up the dry compound and place in containers for use or disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4. EPA Hazardous Waste Classification - None.

5.3 Name. FERROUS SULFATE, HEPTAHYDRATE

$FeSO_4 \cdot 7H_2O$ FW 278.05

Copperas

Green vitriol CAS 7782-63-0

Iron(II)sulfate, heptahydrate

Iron vitriol

Melanterite (natural)

5.3.1 Specification. AWWA B 402 Standard for Ferrous Sulfate.

5.3.2 Technical description. Ferrous sulfate, heptahydrate (pure) is in the form of blue-green monoclinic crystals with the physical properties shown in Table V. It is efflorescent in dry air, and dehydrates on heating. It decomposes with loss of SO_2 and SO_3 on heating above 300°C. It is soluble in water and methanol, and is slightly soluble in ethanol. Its aqueous solutions are acidic due to hydrolysis. It is oxidized to iron(III) by exposure to moist air, and turns yellow-brown.

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Table V. Ferrous sulfate, heptahydrate - physical properties.

Density, g/cm^3	1.898
Refractive index	1.478
Dehydration points, °C	
-5H_2O	70 to 80
-6H_2O	90 to 100
-7H_2O	300
Solubility in water, g/100 cm^3	
Cold	15.65
50°C	48.6

Ferrous sulfate, heptahydrate, technical grade, is commercially available with iron contents of 19.5 to 21.5 percent (average Fe 20%), meeting the specification requirements of AWWA B 402.

5.3.3. Use. Ferrous sulfate, heptahydrate, is intended for military use as a flocculant and coagulant in the treatment of potable water and waste water. It also eliminates phosphate and sulfide by precipitation. Commercial applications include the manufacture of other ferrous compounds, and use as a reducing agent for the conversion of highly toxic chromium(VI) wastes to less toxic chromium(III) wastes.

5.3.4 Packaging. Refer to 4.1

5.3.5 Safety precautions.

a. Health hazard. Ferrous sulfate particles can be severely irritating to the eyes, and irritating to the skin and respiratory tract. The TLV, as a soluble iron salt, is 1 mg/m^3 as Fe. Solutions of ferrous sulfate are also irritating to the eyes and skin. For personal protective measures, refer to 4.3.1.

b. Fire and explosion hazard. Ferrous sulfate will not burn. If present in a fire and heated to decomposition, it can release irritating and toxic fumes of SO_2 and SO_3.

c. Reactivity. Ferrous sulfate is not dangerously reactive.

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5.3.6 Storage. Ferrous sulfate, heptahydrate, shall be stored in a cool, dry space in tightly sealed waterproof polyethylene-lined containers to avoid caking due to moisture and to avoid oxidation due to air exposure. Refer to 4.3.2.

5.3.7 Disposal. In case of spills, gather up the dry compound and place in containers for use or disposal. The spill area shall be flushed with water and neutralized with soda ash or lime if needed. For appropriate procedures, contact the Installation Environmental Office, the DRMO or Safety and Health Offices. Refer to 4.4.4. EPA Hazardous Waste Classification - None.

5.4 Name. FERROUS SULFIDE, TECHNICAL FeS FW 87.91
Iron(II)sulfide
Troilite (natural) CAS 1317-37-9

5.4.1 Specification. MIL-F-279 Ferrous Sulfide, Technical.

5.4.2 Technical description. Ferrous sulfide (pure) is in the form of black-brown hexagonal crystals with the physical properties shown in Table VI. Ferrous sulfide is covalent rather than ionic in structure, and the S/Fe ratio can exceed unity. It is practically insoluble in cold water, and is decomposed by hot water. It is decomposed by acids with the evolution of hydrogen sulfide gas.

Table VI. Ferrous sulfide - physical properties.

Density, g/cm^3	4.74
Melting point, °C	1193 to 1199
Solubility in water (18°C), g/100 cm^3	0.00062

Military specification MIL-F-279 covers two grades of ferrous sulfide:

Grade A - 75.0% FeS in granular form
Grade B - 85.0% FeS in stick form

The ferrous sulfide shall conform to the chemical and physical requirements shown in Table VII.

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Table VII. Ferrous sulfide, technical - chemical and physical requirements.

	Percent by Weight	
	Grade A	Grade B
Assay, as FeS, min	75.0	85.0
Free sulfur, max	0.5	---
Granulation:		
Retained on 150 micrometer sieve (No. 100)	0.1	---

Standard sieve designation in accordance with ASTM E 11 or ASTM E 323 as applicable.

The Grade B ferrous sulfide shall be dark brown cylindrical sticks.

5.4.3 Use. Grade A ferrous sulfide is intended for military use in the manufacture of pyrotechnics and for laboratory use. Grade B ferrous sulfide is intended for laboratory use, such as in the preparation of hydrogen sulfide gas. Commercial applications include use as a pigment and as a raw material for the production of sulfur oxides and hydrogen sulfide.

5.4.4 Packing. Refer to 4.1.

5.4.5 Safety precautions.

a. Health hazard. Ferrous sulfide particles can be irritating to the eyes, skin and respiratory tract. For personal protective measures, refer to 4.3.1.

b. Fire and explosion hazard. Ferrous sulfide is burnable and the gaseous combustion products, consisting of sulfur oxides, are irritating and toxic. Ferrous sulfide particles in air can cause a dust explosion.

c. Reactivity. Ferrous sulfide is decomposed by hot water, steam and acids with release of hydrogen sulfide gas, which is irritating and toxic. Ferrous sulfide is reactive with oxidizing agents and reactions can be violent.

5.4.6 Storage. Ferrous sulfide shall be stored in air-tight containers in a cool, dry, well-ventilated space away from acids and oxidizing agents. Refer to 4.3.2.

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5.4.7 Disposal. In case of spills, gather up the dry compound and place in containers for use or disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4. EPA Hazardous Waste Classification - Reactive; Waste No. D003.

5.5 Name. LEAD CARBONATE, BASIC FW 775.60
Hydrocerrusite
Lead subcarbonate
White lead CAS 1319-46-6

$$2PbCO_3 \cdot Pb(OH)_2 \text{ or } Pb_3(OH)_2(CO_3)_2$$

5.5.1 Specifications. MIL-L-18618 Lead Carbonate, Basic, Dry (For Ordnance Use).

5.5.2 Technical description. Basic lead carbonate is in the form of a white powder or hexagonal crystals with the physical properties shown in Table VIII. It is insoluble in water. It is decomposed by acids.

Table VIII. Lead carbonate, basic - physical properties.

Density, g/cm^3	6.14
Decomposition point, °C	400

The theoretical total lead content is 80 percent. The theoretical lead carbonate content is 69 percent.

Military specification requirements for basic carbonate are shown in Table IX.

Table IX. Basic lead carbonate, dry - chemical and physical requirements.

Property	Requirement	
	Min	Max
Lead carbonate, wt %	62	69
Total lead (calculated as Pb), wt %	80	---
Moisture, wt %	---	0.7
Impurities, wt %	---	0.5

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Table IX. Basic lead carbonate, dry - chemical and physical requirements (continued).

Property	Requirement	
	Min	Max
pH	5.5	7
Average particle size, micrometer	---	9
Coarse particles, wt %	---	0.5

The material is described chemically as basic lead carbonate with a lead carbonate content of 62 to 69 percent. The remainder (other than impurities and moisture) is generally all lead hydroxide or various proportions of lead hydroxide and anhydrous lead oxide combined in the compound. The material is high grade commercial "white lead" complying with the above requirements.

5.5.3 Use. Basic lead carbonate is intended for military use in propellant powders. Most commercials applications have been curtailed because of the lead hazard to children.

5.5.4 Packaging. Refer to 4.1

5.5.5 Safety precautions.

a. Health hazard. Basic lead carbonate particles are highly toxic by ingestion and inhalation after being trapped in the upper respiratory tract. The particles can be irritating to the eyes, skin and mucous membranes. As a lead compound, it is a suspected carcinogen. The TLV of lead inorganic dusts and fumes, as Pb, is 0.15 mg/m^3, and the PEL for lead, as Pb, is 0.05 mg/m^3. For personal protective measures, refer to 4.3.1.

b. Fire and explosion hazard. Basic lead carbonate will not burn and the dust is not an explosion hazard.

c. Reactivity. Basic lead carbonate is decomposed by acid. It is not dangerously reactive.

5.5.6 Storage. Basic lead carbonate shall be stored in tightly sealed containers in a dry space away from acids. Refer to 4.3.2.

5.5.7 Disposal. In case of spills, gather up the dry compound and place in containers for use or disposal. For appropriate procedures, contact the Installation

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Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4. Lead is listed in 40 CFR Section 261.24, Table 1 for toxicity characteristics. Lead carbonate will exhibit the characteristic of toxicity for lead. Designations of TCLP waste apply only to material declared as waste.

5.6 Name. LEAD CHROMATE $PbCrO_4$ FW 323.18
Chrome yellow
Crocoite (natural) CAS 7758-97-6

5.6.1 Specification. JAN-L 488 Lead Chromate (For Use in Ammunition).

5.6.2 Technical description. Lead chromate (pure) is in the form of yellow monoclinic crystals with the physical properties shown in Table X. It is practically insoluble in water. It is decomposed and dissolved by acids and alkalies.

Table X. Lead chromate - physical properties.

Density, g/cm^3	6.12
Melting point, °C	844
Solubility in water (25°C), g/100 cm^3	0.0000058

The military specification requirements for lead chromate are shown in Table XI.

Table XI. Lead chromate - chemical and physical requirements.

Property	Requirement
Purity, % min	99.2
Moisture, % max	0.2
Soluble matter, % max	0.2
Grit, % max	0.002
Apparent density, g/mL, min	0.90
Granulation: through 45 micrometer sieve † (No. 325), % min	100.0

†Standard sieve designation in accordance with ASTM E 11 or ASTM E 323 as applicable.

5.6.3 Use. Lead chromate is intended for military use in the manufacture of non gaseous powder. Commercial applications include use as a paint pigment.

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5.6.4 Packaging. Refer to 4.1

5.6.5. Safety precautions.

a. Health hazard. Lead chromate particles are highly toxic by ingestion and inhalation after being trapped in the upper respiratory tract. The particles can be irritating to the eyes, skin and mucous membranes. Lead chromate is classified by ACGIH as an industrial substance suspected of carcinogenic potential for man with a TLV, as Cr, of 0.05 mg/m^3. The OSHA ceiling limit for chromates, as Cr, is 0.1 mg/m^3, and the PEL for lead, as Pb, is 0.05 mg/m^3. The TLV, as Cr, is 0.05 mg/m^3. For personal protective measures, refer to 4.3.1.

b. Fire and explosion hazard. Lead chromate will not burn, but as an oxidizing agent can support a fire involving combustibles. If present in the vicinity of a fire, it shall be kept cool with large amounts of water.

c. Reactivity. Lead chromate reacts with strong mineral acids to form chromic acid. Lead chromate is an oxidizing agent, and can react with reducing materials.

5.6.6 Storage. Lead chromate shall be stored in tightly sealed containers in a dry space away from acids and combustible material. Refer to 4.3.2.

5.6.7 Disposal. In case of spills, gather up the dry compound and place in containers for use or disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4. Lead and chromium are both listed in 40 CFR Section 261.24, Table 1 for toxicity characteristics. Lead chromate will exhibit the characteristic of toxicity for lead and chromium. Designations of TCLP waste apply only to material declared as waste.

5.7 Name. LEAD DIOXIDE, TECHNICAL PbO_2 FW 239.19
Lead oxide, brown
Lead peroxide CAS 1309-60-0
Lead superoxide
Plattnerite
Plumbic acid, anhydrous

5.7.1 Specification. MIL-L-376 Lead Dioxide, Technical.

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5.7.2 Technical description. Lead dioxide (pure) is in the form of chocolate-brown tetragonal crystals with the physical properties shown in Table XII. It is insoluble in water. It is decomposed and dissolved by dilute hydrochloric acid. It is an oxidizing agent.

Table XII. Lead dioxide - physical properties.

Density, g/cm^3	9.375
Decomposition point, °C	290

The military specification covers two types and two classes of lead dioxide.

Type I - Low alkalinity
Type II - High alkalinity
Class 1 - Subsieve
Class 2 - 100 mesh, nominal

The chemical requirements for the two types of lead dioxide are shown in Table XIII.

Table XIII. Lead dioxide - chemical requirements.

Property	Percent by Weight	
	Type I	Type II
Lead dioxide, min	95.0	95.0
Water-soluble salts, max	0.05	0.05
Acidity	None	None
Alkalinity, as Na_2CO_3, max	0.01	0.10
Ammonium salts	None	None

The physical requirements for the two classes of lead dioxide are shown in Table XIV.

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Table XIV. Lead dioxide - physical requirements.

Particle Size Distribution	Percent by Weight	
	Class 1	Class 2
†Retained on 150 micrometer sieve (No. 100)	---	0.1
Retained on 106 micrometer sieve (No. 140)	---	10.0
Retained on 75 micrometer sieve (No. 200)	0.0	---
Retained on 45 micrometer sieve (No. 325)	5.0	---
Larger than 20 micrometers	20.0	---
Smaller than 5 micrometers	15.0	---
Apparent density, g/cm^3, min	1.20	---

† Sieve designation in accordance with ASTM E 11 or ASTM E 323 as applicable.

5.7.3 Use. Lead dioxide is intended for military use in pyrotechnic and primer formulations. Commercial applications include use in electrodes of lead-acid batteries, as an oxidizing agent, and as a curing agent for polysulfide elastomers.

5.7.4 Packaging. Refer to 4.1.

5.7.5 Safety precautions.

a. Health hazard. Lead dioxide particles are highly toxic by ingestion and inhalation after being trapped in the upper respiratory tract. The particles can be irritating to the eyes, skin and mucous membranes. As a lead compound, it is a suspected carcinogen. The TLV of lead inorganic dusts and fumes, as Pb, is 0.15 mg/m^3, and the PEL for lead, as Pb, is 0.05 mg/m^3. For personal protective measures, refer to 4.3.1.

b. Fire and explosion hazard. Lead dioxide will not burn, but as an oxidizing agent, it can support a fire involving combustibles. If present in the vicinity of a fire, it shall be kept cool with large amounts of water.

c. Reactivity. Lead dioxide is reactive with acids. Lead dioxide is an oxidizing agent and can react with reducing materials.

5.7.6 Storage. Lead dioxide shall be stored in tightly sealed containers in a dry space away from acids and combustible materials. Refer to 4.3.2.

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5.7.7 Disposal. In case of spills, gather up the dry compound and place in containers for use or disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4. Lead is listed in 40 CFR Section 261.24, Table 1 for toxicity characteristics. Lead dioxide will exhibit the characteristic of toxicity for lead. Designations of TCLP waste apply only to material declared as waste.

5.8 Name. LEAD NITRATE, TECHNICAL $Pb(NO_3)_2$ FW 331.20

CAS 10099-74-8

5.8.1 Specification. MIL-L-20549 Lead Nitrate, Technical.

5.8.2 Technical description. Lead nitrate (pure) is in the form of colorless cubic or monoclinic crystals with the physical properties shown in Table XV. It is soluble in water. Unless the solution is slightly acid with nitric acid, the basic nitrate salts, such as $Pb(OH)NO_3$, are precipitated due to hydrolysis. Lead nitrate is decomposed and dissolved by alkali hydroxide solutions with the formation of the $Pb(OH)_3^-$ ion. Lead nitrate decomposes at elevated temperatures to form PbO, NO_2 and O_2. It is an oxidizing agent.

Table XV. Lead nitrate - physical properties.

Density, g/cm^3	4.53
Refractive index	1.782
Decomposition point, °C	470
Solubility in water, g/100 cm^3	
(0°C)	37.65
(100°C)	127

The military specification covers one technical grade of lead nitrate. The lead nitrate shall be white in color. The chemical requirements are shown in Table XVI.

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Table XVI. Lead nitrate - chemical requirements.

Characteristic	Percent by Weight	
	Min	Max
Assay, as $Pb(NO_3)_2$	98.0	---
Water content	---	1.25
Water-insoluble matter	---	0.20
Acidity, as HNO_3	---	0.50
Copper, as Cu	---	0.002

5.8.3 Use. Lead nitrate is intended for military use in the manufacture of lead styphnate and lead azide. Commercial applications include use as a raw material for production of other lead compounds, as a mordant, and as an oxidizer.

5.8.4 Packaging. Refer to 4.1.

5.8.5 Safety precautions.

a. Health hazard. Lead nitrate particles are highly toxic by ingestion and inhalation after being trapped in the upper respiratory tract. The particles can be irritating to the eyes, skin and mucous membranes. As a lead compound, it is a suspected carcinogen. The TLV of lead inorganic dusts and fumes, as Pb, is 0.15 mg/m^3, and the PEL for lead, as Pb, is 0.05 mg/m^3. For personal protective measures, refer to 4.3.1.

b. Fire and explosion hazard. Lead nitrate will not burn, but as an oxidizing agent, it can support a fire involving combustibles. It emits toxic nitrogen dioxide fumes if heated to decomposition. If present in the vicinity of a fire, it shall be kept cool with large amounts of water.

c. Reactivity. Lead nitrate is an oxidizing agent and can react with reducing materials.

5.8.6 Storage. Lead nitrate shall be stored in tightly sealed containers in a dry space away from acids and combustible materials. Refer to 4.3.2.

5.8.7 Disposal. In case of spills, gather up the dry compound and place in containers for use or disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4. Lead is listed in 40 CFR Section 261.24, Table 1 for toxicity characteristics. Lead nitrate will

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exhibit the characteristic of toxicity for lead. Designations of TCLP waste apply only to material declared as waste.

5.9 Name. LEAD THIOCYANATE $Pb(SCN)_2$ FW 323.35
Lead sulfocyanate

CAS 592-87-0

5.9.1 Specification. MIL-L-65 Lead Thiocyanate (Sulphocyanate).

5.9.2 Technical description. Lead thiocyanate (pure) is in the form of white monoclinic crystals with the physical properties shown in Table XVII. It is very slightly soluble in water. It is decomposed and dissolved by nitric acid, and also by alkali hydroxide solutions. It is dissolved by KCNS solution, forming a metal complex. Lead thiocyanate decomposes at elevated temperatures.

Table XVII. Lead thiocyanate - physical properties.

Density, g/cm^3	3.82
Decomposition point, °C	190
Solubility in water, g/100 cm^3	
(20°C)	0.05
(100°C)	0.2

The military specification covers one type of lead thiocyanate. The lead thiocyanate shall be white or yellow in color, and in the form of discrete crystals. The chemical and physical requirements are shown in Table XVIII.

Table XVIII. Lead thiocyanate - chemical and physical requirements.

Property	Requirement
Lead, as $Pb(SCN)_2$, % min	99.3
Thiocyanate, as $Pb(SCN)_2$, % min	99.3
Chloride, as $PbCl_2$, % by max	0.20
Sodium, as NaSCN, % by max	0.20
Moisture, % max	0.20
Insoluble matter, % max	0.20
† Granulation: retained on, % by wt	
106 micrometer sieve (No. 140)	0
45 micrometer sieve (No. 325)	25

† Standard sieve designation in accordance with ASTM E 11 or ASTM E 323 as applicable.

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5.9.3 Use. Lead thiocyanate is intended for military use in the manufacture of priming mixtures. Commercial applications include use as an ingredient in matches.

5.9.4 Packaging. Refer to 4.1

5.9.5 Safety precautions.

a. Health hazard. Lead thiocyanate particles are highly toxic by ingestion and inhalation after being trapped in the upper respiratory tract. The particles can be irritating to the eyes, skin and mucous membranes. As a lead compound, it is a suspected carcinogen. The TLV of lead inorganic dusts and fumes, as Pb, is 0.15 mg/m^3, and the PEL for lead, as Pb, is 0.05 mg/m^3. For personal protective measures, refer to 4.3.1.

b. Fire and explosion hazard. Lead thiocyanate will not burn, but emits toxic fumes if heated to decomposition. If present in the vicinity of a fire, it shall be kept cool with large amounts of water.

c. Reactivity. Lead thiocyanate is reactive with acids to produce thiocyanic acid and its decomposition products, the fumes of which are toxic and irritating.

5.9.6 Storage. Lead thiocyanate shall be stored in tightly sealed containers in a dry space away from acids and combustible materials. Refer to 4.3.2.

5.9.7 Disposal. In case of spills, gather up the dry compound and place in containers for use or disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4. Lead is listed in 40 CFR Section 261.24, Table 1 for toxicity characteristics. Lead thiocyanate will exhibit the characteristic of toxicity for lead. Designations of TCLP waste apply only to material declared as waste.

5.10 Name. LITHIUM CHLORIDE LiCl FW 42.39

CAS 7447-41-8

5.10.1 Specifications. MIL-L-47058 Lithium Chloride, Purified Grade; MIL-L-63470 Lithium Chloride (For Use in Ammunition).

5.10.2 Technical description. Lithium chloride (pure) is in the form of white cubic crystals with the physical properties shown in Table XIX. Lithium chloride is deliquescent, and the ion is hydrated in solution. It is soluble in water, ethyl alcohol, and methyl alcohol. It is slightly soluble in acetone. LiCl is ionic under all conditions, including the fused state. The dimer $(LiCl)_2$ exists in the vapor state.

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Table XIX. Lithium chloride - physical properties.

Density, g/cm^3	2.068
Refractive index	1.662
Melting point, °C	614
Boiling point, °C	1325 to 1360
Solubility in water, g/100 cm^3	
(0°C)	63.7
(25°C)	130

The military specification MIL-L-47058 covers one grade of purified lithium chloride with the chemical and physical requirements shown in Table XX. The LiCl shall be free-flowing and free from lumps and caking.

Table XX. Lithium chloride, purified - chemical and physical requirements.

Purity, % min	95.0
Insoluble material, % max	0.1
Alkalinity, as Li_2CO_3, % max	0.4
Impurities, % max	
Sodium	0.20
Potassium	0.01
Nitrates	0.001
Chlorates	0.001
Sulfates	0.02
Calcium	0.04
Heavy metals	0.002
Iron	0.001

The military specification MIL-L-63470 covers one grade of lithium chloride having D values which conform to the D values as listed in the X-ray Powder Data Files of ASTM. The lithium chloride shall also conform to the chemical and physical requirements shown in Table XXI.

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Table XXI. Lithium chloride - chemical and physical requirements.

Purity, % min	98.0
Moisture, % max	1.0
Iron, ppm, max	200
pH	6.5 to 9.0
† Granulation: Retained on 850 micrometer sieve (No. 20)	10.0

† Standard sieve designation in accordance with ASTM E 11 or ASTM E 323 as available.

5.10.3 Use. Lithium chloride is intended for military use in various electrochemical applications, including thionyl chloride reserve-type batteries. Commercial applications include use in dry batteries, as a welding flux, as a heat-exchange medium, as a desiccant, in pyrotechnics, and in production of lithium metal by electrolysis.

5.10.4 Packaging. Refer to 4.1

5.10.5 Safety precautions.

a. Health hazard. Lithium chloride particles are highly toxic by ingestion and inhalation after being trapped in the upper respiratory tract. The particles can be irritating to the eyes, skin and mucous membranes. There is no PEL or TLV for lithium chloride. For personal protective measures, refer to 4.3.1.

b. Fire and explosion hazard. Lithium chloride will not burn and does not decompose on heating.

c. Reactivity. Lithium chloride is not dangerously reactive.

5.10.6 Storage. Lithium chloride shall be stored in tightly sealed containers in a dry space. Refer to 4.3.2.

5.9.7 Disposal. In case of spills, gather up the dry compound and place in containers for use or disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4. EPA Hazardous Waste Classification - None.

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5.11 Name. LITHIUM HEXAFLUOROARSENATE $LiAsF_6$ FW 195.85
Lithium hexafluoarsenate
Lithium hexafluoroarsenate(V) CAS 29935-35-1

5.11.1 Specification. MIL-L-48765 Lithium Hexafluoroarsenate (For Use in Ammunition).

5.11.2 Technical description. Lithium hexafluoroarsenate is in the form of a white crystalline powder. It is very hygroscopic and soluble in water and methyl formate. The military specification covers one grade of lithium hexafluoroarsenate which shall have a specified X-ray diffraction pattern shown in Table XXII, or infrared spectrum shown in Table XXIII.

Table XXII. Lithium hexafluoroarsenate - X-ray diffraction - peak d-values.

Decreasing order of intensity
3.30 - 3.70
4.40 - 4.65
2.90 - 3.10
1.65 - 1.76

Table XXIII. Lithium hexafluoroarsenate - infrared spectrum.

Peak (μm)	Range
2.96	2.85 - 3.05
6.15†	6.00 - 6.30
14.60	13.50 - 14.90
26.60	25.50 - 31.00

†May appear as doublet.

The lithium hexafluoroarsenate shall conform to the chemical and physical requirements shown in Table XXIV.

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Table XXIV. Lithium hexafluoroarsenate - chemical and physical requirements.

Impurities, allowable concentrations, ppm, max	
Total halogens	50
Water	150
pH	
In water	4.0 to 7.0
In methyl formate (MF)	3.8 to 7.5
Solubility in MF, %	100
Potentiometric value of 2-molar solution in methyl formate, mV	<450

5.11.3 Use. Lithium hexafluoroarsenate is intended for military use in lithium reserve-type batteries.

5.11.4 Packaging. Refer to 4.1

5.11.5 Safety precautions.

a. Health hazard. Lithium hexafluoroarsenate particles are toxic by ingestion and inhalation after being trapped in the upper respiratory tract. The particles can be irritating to the eyes, skin and mucous membranes. The TLV for soluble arsenic compounds, as As, is 0.2 mg/m^3. For personal protective measures, refer to 4.3.1.

b. Fire and explosion hazard. Lithium hexafluoroarsenate will not burn, but can decompose on heating. If present in a fire, it can release toxic arsenic and fluoride fumes.

c. Reactivity. Lithium hexafluoroarsenate is reactive with strong acids, forming hydrofluoric acid and releasing hydrogen fluoride fumes.

5.11.6 Storage. Lithium hexafluoroarsenate shall be stored in tightly sealed containers in a cool, dry space away from combustibles and acids. Refer to 4.3.2.

5.11.7 Disposal. In case of spills, gather up the dry compound and place in containers for use or disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4. Arsenic is listed in 40 CFR Section 261.24, Table 1 for toxicity characteristics. Lithium hexafluoroarsenate will exhibit the characteristic of toxicity for arsenic. Designations of TCLP waste apply only to material declared as waste.

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5.12 Name. LITHIUM TETRAFLUOROBORATE $LiBF_4$ FW 93.74
Lithium fluoroborate

CAS 14283-07-9

5.12.1 Specification. MIL-L-48766 Lithium Tetrafluoroborate (For Use in Ammunition).

5.12.2 Technical description. Lithium tetrafluoroborate is in the form of a white crystalline powder. It decomposes on heating. It is soluble in water and methyl formate. The military specification covers one grade of lithium tetrafluoroborate which shall have a specified X-ray diffraction pattern shown in Table XXV, or infrared spectrum shown in Table XXVI.

Table XXV. Lithium tetrafluoroborate - X-ray diffraction - peak d-values.

Peak d-value	Range
3.35	3.30 - 3.40
4.25	4.17 - 4.33
3.97	3.88 - 4.05
3.16	3.10 - 3.22

Table XXVI. Lithium tetrafluoroborate - infrared spectrum.

Peak (μm)	Range
2.94	2.85 - 3.05
6.15†	6.05 - 6.30
9.66	9.00 - 10.00
16.10	15.40 - 16.80

†May appear as doublet.

The lithium tetrafluoroborate shall conform to the chemical and physical requirements shown in Table XXVII.

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Table XXVII. Lithium tetrafluoroborate - chemical and physical requirements.

Impurities, allowable concentrations, ppm, max	
Total halogens	50
Water	500
pH	
In water	≥2.0 to 7.0
In methyl formate (MF)	≥2.5 to 7.0
Solubility in MF, %	97
Hydrolysis/Dehydration	
Methanol, at 200 hrs, % max	12
Dimethyl ether, at 200 hrs, % max	0.1

5.12.3 Use. Lithium tetrafluroroborate is intended for military use in lithium reserve-type batteries.

5.12.4 Packaging. Refer to 4.1

5.12.5 Safety precautions.

a. Health hazard. Lithium tetrafluoroborate particles are toxic by ingestion and inhalation after being trapped in the upper respiratory tract. The particles can be irritating to the eyes, skin and mucous membranes. The PEL and TLV for fluorides, as F, is 2.5 mg/m^3. For personal protective measures, refer to 4.3.1.

b. Fire and explosion hazard. Lithium tetrafluoroborate will not burn, but can decompose on heating. If present in a fire, it can release toxic fluoride fumes.

c. Reactivity. Lithium tetrafluoroborate is reactive with strong acids, forming hydrofluoric acid and releasing hydrogen fluoride fumes.

5.12.6 Storage. Lithium tetrafluoroborate shall be stored in tightly sealed containers in a cool, dry space away from combustibles and acids. Refer to 4.3.2.

5.12.7 Disposal. In case of spills, gather up the dry compound and place in containers for use or disposal. For appropriate procedures, contact the Installation Environmental Office, the DRMO, or Safety and Health Offices. Refer to 4.4.4.

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6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This standard is intended to cite nomenclature, Chemical Abstract Service Registry Number, 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 (Ferric Chloride through Lithium Tetrafluoroborate) preferred for application by the Department of Defense.

6.2 Subject term (key word) listing.

Exposure limits, hazardous chemicals
Ferric chloride, anhydrous, technical
Ferric oxide, technical
Ferrous sulfate, heptahydrate, technical
Ferrous sulfide, technical
Hazardous wastes, disposal and storage of
Information, hazardous chemicals
Lead carbonate, basic, technical
Lead chromate, technical
Lead dioxide, technical
Lead nitrate, technical
Lead thiocyanate, technical
Lithium chloride, technical
Lithium hexafluoroarsenate, technical
Lithium tetrafluoroborate, technical
Safety, hazardous chemicals

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

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Assignee: GS

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

Review activities:
Army - AR, MD, SM
DOD - DP, GS

User activities:
Army - ME
Navy - MS, OS, YD

Preparing Activity: Army - EA

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