

**MIL-STD-611A**

20 December 1974

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**SUPERSEDING  
MIL-STD-611**

21 June 1967

**MILITARY STANDARD**

**ELEMENTS, CHEMICAL, EXCEPT ACS CHEMICALS**



**FSC 6810**

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20 December 1974

DEPARTMENT OF DEFENSE  
Washington, D. C. 20301

Elements, Chemical, Except ACS Chemicals

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1. This Military Standard is mandatory for use by all Departments and Agencies of the Department of Defense.
2. Recommended corrections, additions, or deletions should be addressed to Commander, Edgewood Arsenal, Attn: SAREA-DE-ES, Aberdeen Proving Ground, Maryland 21010.

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#### FOREWORD

This standard is mandatory 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.

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## 1. SCOPE

1.1 Coverage. This standard is a presentation of nomenclature, symbols, physical and chemical properties and requirements, military and typical commercial uses, direction for use, packaging data, labeling, general safety precautions, storage information, shelf life, and disposal data of all military standard elements, except ACS. This standard does not necessarily include all classifications of the items represented by the title or those which are commercially available. Elements which are ACS grade are covered in MIL-STD-1218, ACS Chemicals. It does contain items preferred for use in the selection of elements, except ACS for application by the Department of Defense.

1.2 Application. Items listed herein accommodate essential requirements of the military and defense agencies, and will effect continued economies in all logistics functions where properly employed in new applications.

## 2. REFERENCED DOCUMENTS

The issue of the following documents in effect on the date of invitation for bids form a part of this standard to the extent specified herein.

### Federal Specifications

O-C-265	Chemicals, Analytical, General Specification for
PPP-C-186	Containers, Packaging and Packing for Drugs, Chemicals and Pharmaceuticals
PPP-C-301	Chemicals, Dry and Paste, Packaging and Packing of

### Military Specifications

MIL-P-211	Phosphorus, Red, Technical
MIL-S-230	Silicon, Powdered, Technical
MIL-Z-365	Zinc, Dust (For Use in Pyrotechnics)
MIL-M-382	Magnesium Powder (For Use in Ammunition)
MIL-Z-399	Zirconium (Granular and Powdered)
JAN-N-412	Nickel, Powdered (For Use in Ammunition)
MIL-T-458	Tin, Pulverized
JAN-M-476	Manganese, Powdered (For Use in Ammunition)
MIL-S-487	Sulfur, Ground (For Use in Ammunition)
MIL-C-506	Charcoal, Activated, Powdered
MIL-A-512	Aluminum Powder, Flaked, Grained and Atomized
MIL-P-670	Phosphorus, Red, Stabilized
JAN-C-768	Copper, Powdered (For Use in Ammunition)
MIL-C-10202	Charcoal, Activated, Technical
MIL-A-10841	Antimony, Technical
MIL-I-12058	Iron, Technical
MIL-T-13405	Titanium, Technical, Powdered
MIL-P-14030	Platinum, Analyzed Reagent
MIL-C-17605	Charcoal, Activated, Technical, Unimpregnated

### Purchase Descriptions

EA PD 4-194	Potassium, Reagent
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### Military Standard

MIL-STD-129	Marking for Shipment and Storage
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## Rules and Regulations

### DOT Shipping Regulations Uniform Freight Classification Rules

## 3. GLOSSARY

### 3.1 Definitions.

Activated - To treat (charcoal or carbon), as by heating in steam, to enhance its adsorptive property. This definition applies only to charcoal in this standard.

Adulterant - Any material added to a substance which makes it impure as an ingredient included which is not part of the professed substance, thereby lowering the quality.

Allotropic - The property shown by certain elements or compounds being capable of existence in more than one form, due to a difference in the arrangement of atoms and molecules.

Amorphous - A substance without definite form or which is not crystallized.

Analyzed reagent grade - Denotes high quality chemicals which are suitable for exacting analytical work and which bear a label giving a statement of the maximum percentages of the important impurities present. Generally, analyzed reagent grade is comparable to ACS grade for those chemicals where an ACS Standard does not exist. All commercial listings of reported "reagent" chemicals and "CP" chemicals which include an analysis of impurities in the identification label shall be designated as analyzed reagent, provided they are not ACS grade. Also, chemicals meeting the specifications of "reagent" chemicals as found in the non-monographed sections of the "United States Pharmacopeia" or "The National Formulary" shall be designated as analyzed reagent. Identifications of chemicals of analyzed reagent grade which exceed the normal impurities limitation for this grade must be further expanded to indicate any significantly lower impurities limits. These items are normally identified in trade by a statement such as "Low in Iron", "Free from Arsenic".

Aqua regia - A mixture of one part nitric acid and three parts hydrochloric acid which will dissolve gold or platinum.

Atomic weight - The relative weight of the atom of an element, referred to that of some other element. In this standard the isotope  $O^{16}$  is used as a basis.

Atomized - Reduced to very fine particles.

Autoignition temperature - The temperature at which the combustion of a substance will occur spontaneously. This action is independent of the presence of an igniter such as electrical sparks or fire.

Boiling point - The temperature at which the vapor pressure of a liquid is equal to the external pressure. In this standard, if there is no mention of the external pressure at which the boiling point was determined, it is understood to be approximately one atmosphere (760 mm mercury).

Density - The concentration of matter expressed as a ratio of its mass per unit volume.

Ductile - Capable of being drawn into a thin wire.

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Electrolysis - Chemical decomposition by the action of an electric current.

Element - A substance which cannot be decomposed by the ordinary types of chemical change, or be made by chemical union.

Flash point - The lowest temperature at which a liquid or solid will give off a vapor sufficient to form an ignitable mixture in air.

Molecular weight - The sum of the atomic weights of all the atoms appearing in a chemical formula. In this standard, the molecular weight is computed according to international atomic weight values of 1965.

Linear coefficient of thermal expansion - The ratio of the change in length per degree centigrade to the length at zero degrees centigrade (0°C).

Malleable - Capable of being extended or shaped by beating with a hammer, or by the pressure of rollers.

Melting point - The temperature at which the liquid and solid phases of a substance exist together in equilibrium.

Nonactinic - A material, such as amber colored glass, that protects light sensitive chemicals from the lower wave lengths of the spectrum.

Nonactivated - Material that has not been activated.

Pyrotechnics - Ammunition containing chemicals that produce a smoke or brilliant light in burning, used for signalling or for lighting up an area at night.

Reagent grade - Denotes reagent grade chemicals which do not bear a label stating the percentages of the importance impurities present. Reagent grade chemicals have limited use in analytical work because of the uncertainty as to the kind and amount of impurities present. These chemicals find extensive use in laboratory synthesis and in certain analytical procedures where the inherent impurities are not critical to the intended reaction.

Refractive index - A constant, characteristic of each substance, which represents the ratio of the velocity of light in a vacuum to that in the substance.

Specific gravity - The ratio of the mass of a body to the mass of an equal volume of water at 4°C or other specified temperature. In this standard, the first temperature indicates the temperature of the substance, and the second indicates the temperature of water it is referred to. If there is no mention of the temperatures, (20°/4°C) is understood.

Sublimation - The changing of a solid to a vapor and recondensation of the vapor directly as a solid without apparently a liquid phase.

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.



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Thermal conductivity - The time rate of transfer of heat by conduction, through unit thickness, across a unit area, for a unit difference in temperature. Units: calories per second per cubic centimeter and a difference in temperature of 1°C.

Vapor pressure - The pressure exerted when a solid or liquid is in equilibrium with its own vapor. The vapor pressure is a function of the substance and of the temperature.

3.2 Abbreviations. The same abbreviation is used for all tenses, the possessive case, the singular and plural forms of a given word.

ACS - American Chemical Society

AW - Atomic weight

BTU - British Thermal Unit

C - Celsius (formerly Centigrade)

cal - caliber

cc - cubic centimeter

DOT - Department of Transportation

F - Fahrenheit

ft - foot

FW - Formula weight

gal - gallon

in - inch

lb - pound

max - maximum

MIL-STD- - Military Standard

min - minimum

ml - milliliter

no. - number

NF - National Foundary

oz - ounce

ppm - parts per million

sec - secondary

USP - United States Pharmacopeia

USS - United States Standard

- micron

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#### 4. GENERAL REQUIREMENTS

4.1 Chemical and physical requirements. All values given in tables of chemical and physical requirements are in maximum percent by weight unless otherwise indicated.

4.2 Date of manufacture. All chemicals in this standard shall not be older than one year when purchased except where specified otherwise under storage data.

4.3 Nomenclature. All chemicals in this standard conform to the military definitions of analyzed reagent grade, reagent grade, and technical grade as set forth under Section 3.1. The Department of Defense item names, as used throughout this standard, are in capital letters. Other names that are sometimes used commercially are in small letters immediately beneath.

4.4 Packaging data and labeling. In addition to being packaged in accordance with Federal Specification PPP-C-186, all elements included in this standard shall be packaged in accordance with Federal Specification PPP-C-301 and with all applicable documents mentioned in these two specifications. All elements included in this standard shall be marked for shipment and storage in accordance with MIL-STD-129.

4.5 Safety. General laboratory safety and hygienic measures should be exercised in the use of any of these chemicals. Only general safety precautions are outlined in this standard. For more specific information the applicable safety or medical authorities must be consulted.

4.6 Shelf life. Factors such as moisture, temperature, type and condition of container and exposure to sunlight and the atmosphere cause variations in shelf life. Ideal storage conditions are outlined for each item. An approximate period of time after which this material will no longer be suitable for its intended use is also presented. The term "cool" denotes temperatures from above freezing up to 80° Fahrenheit but not consistently over 70° when stored out of direct sunlight. The term "dry" is usually used to denote an area where condensation does not come in contact with the packages or contents (for example, storing on pallets away from walls in an enclosure or building). Periodic examinations of the material should be made more frequently when storage conditions vary from the ideal. For applications where quality may be critical each element (substance) should be analyzed prior to use.

4.7 Solubility data. Solubility data is only given for the most common solvents.

4.8 Temperature. If the temperature at which a property was determined is not specified, it is understood to be room temperature (15 to 20°C or 59 to 68°F).

4.9 Use data. Typical commercial uses are given without regard to specific grades.

4.10 Pollution potential. All elements described in this military standard should be assumed to have a pollution potential; however, to minimize the potential, use, storage, and disposal instructions must be strictly observed.

4.11 Disposal data. To minimize disposal problems, it is recommended that no more than a 1-year supply of each item be stocked. Should excess or unserviceable material occur, dispose of material as outlined in the Defense Utilization Manual DOD 4140.34-M or the Defense Disposal Manual DOD 4160.21-M. In the case of unserviceable material, consideration should be given to recycling or reprocessing under government contract. Last, in order of preference, if none of the previous options are practical, sell to industry.

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5. DETAIL REQUIREMENTS

5.1 Name. ALUMINUM, TECHNICAL, Al, AW 26.9815  
 Aluminum

5.1.1 Specification. MIL-A-512, Aluminum Powder, Flaked, Grained, and Atomized.

5.1.2 Technical description. Aluminum has atomic number 13 in group 3a of the periodic system. It is a silvery-white to bluish, ductile, malleable metal which, when crystallized, is in cubic form. Aluminum has a specific gravity of 2.6989, a melting point of 660.2°C, and a boiling point of 2467°C. It is insoluble in water, concentrated or fuming nitric acid, hydrogen peroxide, or hot acetic acid. It is soluble in alkali, hydrochloric acid, or sulfuric acid. Pure (99+ %) aluminum is resistant to most acids and ordinary corrosion but is attacked by caustic alkalies, the halogens, or their acids. It is unaffected by sulfides and nitrates. This metal is light weight, nontoxic (except when inhaled as a fine powder or aluminum oxide smoke), has a pleasing appearance, excellent corrosion resistance due to the formation of self-protecting oxide coat, high thermal conductivity, high reflectivity, and can be easily formed, machined, or cast. It is non-sparking and nonmagnetic, second in the scale of malleability of metals, and sixth in ductility. Aluminum, technical shall be made from aluminum metal of such purity that the product meets the requirements of Table I. It shall be free of grit and other harmful contamination. Mica fillers or other adulterants shall not be used.

TABLE I - Chemical requirements

Requirement	Grade A	Grade B	Grade C	Grade D	Grade E	Grade F
Al, min, % <sup>1</sup>	85.0	93.0	91.5	92.5	96.0	98.75
Cu, max, %						0.5
Fe, max, %		0.8			() <sup>2</sup>	0.5
Si, max, %					() <sup>2</sup>	0.5
Mg, max, %						0.1
Zn, max, %					0.5	0.25
Other elements, total, max, %		() <sup>3</sup>				0.5
Total of all impurities, max, %	15.0 <sup>4</sup>	7.0	8.5	7.5	4.0	1.25
Alkalinity as Mg(OH) <sub>2</sub> max, %						0.07
Nonvolatile matter, min, %	99.0	99.5	99.80	99.80	99.95	99.95
Easily extracted fatty and oily matter, max, %	3.0	1.5			0.2	0.2

1. By difference.
2. The permissible maximum amount of iron plus silicon is 1.5 percent.
3. The permissible maximum amount of other elements plus iron is 1.2 percent.
4. None of the elements included in "total of all impurities" shall exceed 2.0 percent.

5.1.3 Use data. Aluminum, technical, Grade A is intended for military use in primer composition; Grade B material is for use in pyrotechnics; Grade C material is for use in hexachloroethane screening smoke mixtures, grenade incendiaries, incendiary mixtures, cryptographic equipment destroyers and ignition cylinders; Grade D material is for use in incendiary thermite; Grade E material is for use in high explosive incendiary projectiles; and Grade F material is for use in heavy explosives. Typical commercial applications of aluminum include use in photography and as a reducing agent in a reaction with an oxide of iron in welding. It is also used in protective ointments and solid fuel propellants. Aluminum that is evaporated in a vacuum forms a highly reflective coating for both visible light and radiant heat. Aluminum is also used in the

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manufacturing of rayon, acetic acid, and food products.

TABLE II - Particle size distribution

USS Sieve Designation	Percentage retained							
	Class 1	Class 2	Class 3	Class 4	*Class 5	Class 6	* Class 7	*Class 8
No. 12					0			0.5
No. 20			2.0					
No. 30					13.0 to 26.0		0.5	
No. 40								
No. 50				0	35.0 to 45.0			
No. 100		0.2	30.0	3.0		2.0		
No. 140					**30.0 to 46.0			
No. 200		20.0	65.0	3.0 to 20.0		20.0		
No. 230							70.0	70.0
No. 325	1.0					10.0 to 35.0	50.0 min	65.0 min

\* DOD activities who test these classes on the basis of percent passing, use Interim Amendment 3 to MIL-A-512.

\*\* A maximum of 3.0 percent shall pass through this sieve.

5.1.4 Packaging data and labeling. For military use aluminum, technical is packaged in 600-pound unit quantity drums except for Grade B material (assay of 93.0%) which is packaged in 225-pound unit quantity drums. There are no DOT shipping regulations for this element.

5.1.5 Safety precautions. Aluminum powder is generally considered not hazardous. However, large concentrations of the fine dust can irritate the eyes and do form flammable and explosive mixtures with air. Do not use water to extinguish a fire of aluminum dust because an explosion may result; use rock dust, ashes, or sand to smother it. Personnel exposed to high concentrations of the fine powder or oxide smoke (formed by burning aluminum) should avoid excessive inhalation. For more specific information, the appropriate safety or medical authorities must be consulted in order to determine personal protective measures and environmental controls.

5.1.6 Storage data. Aluminum, technical in powder form should be stored in a dry room at a temperature between 50°F and 80°F at least one yard from radiators or steam pipes. When stored under these conditions and kept in tightly closed containers to keep out impurities it has an indefinite shelf life.

5.1.7 Disposal data. See paragraph 4.11.

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5.2 Name. ANTIMONY, ANALYZED REAGENT, Sb, AW 121.75  
 Antimony, Regulus  
 Stibium

5.2.1 Specification. None.

5.2.2 Technical description. Antimony has atomic number 51 in group 5a of the periodic system. It is a silver-blue-white, lustrous, hard, extremely brittle metal which, when crystallized, is in hexagonal form. It has a hardness of 3 to 3.5, the specific gravity is 6.691, the melting point is 630.5°C, and the boiling point is 1380°C. It is insoluble in water or dilute acids but is soluble in hot concentrated sulfuric acid or aqua regia. It is not acted on by air at room temperature but burns brilliantly when heated, forming white fumes of the oxide  $Sb_2O_3$ . It is a poor conductor of heat and electricity.

TABLE III - Chemical and physical requirements of  
 antimony, analyzed reagent

Assay (as Sb) min % by wt	99.5
Arsenic (As) max % by wt	0.06
Copper (Cu) max % by wt	0.01
Form	Powder
Iron (Fe) max % by wt	0.02
Lead (Pb) max % by wt	0.30
Tin (Sn) max % by wt	0.01

5.2.3 Use data. Antimony, analyzed reagent grade, is intended for military use as a general laboratory reagent and for use in pyrotechnics. Typical commercial applications of antimony include use for hardening and mechanically strengthening lead, particularly in cable sheaths and lead storage batteries, in bearing metal, type metal, pewter, Britannia metal, and in making antimony compounds. The metal is used in many alloys in a percentage of one to twenty.

5.2.4 Packaging data and labeling. Antimony, analyzed reagent grade is packaged in 1-pound unit quantity bottles for military use. The bottle shall be a wide mouth Boston Round design of polyethylene having a tight closure. There are no applicable DOT shipping regulations for this element. Each bottle shall be labeled as indicated in paragraph 5.3.4.

5.2.5 Safety precautions. Antimony is poisonous if swallowed. If this material is swallowed, induce vomiting at once and consult the proper medical authorities. Vapors produced by burning antimony are hazardous. Conditions of exposure to the fumes may necessitate the use of protective equipments. For more specific information the appropriate safety or medical authorities must be consulted in order to determine personal protective measures and environmental controls.

5.2.6 Storage data. Antimony, analyzed reagent should be stored in tightly closed containers in a cool, dry place. When stored under these conditions, the shelf life is indefinite.

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5.2.7 Disposal data. See paragraph 4.11.

5.3 Name. ANTIMONY, TECHNICAL, Sb, AW 121.75  
Antimony Regulas  
Stibium

5.3.1 Specification. MIL-A-10841, Antimony, Technical.

5.3.2 Technical description. See paragraph 5.2.2. The technical grade shall be crystal or powder form. The minimum assay shall be 98.0 percent by weight, have a maximum of 0.1 percent by weight of moisture, and shall have the particle size characteristics listed in Table IV.

TABLE IV - Particle size characteristics

<u>Sieve Size</u>	<u>Minimum % by weight passing</u>
177-micron (No. 80)	99.5
105-micron (No. 140)	90.0
53-micron (No. 270)	75.0

5.3.3 Use data. Antimony, technical grade is intended for military use in starter mixtures. See paragraph 5.2.3 for typical commercial uses.

5.3.4 Packaging data and labeling. Unit quantities of 500 lbs shall be packed in steel drums conforming to DOT specification 17H. All inner surfaces of the drum shall be dry and free of rust, oil, grease, and other foreign matter. Each drum shall be labeled in accordance with MIL-STD-129 and DOT regulations and as follows.

DANGER

Dust hazardous if inhaled. Causes irritation of skin, eyes, nose, and throat. Poisonous if swallowed. Heat or acid may produce highly toxic fumes. Dust may explode upon contact with flame.

Do not get in eyes, on skin or on clothing. Do not breathe dust; use only with adequate ventilation. Wash immediately upon skin contact. Keep cool and dry. Keep away from open flame.

5.3.5 Storage data. Store in a cool, dry area and keep containers tightly closed. Under these conditions the shelf life is indefinite.

5.3.6 Safety precautions. See paragraphs 5.2.5 and 5.3.4 labeling requirements.

5.3.7 Disposal data. See paragraph 4.11.

5.4 Name. BISMUTH, ANALYZED REAGENT, Bi, AW 208.98

5.4.1 Specification. None.

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5.4.2 Technical description. Bismuth has atomic number 83 in group 5a of the periodic system. It is a grayish-white, hard, brittle metal with a pinkish tinge. It crystallizes in rhombic form. Bismuth has a specific gravity of 9.747 and a boiling point of 1560±5°C. It is insoluble in water and is soluble in hot concentrated sulfuric acid, hot concentrated nitric acid, or aqua regia. It is slightly soluble in hydrochloric acid in the presence of oxygen. Bismuth has a hardness of 2 to 2.5 and the thermal conductivity of 0.018 cal/sec/cc at 100°C is less than any metal except mercury. Bismuth is the most diamagnetic metal of all, has a high electrical resistance, and the greatest increase in electrical resistance of any metal when placed in a magnetic field (the Hall effect). It expands 3.32% on solidification. Bismuth heated in air burns with a blue flame forming yellow fumes of the oxide. Bismuth, analyzed reagent shall be in granular or powder form of any applicable size and have a melting point of 271°C.

TABLE V - Chemical requirements of  
 bismuth, analyzed reagent

Assay (as Bi), min	99.8%
Antimony, max	0.01%
Arsenic, max	0.0005%
Copper, max	0.002%
Iron, max	0.002%
Lead, max	0.005%
Zinc, max	0.005%

5.4.3 Use data. Bismuth, analyzed reagent is intended for military use as a general laboratory reagent. Typical commercial applications of bismuth include use for low-melting alloys, for the coating of other metals, as a heat transfer medium in nuclear power production, as an alloy with manganese to form permanent magnets (bismanel), in a molten-metal continuous dyeing process, as an ingredient for heat resisting paint and for the production of bismuth salts.

5.4.4 Packaging data and labeling. For military use this reagent is packaged in ¼-lb unit quantity bottles. The bottle shall be made of nonactinic glass and shall be a commercial standard Boston Round design. There are no DOT shipping regulations for bismuth. Each bottle shall be labeled "CAUTION! Do Not Take Internally".

5.4.5 Safety precautions. Metallic bismuth is considered to be inert. However, conditions of exposure to a dust or mist of bismuth may necessitate the use of respiratory protection. For more specific information the appropriate safety or medical authorities must be consulted in order to determine personal protective measures and environmental controls.

5.4.6 Storage data. This material should be stored in tightly closed containers in a cool, well ventilated place, out of direct rays of the sun, and away from areas of acute fire hazard. It should be periodically inspected and monitored. Under these conditions the shelf life is indefinite.

5.4.7 Disposal data. See paragraph 4.11.

5.5 Name. CADMIUM, ANALYZED REAGENT, Cd, AW 112.40

5.5.1 Specification. None.

5.5.2 Technical description. Cadmium has atomic number 48 in group 2b of the periodic system. It is a soft, silver or blue-white, ductile, malleable metal or grayish-white

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powder which, when crystallized, is in hexagonal form. The specific gravity of cadmium is 8.65, the melting point is 320.9°C, and the boiling point is 765°C. It is insoluble in water and is soluble in acids and ammonium nitrate solutions. This material tarnishes in moist air, becomes brittle at 80°C, and burns when heated. It is similar in many respects to zinc. Cadmium, analyzed reagent shall be in stick form.

TABLE VI - Chemical and physical requirements of  
 cadmium, analyzed reagent

	<u>Percent</u>
Assay (as Cd), minimum	99.9
Copper (Cu), maximum	0.005
Iron (Fe), maximum	0.001
Lead (Pb), maximum	0.01
Zinc, maximum	0.05

5.5.3 Use data. Cadmium, analyzed reagent is intended for military use as a general laboratory reagent. Typical commercial applications of this element include use for cadmium plating (60% of use), the manufacture of cadmium salts, cadmium-vapor lamps, white pigment, smoke bombs, small arms ammunition, low-melting alloys, bearing alloys, with low coefficients of friction and great resistance to fatigue, electric instruments, incandescent light filaments, many types of solder such as aluminum solder, as a substitute for tin solders, dental amalgams, ceramic coatings, deoxidizer in metallurgy, coloring glass, nickel-plating, process engraving, lithography, Weston standard cell, nickel-cadmium storage battery, and as a barrier to control atomic fission.

5.5.4 Packaging data and labeling. This element is packaged in 1-pound unit quantity mailing tubes for military use. It should bear a poison label and be kept clearly labeled as such. There are not DOT shipping regulations for cadmium.

5.5.5 Safety precautions. Cadmium is poisonous when swallowed. Inhalation of fume or dust is hazardous to health. Conditions of exposure may necessitate the use of appropriate protective measures and equipment. For more specific information the appropriate safety or medical authorities must be consulted in order to determine personal protective measures and environmental controls.

5.5.6 Storage data. This material should be stored in tightly closed containers in a cool, well-ventilated place, out of the direct rays of the sun and away from areas of acute fire hazard. It should be periodically inspected and monitored. Under these conditions the shelf life is indefinite.

5.5.7 Disposal data. See paragraph 4.11.

5.6 Name. CHARCOAL, ACTIVATED, TECHNICAL, C, AW 12.0115  
 Activated Carbon  
 Decolorizing Carbon  
 Petroleum Charcoal  
 Shell Charcoal

5.6.1 Specifications. MIL-C-10202, Charcoal, Activated, Technical; MIL-C-13724, Charcoal, Activated, Impregnated, ACS; MIL-C-17605, Charcoal, Activated, Technical, Unimpregnated; and MIL-C-506, Charcoal, Activated, Powdered.



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5.6.2 Technical description. Carbon has atomic number 6 in group 4a of the periodic system. There are two allotropic forms of carbon; diamond and graphite. Charcoal, lampblack, and soot are sometimes called a third allotropic amorphous form but are actually microcrystalline forms of graphite. This standard is only concerned with activated charcoal and nonactivated charcoal (5.7). Charcoal has a black color, a specific gravity of 1.8 to 2.1, and a boiling point of 4827°C. It sublimes above 3500°C. It is insoluble in acid, alkali, or water. Activated charcoal has a large surface area due to a fine state of subdivision or porous character, so that it has a capacity for removing colored, odoriferous, and other substances from air, gas, or solution. The powdered, activated charcoal shall conform to the quantitative requirements in Table VII.

TABLE VII - Quantitative Requirements  
 (5-lb can and 50-lb drum)

	<u>Minimum</u>	<u>Maximum</u>
Moisture, percent by weight		8.0
Fineness		
Percent passing 100-mesh sieve	95.0	
Percent passing 200-mesh sieve	85.0	
Total water soluble material		
Percent by weight		3.5
pH	6.5	10.0
Iodine value (percent iodine removed)	92.5	

The chlorine demand of a thiodiglycol solution having a chlorine demand of 50 plus or minus 2 parts per million (ppm) shall be reduced a minimum of 90% by 2500 ppm of charcoal. When activated charcoal in the amount of 2,000 mg is added to one liter of water (2000 ppm suspension), the chemical characteristics of the water shall not be increased by more than 60% of the amount established by the U. S. Public Health Service Drinking Water Standards. Where limits have been established for "Amounts Not to Exceed" and "Cause for Rejection", the amounts established as "Cause for Rejection" shall be the governing factor.

TABLE VIII - Chemical and physical requirements of  
 charcoal, activated (for impregnation), technical  
 (3-lb can and 100-lb drum)

Chlorine content, %	0.35
Derivation	A/A
Form	Granular
Particle size gradation	Passing No. 8 sieve retained on No. 12 sieve, 0 to 2; passing No. 12 sieve retained on No. 16 sieve, 10 to 30; passing No. 16 sieve retained on No. 20 sieve, 40 to 65; passing No. 20 sieve, retained on No. 30 sieve, 10 to 35; passing No. 30 sieve, 0 to 2.5
Volatile matter, %	5.0

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The 3-lb cans and 100-lb drums of activated charcoal shall yield charcoal, when impregnated, which shall conform to Table VIII. See MIL-C-10202 and MIL-C-13724. The 2.1-lb polyethylene bag of activated charcoal shall be in block pellet form, and have a particle size gradation of: USS Sieve Size No. 8, 83.0% retained; and USS Sieve Size No. 16, 17.0% retained. Unimpregnated activated charcoal in 5.2-lb cloth bags shall be in granular form. This charcoal shall have a gas life of not less than 50 minutes when tested against chloropicrin (Trichloronitromethane or nitrochloroform,  $\text{CCl}_2\text{NO}_2$ ) and shall sorb not less than 50% nor more than 6% carbon tetrachloride ( $\text{CCl}_4$ ) when tested as specified in MIL-C-17605. The hardness shall not be less than 90.0, it shall have an apparent density of not more than 0.57 and not less than 0.42 grams per milliliter, and it shall contain no more than 5.0% moisture when tested as specified in MIL-C-17605. It shall have a particle size gradation conforming to Table IX.

TABLE IX - Gas sorption requirements of charcoal, activated (for impregnation), technical which has been impregnated

Agent	3-lb can and 100-lb drum Minimum life in minutes		
	Unaged (Average)	Aged (Average)	Rough handled
Arsine	45	-	-
Chloropicrin	20	-	18
Cyanogen chloride	30	40% of unaged	-
Hydrocyanic acid	25	-	-
Phosgene	25	-	-

TABLE X - Particle size gradation of unimpregnated activated charcoal (5.2-lb cloth bag)

Sieve	Percent
On No. 4	0
Thru No. 4, on No. 6	0 - 5
Thru No. 6, on No. 8	40 - 60
Thru No. 8, on No. 12	40 - 60
Thru No. 12, on No. 16	0 - 5
Thru No. 16, on No. 50	0 - 0.4
Thru No. 50	0 - 0.01

4.6.3 Use data. The intended military use of activated charcoal in the 5-pound can and 50-pound drum is for Erdlater-type military water supply equipment. Activated charcoal in the 3-pound can and 100-pound drum is for use as a base for the preparation of impregnated charcoal. The 2.1-pound polyethylene bag of charcoal is for use in nuclear submarines on a 3000-pound per square inch air filter. Charcoal in the 5.2-lb cloth bag is for use in the main filters of nuclear submarines for purification of the ambient air and in sanitary and water closet filter canisters on submarines. Typical

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commercial applications of activated charcoal include use as a precipitant in the cyanide process, precipitant of iodine and lead salts from solution, catalyst, decolorizing and filtering medium, adsorbent in recovery of volatile solvents, gas adsorbent, in gunpowder and other explosives, fuel, poultry farming, arc light electrodes, artificial leather, metallurgy, heat insulating compositions, crayons, pharmaceutical preparations, plastics, gas absorbent in refrigeration, and for decolorizing sugar.

5.6.4 Packaging data and labeling. For military use, activated charcoal is packaged in 5-pound unit quantity metal cans; in 50-pound unit quantity fiber drums with minimum three-mil-thick heat-sealed polyethylene linings; in 3-pound unit quantity cans; in 100-pound unit quantity steel drums with bolted removable heads which shall be watertight and airtight when the covers are secured; and in 2.1-pound unit quantity polyethylene bags with double cardboard containing two charges, a total of 4.2-pounds of charcoal. Activated charcoal is also packaged in 5.2-pound unit quantity cloth bags having dimensions of 12-inches by 8-inches by 5-inches. The bags are fabricated of unbleached cotton sheeting with double stitched sewn seams and square corners. After each bag has received 5.2-pounds of charcoal, the bag shall be stitched and the excess part of the bag folded to give minimum dimensions. It shall be further placed in a multilayer paper minimum size. The label shall bear the following:

- (a) Activated charcoal, Type U
- (b) Intended use data

This charcoal shall be purchased on a dry basis. According to DOT shipping regulations activated charcoal must bear a yellow label for a wet railway express shipment. This material is exempt from specification packaging, marking, and labeling requirements for transportation by rail freight, highway, or water.

5.6.5 Safety precautions. Petroleum charcoal 2.1-pound polyethylene bag size does not present any significant hazards. However, the other forms of charcoal are flammable solids. Conditions of exposure may necessitate the use of appropriate protective measures and equipment. For more specific information the appropriate safety or medical authorities must be consulted in order to determine personal protective measures and environmental controls.

5.6.6 Storage data. Store away from areas of acute fire hazard and powerful oxidizing materials. Keep this material plainly labeled.

5.6.7 Disposal data. See paragraph 4.11.

5.7 Name. CHARCOAL, NONACTIVATED, TECHNICAL, C, AW 12.0115  
Bone Charcoal  
Nonactivated Carbon

5.7.1 Specification. None.

5.7.2 Technical description. Nonactivated charcoal shall be in granular form and have any applicable particle size gradation. See paragraph 5.5.2 for technical description.

5.7.3 Use data. Nonactivated charcoal is intended for military use on the Chemical Base Laboratory, M2A1. Typical commercial applications of non-activated charcoal include use as a pigment, for rubber tires, printing, stenciling and drawing inks, leather, stone polish, phonograph records, and electrical insulating apparatus.

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5.7.4 Packaging data and labeling. For military use nonactivated charcoal is packaged in 1-pound unit quantity bottles. This material in 1-pound package is exempt from specification packaging, marking, and labeling requirements for transportation by rail freight, highway, or water. Nonactivated charcoal is a dangerous fire hazard.

5.7.5 Safety precautions. Same as 5.6.5.

5.7.6 Storage data. Same as 5.6.6.

5.7.7 Disposal data. See paragraph 4.11.

5.8 Name. COPPER, TECHNICAL, Cu, AW 63.54

5.8.1 Specification. JAN-C-768, Copper, Powdered (For Use in Ammunitions).

5.8.2 Technical description. Copper has a distinctive reddish color, a specific gravity of 8.96, melting point of 1083°C; boiling point of 2595°C. It is a complexing agent. Copper dissolves readily in nitric and hot concentrated sulfuric acid, in hydrochloric and dilute sulfuric acid slowly but only when exposed to the atmosphere. It is more resistant to atmosphere corrosion than iron forming a green layer of hydrated basis carbonate. It is readily attacked by alkalies. It is essentially nontoxic in elemental form, but as a powder, it is combustible. Copper shall be powder form, electrolytic copper with a minimum assay of 99.0%. A minimum of 99.5% shall pass through US Standard Sieve No. 200.

5.8.3 Use data. Powdered copper is intended for military use in pyrotechnic compositions. Commercial uses are alloys (brass, bronze, monel metal, beryllium-copper), alloy castings, electroplated protective coatings and undercoats for nickel, chromium, zinc, etc; and cooking utensils.

5.8.4 Packaging data and labeling. Powdered copper shall be packed in 10-pound unit quantities in suitable moisture proof cardboard drums with liners so constructed as to be acceptable to common or other carrier for safe transportation at the lowest rate to point of delivery. Each drum shall be labeled with the following.

DANGER! FLAMMABLE

Keep away from flame, sparks, or  
oxidizing agent chemicals.

In addition, each drum shall be labeled with the name, specification number, manufacturer, lot number, and date of manufacture.

5.8.5 Storage data. Store in a cool dry area away from flame, sparks, and chemicals which function as oxidizing agents. Keep drums tightly closed to prevent possible spontaneous ignition and explosion due to contact with air.

5.8.6 Safety precautions. Copper powder is considered flammable when exposed to flame, sparks, or oxidizing agents. In case of fire use powdered graphite, dolomite, sodium chloride, etc. DO NOT USE WATER. Instructions should be obtained from the commercial supplier of the copper powder.

5.8.7 Disposal data. See paragraph 4.11.

5.9 Name. IRON, TECHNICAL, Fe, AW 55.847  
Ferrum

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5.9.1 Specification. MIL-I-12058, Iron, Technical.

5.9.2 Technical description. Iron has atomic number 26 of group 8 of the periodic system. Iron is a silvery-white, tenacious, lustrous, malleable ductile metal, which when crystallized is in cubic form. It is the only metal which can be hardened by heating and sudden cooling, (tempered); heating and slow cooling make it very pliable. Iron is magnetic and can be magnetized, but soon loses its magnetism whereas steel retains it. It oxidizes rapidly (rusts) in damp or salty air and is dissolved or corroded by acids. It reacts with hot steam to yield hydrogen and iron oxides. Iron is very brittle at very low temperatures, softens at red-heat, and can be welded at white-heat. Iron is difficult to purify and the pure metal is rarely encountered and practically all commercial forms are impure in one way or another. The impurities are costly to remove or else are added to achieve desirable properties. Probably the purest form is powdered iron obtained by decomposition of iron pentacarbonyl. Pure iron has a specific gravity of 7.874 and melts at 1535°C. The boiling point is 3000°C. Iron is insoluble in water and alkali, alcohol, or ether. It is soluble in acid. Pure iron is very reactive chemically.

TABLE XI - Chemical requirements of iron

Property	Percent by weight
Assay, minimum	
Metallic iron	89.0
Total iron	97.0
Carbon	0.10
Grease and oil	0.05
Manganese	0.10
Silicon	0.10

TABLE XII - Granulation requirements of iron

<u>Granulation</u>	<u>Percent</u>
Passing through 149-micron (No. 100) sieve	99.9 min
Passing through 74-micron (No. 200) sieve	75.0 min
Passing through 44-micron (No. 325) sieve	25.0 - 50.0

5.9.3 Use data. This element is intended for military use in pyrotechnic mixtures. Typical commercial applications of this element include use in alloys. Pig iron contains about 3% carbon with S, Si, Mn, and P. It is hard, brittle, fairly fusible, and usually has a "fibrous" structure. Carbon steel is an alloy of iron with carbon, with small amounts of Mn, S, P, and Si. Alloy steels are carbon steels with other additives, such as nickel, chromium, or vanadium. Iron is the cheapest, most abundant, useful, and important of all metals.

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5.9.4 Packaging data and labeling. For military use, iron, technical is packaged in 25-pound unit quantity cans. There are no DOT shipping or labeling regulations for this material.

5.9.5 Safety precautions. Iron dust can be harmful to the lungs and eyes. Conditions of exposure may necessitate the use of appropriate protective measures and equipment. For more specific information the appropriate safety or medical authorities must be consulted in order to determine personal protective measures and environmental controls.

5.9.6 Storage data. Keep this material in tightly closed containers and away from moist, humid areas. Iron has an indefinite shelf life when stored under ideal conditions.

5.9.7 Disposal data. See paragraph 4.11.

5.10 Name. MAGNESIUM, REAGENT, Mg, AW 24.312

5.10.1 Specification. None.

5.10.2 Technical description. Reagent grade magnesium shall be in the form of ribbons or fine shavings of any size gradation. See 5.11.2 for technical description.

5.10.3 Use data. Reagent grade magnesium is intended for military use as a general laboratory reagent. Typical commercial applications are the same.

5.10.4 Packaging data and labeling. Reagent grade magnesium is packaged for military use in 1-pound unit quantity glass bottles in machine turnings form and in 1-ounce unit quantity paper packages in ribbon form. Each container shall be marked to show the minimum percent of free magnesium, the type (ribbon form or machine turnings), and shall conform to DOT shipping regulations governing the transportation of explosives and other dangerous articles. Packages shall bear a yellow label.

5.10.5 Safety precautions. Magnesium, reagent grade is a dangerous fire hazard and can cause explosions when improperly handled or stored. Magnesium is not considered a poisonous material in itself; however, if it is mixed with zinc, cyanide, arsenate, or chromate, poisonous fumes may be emitted causing skin or respiratory irritation. For specific use, consult the appropriate medical authorities for personal protective measures and environmental controls.

5.10.6 Storage data. Magnesium, reagent grade should be stored in a dry, well ventilated place away from areas of open flame and acute fire hazard, and away from powerful oxidizing agents. Containers should be kept tightly closed and plainly labeled. The shelf life under these conditions is indefinite.

5.10.7 Disposal data. See paragraph 4.11.

5.11 Name. MAGNESIUM, TECHNICAL, Mg, AW 24.312

5.11.1 Specification. MIL-M-382, Magnesium Powder (For Use in Ammunition).

5.11.2 Technical description. Magnesium is a silvery-white, malleable, moderately hard metal. It is lightest known structural metal possessing properties of permanence and stability. It oxidizes and tarnishes in moist air, but is stable in dry air. Magnesium has atomic number 12 of group 2a of the periodic system. The specific gravity is 1.738, the melting point is 651°C, and the boiling point is 1107°C. In finely divided form it is easily ignited and burns with an intense white light. The solid form

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must be heated nearly to its melting point before it will burn. Magnesium reacts very slowly with cold water to form magnesium hydroxide. This reaction accelerates very slowly as the temperature is increased to that of boiling water.

TABLE XIII - Chemical and physical requirements of  
 magnesium, technical

PROPERTY	PERCENT			
	GRADE A TYPE I	GRADE B TYPE I	TYPE II	TYPE III
Aluminum (as Al), max	-	10	-	-
Aluminum plus free metallic magnesium, min	-	96	-	-
Carbides, max	0.004	0.004	0.004	0.004
Form	Shavings, turnings, flakes, or plates	Shavings, turnings, flakes, or plates	Oblong chiplike particles with rounded edges	Granular or spheroidal particles
Free metallic, magnesium, min	96	86	96	98
Granulation - nominal, mesh size based on US Standard Sieves in accordance with RR-S-366	35 - 80 48 - 120 50- 100 80 - 120 100 - 200 140 150 and finer	200 and finer	30 to 70 (125-lb drum)	48 - 100 80 - 200 100 and finer 170 and finer 200 - 300 125-lb drum 230 - 270
Material insoluble in sulfuric acid, max	0.15	-	0.15	0.15
Material volatile at 105°C, max	0.1	0.1	0.1	0.1
Oil and grease, max	0.02	0.02	0.02	0.02
Total iron (as Fe <sub>2</sub> O <sub>3</sub> ), max	0.025	-	0.25	0.25

5.11.3 Use data. Magnesium, technical grade is intended for military use, in the manufacture of tracer, igniter, signal flare, and pyrotechnic compositions, for the filling of chemical munitions and bursting type igniters. In general, higher density material will give longer burning times. Typical commercial applications include use in the manufacture of flashlight powders; pyrotechnics; magnesium salts; ceramics; organic chemicals; optical mirrors; dies; printing plates; and in refining nickel, brass, and bronze alloys.

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TABLE XIV - Apparent density requirements of  
 magnesium, technical

Granulation (nominal sieve size)	Density in grams per milliliter		Package Size
	Minimum	Maximum	
30 to 70	0.65	0.75	12-lb drum
35 to 80	0.55	0.65	100-lb drum
48 to 100	0.90	-	100-lb drum
48 to 120	None required	-	100-lb drum
50 to 100	0.45	0.625	100-lb drum
50 to 120	None required	-	100-lb drum
80 to 200	0.90	-	100-lb drum
100 and finer	0.90	-	100-lb drum
100 to 200	None required	-	100-lb drum
140	None required	-	100-lb drum
150 and finer	None required	-	100-lb drum
170 and finer	0.90	-	100-lb drum
200 and finer	0.70	-	100-lb drum
200 to 300	0.90	-	125-lb drum
230	0.90	-	100-lb drum
270	0.90	-	100-lb drum

5.11.4 Packaging data and labeling. Technical grade magnesium is packaged for military use in 100-lb and 125-lb unit quantity drums. Unless otherwise specified in the contract or order, magnesium powder shall be shipped in unlined, full, open-head steel drums protected against corrosion and conforming to the requirements of DOT Regulations for the Transportation of Explosives and Other Dangerous Articles. Each drum shall be provided with a tubular rubber cover gasket, firmly cemented in place. When the jack-screw is tightened, the rim shall be tapped with a mallet to insure complete and proper sealing of the gasket. If a drum is to be reused for the shipment of magnesium powder, new gaskets shall be used each time. In addition, each drum reused shall pass the tests and conditions for new drums. Marking to insure safe handling shall conform to



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DOT Regulations for Transportation of Explosives and Other Dangerous Articles. Unless otherwise specified, each container shall be plainly marked with the following information: Minimum percent free metallic magnesium, type of magnesium (flaked, chip, atomized), and nominal mesh size. According to DOT shipping regulations, magnesium must be shipped as a flammable solid bearing a yellow label.

5.11.5 Safety precautions. Magnesium is not considered a dangerous material when properly handled. It is, however, a dangerous fire hazard, especially in the finely divided form. Mixtures of air and powdered magnesium are explosive. If boron trichloride gas is used as an extinguishing agent, irritating fumes may result similar to hydrochloric acid fumes. These fumes are a health hazard. For specific information concerning this aspect the appropriate safety or medical authorities must be consulted in order to determine personal protective measures and environmental controls.

5.11.6 Storage data. Magnesium, especially the fine divided form, should be stored in a dry, well ventilated place, away from areas of open flame and acute fire hazard, and away from powerful oxidizing agents. Containers should be kept tightly closed and plainly labeled. The shelf life under these conditions should be indefinite.

5.11.7 Disposal data. See paragraph 4.11.

5.12 Name. MANGANESE, TECHNICAL, Mn, AW 54.94

5.12.1 Specification. JAN-M-476, Manganese, Powdered (For Use in Ammunition).

5.12.2 Technical description. There are four allotropic forms, of which alpha is most important. It is brittle, silvery metal. The specific gravity is 7.44, Mohs hardness of 5, melting point is 1245°C, boiling point is 2097°C. It decomposes water but dissolves readily in mineral acids. Pure manganese cannot be fabricated. Manganese powder shall conform to requirements in Table XV below.

TABLE XV - Detail requirements of  
 manganese, technical

Property	Grade I % min	Grade II % min	Grade III % min
Total manganese	99.5	98.0	95.0
Free metallic manganese	99.0		
Granulation:			
Through No. 200 Sieve		98.0	99.0
Through No. 230 Sieve	100		
Through No. 325 Sieve	98		
Particles less than 10-micron diameter	50% max		

Grade I shall be ground to the proper granulation in an inert atmosphere.

5.12.3 Use data. Grade I powder is intended for use in the manufacture of delay powder. Grades II and III are intended for use in pyrotechnic mixtures. Commercially used in ferroalloys (steel manufacture), nonferrous alloys (improved corrosion resis-

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tance and hardness), high-purity salts for various chemical uses, purifying and scavenging agent in metal production.

5.12.4 Packaging data and labeling. Powdered manganese shall be packed in plain steel drums conforming to specification 17H of DOT Regulations for Transportation of Explosives and Other Dangerous Articles. Each drum shall have a removable head and shall be airtight when the cover is secured in place. The gross weight of the drum and contents shall not exceed 110-pounds. Each drum shall be labeled as follows:

CAUTION! FLAMMABLE AND TOXIC

May form hydrogen on contact with water  
or steam. Avoid inhalation of dust.

In addition, each drum shall be labeled with the name, specification number, grade number, manufacturer, lot number, and date of manufacturer.

5.12.5 Storage data. Store in a dry area away from flames and keep covers securely in place when not in use. Under these conditions, shelf life is indefinite.

5.12.6 Safety precautions. Do not expose to flame. Avoid prolonged or repeated inhalation to prevent damage to central nervous system. In case of fire use a dry chemical to extinguish. For more specific information the appropriate safety or medical authorities must be consulted in order to determine personal protective measures and environmental controls.

5.12.7 Disposal data. See paragraph 4.11.

5.13 Name. NICKEL, TECHNICAL, NI, AW 58.71

5.13.1 Specification. JAN-N-412, Nickel, Powdered (For Use In Ammunition).

5.13.2 Technical description. Nickel is a malleable, silvery metal. It is readily fabricated by hot and cold working. It has excellent resistance to corrosion, also takes high polish. Nickel has a specific gravity of 8.908, a melting point of 1455°C, and a boiling point of 2900°C. It is attacked slightly by hydrochloric and sulfuric acids, somewhat more by nitric acid. It is highly resistant to alkalis. Nickel shall be in powder form and shall have a minimum assay of 95.0 percent as free metallic nickel, 2.0 percent maximum mercury, and 0.2 percent maximum moisture. A 100-percent minimum shall pass through a No. 100 US Standard Sieve. The average particle diameter shall be  $1.5 \pm 0.5$  microns.

5.13.3 Use data. Nickel powder is intended for use in the manufacture of non-gaseous fuze powder. Commercial uses are electroplated protective coatings, electro-formed coatings, catalysts, alkaline storage battery, fuel cell electrodes, ceramics, hydrogenation of vegetable oils.

5.13.4 Packaging data and labeling. Nickel powder shall be packed in containers acceptable to common or other carrier, for safe transportation. Each container shall be labeled.

CAUTION! FLAMMABLE AND TOXIC

Do not expose to flame, sparks, or chemicals  
which function as oxidizing agents. Avoid  
breathing dust.

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In addition, each container shall have a yellow label provided in accordance with DOT Regulations. Each container shall also be labeled with the name, specification number, manufacturer, lot number, and date of manufacture.

5.13.5 Storage data. Store in an area away from flames, sparks and chemicals which act as oxidizing agents. Under the above condition the shelf life is indefinite.

5.13.6 Safety precautions. This material is a moderate fire hazard when exposed to heat and flame or by chemical reaction with oxidizing agents. Avoid prolonged or repeated breathing of dust. Conditions of exposure may necessitate the use of appropriate protective measures and equipment to be determined by the proper medical or safety authorities.

5.13.7 Disposal data. See paragraph 4.11.

5.14 Name. PHOSPHORUS, RED, ANALYZED REAGENT, P, AW 30.7738  
P<sub>4</sub>, AW 123.8952

5.14.1 Specification. O-C-265.

5.14.2 Technical description. Reagent grade red phosphorus shall have a minimum assay of 99.0% by weight and the maximum impurities shall be limited to 0.6% by weight residue on ignition. See 5.15.2 for technical description.

5.14.3 Use data. Reagent grade red phosphorus is intended for military use as a general laboratory reagent. Typical commercial applications are the same.

5.14.4 Packaging data and labeling. Reagent grade red phosphorus for military use is packaged in  $\frac{1}{4}$ -pound unit quantity cans and shipped in 11-pound unit quantity maximum lots. All containers shall be shipped as a flammable solid bearing a yellow label and shall be marked in accordance with MIL-STD-129.

5.14.5 Safety precautions. See paragraph 5.15.5 for safety precautions.

5.14.6 Storage data. See paragraph 5.15.6 for storage data.

5.14.7 Disposal data. See paragraph 4.11.

5.15 Name. PHOSPHORUS, RED, TECHNICAL, P, AW 30.9738  
Phosphorus P<sub>4</sub> AW 123.8952  
Red Phosphorus

5.15.1 Specifications. MIL-P-211, Phosphorus, Red, Technical and MIL-P-670, Phosphorus, Red, Stabilized.

5.15.2 Technical description. Phosphorus has atomic number 15 of group 5a of the periodic system. It is a nonmetallic element that exists in several allotropic forms. These are white or yellow phosphorus, black phosphorus, and red phosphorus. This standard is concerned only with the red form. Red phosphorus is an amorphous, reddish-brown crystals of cubic form. The specific gravity is 2.34, it sublimates at 417°C, and the melting point is 590°C at 43 atmosphere of pressure. This material ignites in air at about 260°C. Red phosphorus is very slightly soluble in cold water, insoluble in hot water, carbon disulfide, ether, or ammonia. It is soluble in absolute alcohol. This form of phosphorus is obtained from white phosphorus by heating at 240-250°C in the presence of a catalyst, such as iodine. Red phosphorus does not ignite spontaneously, does not glow in the air, and is not poisonous like the white variety. Phosphorus under

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MIL-P-211 shall have the following granulation: 98.0% minimum shall pass through a US Standard Sieve Size No. 100 (149-micron) sieve and no more than 0.1% by weight shall be retained on a No. 40 (420-micron) sieve. Aluminated phosphorus under MIL-P-670 shall have the following granulation: Before alumination - phosphorus shall have 3% maximum of particles less than 10-micron diameter, and After alumination - powder shall pass through the following sieves: US Standard Sieve No. 100, 98.0% minimum; US Standard Sieve No. 140, 85.0% minimum; and US Standard Sieve No. 325, 50 ± 20%.

TABLE XVI - Chemical requirements of  
 red phosphorus, technical

<u>Requirements</u>	<u>MIL-P-211</u>	<u>MIL-P-670</u>
Assay (as red phosphorus), min	99.0	93.0
Acidity (as H <sub>3</sub> PO <sub>4</sub> )	0.10	-
White phosphorus	0.02	0.01
Moisture	0.20	-
Copper ppm, max		50
Iron ppm, max		50
Copper and iron product content ppm, max		125
Alumina (as Al(OH) <sub>3</sub> ) percent		2.5 ± 0.5

5.15.3 Use data. Red phosphorus, technical is intended for military use in pyrotechnic mixtures. Typical commercial applications of phosphorus include use of its compounds in gasoline additives, animal feeds, fertilizers, detergents, soaps, and for the prevention of boiler scale and corrosion in pipes and boiler tubes. Red phosphorus is used in the manufacture of matches. Phosphorus is used to manufacture phosphoric acid and its derivatives some of which are used for phosphor bronzes and metallic phosphides, additives to semiconductors, and in electroluminescent coatings.

5.15.4 Packaging data and labeling. Red phosphorus under MIL-P-211 is packaged in 100-pound unit quantity metal drums of approximately 11-gallon capacity conforming to the requirements of DOT specifications. Red phosphorus under MIL-P-670 shall be packaged in hermetically sealed tinned cans of approximately 10-lb capacity. Containers shall conform to DOT Regulations (see Code Federal Regulations CFR 71-90). Red phosphorus is shipped as a flammable solid bearing a yellow label. Containers shall be marked in accordance with MIL-STD-129.

5.15.5 Safety precautions. Red phosphorus is a flammable solid and dangerous fire hazard. It is considered less dangerous than white phosphorus; however, it can give rise to many of the same poisonous symptoms. Inhalation of the fumes from burning are irritating to the nose, throat, lungs, skin, and eyes. Never leave sticks or containers of this element in a dry state out in the air unattended for long periods of time. Fires may be controlled by water in the form of fog or spray, carbon dioxide extinguishers, or by smothering with sand or earth. If swallowed induce vomiting at once and get medical aid. Periodic physical examinations are recommended for personnel who continually handle this material. For more specific information the appropriate safety or medical authorities must be consulted in order to determine personal protective measures and environmental controls.

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5.15.6 Storage data. Store in a cool, ventilated area out of the direct rays of the sun and away from powerful oxidizing agents and acute fire hazards. Personnel should be cautioned regarding the opening and handling of containers of phosphorus. It requires special packaging (see 5.10.4). It can safely be stored under water. Never store near food or food stuffs. Under these ideal conditions the shelf life is indefinite.

5.15.7 Disposal data. See paragraph 4.11.

5.16 Name. PLATINUM, ANALYZED REAGENT, Pt, AW 195.09

5.16.1 Specification. MIL-P-14030, Platinum, Analyzed Reagent.

5.16.2 Technical description. Platinum has atomic number 78 of group 8 of the periodic system. Platinum is a tin-white metal of metallic luster. It is tenacious, malleable, and ductile. It is welded at red heat and has a coefficient of expansion approximately equal to that of glass. Platinum, when crystallized is in cubic form. It has a specific gravity of 21.45, a melting point of 1769°C, and a boiling point of 3827 ± 100°C. It will not oxidize in air at any temperature but is corroded by halogens, cyanide, sulfur, and caustic alkalis. It is of course insoluble in water and also in hydrochloric or nitric acids unless these two acids are mixed to form aqua regia. Platinum dissolves in aqua regia forming chloroplatinic acid ( $H_2PtCl_6$ ), a very important compound. Platinum is harder than silver or gold, the Brineil hardness being hard 97, annealed 42. Platinum black or platinum Mohr is a finely divided black powder of metallic platinum. Platinum, analyzed reagent, shall be in the form of silver-white metal scraps. The material shall contain 0.0000 percent by weight of silver and 0.01 maximum percent by weight of other metals.

5.16.3 Use data. Platinum, analyzed reagent, is intended for military use as a chemical reagent. Typical commercial applications of platinum include use in laboratory ware, of all kinds, industrial equipment, spinnerets for rayon manufacture, jewelry, dentistry, electrical contacts, thermocouples, electroplating, high temperature furnace lining, and as a catalyst (such as in the contact process for sulfuric acid and in the production of gasoline).

5.16.4 Packaging data and labeling. For military use, platinum, analyzed reagent, is packaged in 10-gram unit quantity screw-cap, nonactinic glass bottles. A uniform number of bottles shall be packed in boxes, the weight of each box including the contents shall not exceed 40-pounds. There are no DOT shipping regulations for platinum.

5.16.5 Safety precautions. Platinum, analyzed reagent does not require any special precautions.

5.16.6 Storage data. Store platinum in well closed, nonactinic glass bottles. This material needs no other special storage conditions and has an indefinite shelf life.

5.16.7 Disposal data. See paragraph 4.11.

5.17 Name. POTASSIUM, REAGENT K AW 39.102  
Kalium

5.17.1 Specification. EA PD 4-194, Potassium, Reagent.

5.17.2 Technical description. Potassium has atomic number 19 of group 1a of the periodic system. Potassium is a soft silvery metal which, when crystallized is in cubic form. It is one of the alkali metals which rapidly oxidizes in moist air and

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ignites spontaneously if warm enough. It reacts vigorously with water, acids, or halogens. The specific gravity is 0.862, the melting point is 63.65°C, and the boiling point is 774°C. In water it decomposes to potassium hydroxide. It is soluble in liquid ammonia, aniline, mercury, or sodium. Potassium is one of the most reactive and electropositive of metals. Except for lithium, it is also the lightest known metal. It is soft enough to be cut with a knife and silvery on a fresh surface which oxidizes rapidly in air. To prevent oxidation, potassium must be preserved in a mineral oil, such as kerosene. Like all metals of the alkali group, it decomposes in water with the evolution of hydrogen. It catches fire spontaneously on water. Potassium and its salts impart a violet color to flames. Potassium metal makes up 2.4% by weight of the earth's crust and is the seventh most abundant metal. Potassium, analyzed reagent, shall be soft lumps or sticks, and the freshly cut surface shall be silvery-white, rapidly changing to dull gray.

TABLE XVII - Chemical requirements of potassium

<u>Property</u>	<u>Percent</u>
Chloride (Cl)	0.010
Heavy metals	To pass test
Nitrogen (as NH <sub>3</sub> )	0.010
Sodium (Na)	To pass test
Sulfate (SO <sub>4</sub> )	0.010

5.17.3 Use data. This material is intended for use by the military as a chemical reagent. Typical commercial applications of potassium include use for the preparation of potassium peroxide; and heat exchange alloys (NaK). Potassium salts of importance include the hydroxide, nitrate, carbonate, chloride, chlorate bromide, iodide, cyanide, sulfate, and dichromate.

5.17.4 Packaging data and labeling. Potassium, analyzed reagent is packaged for military use in ¼-pound unit quantity screw-capped glass bottles. Each bottle shall be labeled:

**DANGER!**

Potassium (metal). Reacts violently with water, liberating and igniting hydrogen. May cause burns. Keep from possible contact with water. Keep container tightly closed. Do not get in eyes or on skin. Wear goggles and DRY gloves when handling.

In addition, each bottle shall be labeled to show the maximum impurities of the contents, manufacturer, lot number, and date of manufacture. A permanent waterproofed tag shall be affixed to each package listing the stock number, nomenclature, and quantity. In addition, to any special marking required by the contract or order, all shipping containers shall be marked in accordance with DOT regulations for the Transportation of Explosives and Other Dangerous Articles. Potassium must be shipped in wooden boxes, with air tight metal inside containers which must have a closing device securely fastened by positive means (not friction); in metal barrels or drums; or immersed in enral oil in wooden boxes with inside metal drums, single-trip, having welded side seams, net weight not over 30-lbs, or with inside glass containers, each inclosed in a tin container. In accordance with DOT shipping regulations, potassium is shipped as a flammable solid bearing a yellow label in 25-lb maximum unit quantity lots. There are no exceptions.

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5.17.5 Safety precautions. Potassium is a dangerous fire and explosion hazard; it reacts very violently with water liberating hydrogen, which can ignite spontaneously from the heat of reaction and cause explosions and fires. This material can also burn spontaneously when ignited in oxygen or air. It burns violently, melting and spattering causing burns, fires and explosions. The fumes evolved are irritating to the eyes, skin, and nose. Fires of potassium are difficult to extinguish. Potassium that contacts the skin must be removed at once and the area flushed and washed with soap and water. If the eyes are affected, they should be washed with water for at least 15 minutes. For more specific information, the appropriate authorities must be consulted in order to determine personal protective measures and environmental controls.

5.17.6 Storage data. Store potassium in inert atmospheres, such as nitrogen or argon; or under oxygen-free liquids, such as kerosene or toluene; or in glass capsules which have been filled under a vacuum or inert atmosphere and sealed before oxygen or moisture can enter. It should be stored in a detached fireproof building. It should not be stored where it can contact moisture, powerful oxidizing materials, or high temperatures. Under these conditions, the shelf life is indefinite.

5.17.7 Disposal data. See paragraph 4.11

5.18 Name. SELENIUM, ANALYZED REAGENT      Se      AW 78.96

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

5.18.2 Technical description. Selenium has atomic number 34 of group 6a of the periodic system. It exists in several allotropic forms, three of which are generally recognized but as many as six have been claimed. It can be amorphous or crystalline. Amorphous selenium is red in powder form and black in vitreous form. Crystalline mono-clinic selenium is deep red. The most stable variety, crystalline hexagonal selenium, is metallic gray. Selenium has a very high luster. The specific gravity is 4.79 (20/4°C), the melting point is 217°C, and the boiling point is 684.9±1.0°C. It is insoluble in water or alcohol. It is soluble in sulfuric acid or chloroform. It is very slightly soluble in carbon disulfide. Selenium burns in air with a bluish-red flame, forming selenium dioxide. In minute amounts, it seems to be an essential nutrient but is poisonous in large amounts. Selenium, analyzed reagent shall be dark red amorphous powder or a bluish-black crystalline powder and the material furnished shall not be older than one year from date of manufacture.

TABLE XVIII - Chemical requirements of selenium

<u>Property</u>	<u>Max % by wt</u>
Heavy metals (as Pb)	0.010
Iron (Fe)	0.005
Nitrogen (N)	0.005
Residue on ignition	0.2
Sulfur (S)	0.05

5.18.3 Use data. This element is intended for military use as a general laboratory reagent. Typical commercial applications of selenium include use in the rubber industry as a vulcanizing agent, as a stabilizer in lubricating oils, stainless steels, and in

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the glass industry for making red glass. This element is a member of the sulfur family which it resembles in its compounds and various forms. It exhibits photo-conductive action, where electrical resistance decreases with increased illumination; and photovoltaic action, where light is converted directly into electricity. Selenium is useful in the production of photocells, exposure meters for photographic use, and solar cells because of these properties. It is a p-type semiconductor below its melting point and is finding use in solid state and electronic applications. It is used for copying and reproducing documents. It is also used as a photographic toner and in the fireproofing of electric cable.

5.18.4 Packaging data and labeling. Selenium, analyzed reagent is packaged in  $\frac{1}{2}$ -lb unit quantity screw-capped glass bottles. The bottles shall be sealed with a self-shrinking plastic film or comparable plastic tape as a secondary closure. It shall be cushioned on all sides with vermiculite not less than  $\frac{3}{4}$ -inch thick. The bottle shall be placed in a telescoping type of water-resistant fiber can which is sealed with pressure-sensitive tape. Each bottle shall be labeled: "WARNING! Harmful dust. Avoid breathing dust and prolonged skin contact." In addition, each bottle shall bear a label showing the name of contents, the analysis or maximum impurities of the contents, the manufacturer's lot number, and the date of manufacture. Each package shall have a permanent waterproofed label or tag firmly affixed there to listing the stock number, nomenclature, and quantity. There are no DOT shipping regulations for selenium.

5.18.5 Safety precaution. Selenium is a hazardous material, it combines with hydrogen to form hydrogen selenide, a poisonous flammable gas with a very offensive odor similar to rotten horseradish. Breathing of selenium dust or prolonged skin contact may be harmful. For more specific information, the appropriate safety or medical authorities must be consulted in order to determine personal protective measures and environmental controls.

5.18.6 Storage data. Store this material in tightly closed glass bottles. This reagent decomposes during storage and after one year should be analyzed to determine if it is still suitable for exacting laboratory applications.

5.18.7 Disposal data. See paragraph 4.11.

5.19 Name. SILICON, TECHNICAL S1 AW 28.086

5.19.1 Specification. MIL-S-230, Silicon, Powdered, Technical

5.19.2 Technical description. Silicon is the second most abundant element (25% of the earth's crust). It occurs as dark colored crystals. In the octahedral form the atoms have the diamond arrangement. The so-called amorphous form consists of minute crystals. Silicon is soluble in a mixture of nitric and hydrofluoric acids and in alkalis. It is insoluble in water, nitric and hydrochloric acid. This standard covers two grades and four classes of powdered silicon. Chemical requirements are listed in the following Table.

TABLE XIX - Chemical requirements of silicon, technical

<u>Requirement</u>	<u>Grade I</u>	<u>Grade II</u>
Silicon, min % by wt	97.0	96.5
Iron, max % by wt	1.00	-
Aluminum, max % by wt	1.00	-



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Granulation requirements are listed in the following Table.

TABLE XX - Granulation characteristics

Sieve Size	Percent by weight passing			
	Grade I Class A	Grade I Class B	Grade II Class C	Grade I Class D
149-micron (No. 100), min	99.0	-	-	99.0
88-micron (No. 170), min	-	-	98.0	-
74-micron (no. 200), min	80.0	99.0	-	-
62-micron (No. 230), min	-	-	90.0	-
62-micron (No. 230), max	-	-	-	50.0

5.19.3 Use data. Silicon is intended for use as an ingredient in pyrotechnic compositions. Commercial uses are alloying agent for steels, aluminum, bronze, copper, and iron (ferrosilicon); production of halogenated silanes, organo-silicon compounds (silicone resins), deoxidizer in steel manufacture, and as a semiconductor in electronic systems.

5.19.4 Packaging data and labeling. Silicon shall be packed in 500-lb unit quantity steel drums conforming to DOT Specification 17H. Interior surfaces of the drum shall be dry and free of rust, oil, grease, and other foreign matter. Each drum shall be labeled in accordance with MIL-STD-129 and as follows:

KEEP COOL AND DRY!

In addition, each drum shall be labeled with the name, specification number, lot number, manufacturer, and date of manufacture.

5.19.5 Safety precautions. Powdered silicon when exposed to heat or flame or by chemical reaction with oxidizing agents, is a moderate fire hazard. Conditions of exposure may require the use of appropriate protective measures and equipment to be determined by the proper medical or safety authorities.

5.19.6 Storage data. Store in a cool, dry area. Under these conditions the shelf life is indefinite.

5.19.7 Disposal data. See paragraph 4.11.

5.20 Name. SULFUR, TECHNICAL      S      AW 32.064  
 Brimstone                              S<sub>8</sub>      AW 256.512  
 Flowers of sulfur  
 Sulfur Flour  
 Sulfur Flowers

5.20.1 Specification. MIL-S-487, Sulfur, Ground, (For Use In Ammunition).

5.20.2 Technical description. Sulfur has atomic number 16 of group 6a of the periodic system. In the gas, liquid, or solid state, elemental sulfur occurs in more

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than one allotropic form or modification. These present a confusing multitude of forms whose relations are not yet fully understood. There are at least two stable crystalline forms, two amorphous, and two liquid forms. This standard is concerned with the alpha form only which occurs as powder or rhombic octahedral yellow crystals which are stable at room temperature. The specific gravity is 2.07, the autoignition temperature is 450°F, the melting point with rapid heating is 112.8°C, the flash point is 405°F in a closed cup, the refractive index is 1.957, and the boiling point is 444.6°C. It changes to the beta form at 94.5°C. It is soluble in carbon disulfide, carbon tetrachloride, or benzene. It is slightly soluble in alcohol, toluene, ether, or liquid ammonia. It is insoluble in water. Sulfur, technical grade shall be in powder form and have the following gradations: USS Sieve No. 100, 99.5 minimum percent passing and USS Sieve No. 200, 95.0 minimum percent passing.

TABLE XXI - Chemical and Physical Properties  
 of sulfur

Requirement	Percent by weight				
	Grade A	Grade B	Grade C	Grade D	Grade E
Sulfur, min	99.5	99.5	99.5	99.8	99.5
Moisture, max	0.20	0.10	0.10	0.05	0.10
Acidity, as H <sub>2</sub> SO <sub>4</sub> , max	0.01	0.002	0.002	0.002	0.01
Ash, max	0.10	0.10	0.10	0.05	0.10
Chlorides, as NaCl, max	0.01	0.01	0.01	0.01	0.01
Sulfates, as Na <sub>2</sub> SO <sub>4</sub> , max	-	-	-	0.003	
Particle size:					
Through USS Sieve No. 100, min	98.0	99.5	99.7	99.0	99.0
Through USS Sieve No. 200, min	88.0	95.0	97.0	90.0	85.0 - 95.0
Through USS Sieve No. 325, min	-	-	93.0	80.0	-
Ammonia and ammonium salts	-	0	0	-	0

5.20.3 Use data. The 1-pound bottle and 5-pound bottle are intended for use by the military as general laboratory reagents. Bulk density units are intended for use by the military in black powder, nongaseous powder, primer compositions, and pyrotechnic compositions. The specification requirements are such as to prevent the addition of conditioning agents. Typical commercial applications of sulfur include use for making sulfuric acid (the most important manufactured chemical), in pulp and paper, agricultural fungicide, carbon disulfide, other chemicals and dyes, rubber vulcanization, fumigation, medicine, black gunpowder, and in bleaching dried fruits.

5.20.4 Packaging data and labeling. Sulfur, technical for military use, is packaged in 1 and 5-lb unit quantity glass bottles and in bulk quantity.

5.20.5 Safety precautions. Sulfur is a moderate fire hazard as when the vapors or dust are mixed with air they are flammable and can cause fires and explosions. Water may be

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used to fight fires of this material. Conditions of exposure may necessitate the use of appropriate protective measures and equipment to be determined by the proper medical authorities.

5.20.6 Storage data. Store sulfur in a cool, ventilated area away from open flame, acute fire hazards, and powerful oxidizing agents. Under these conditions, the shelf life is indefinite.

5.20.7 Disposal data. See paragraph 4.11.

5.21 Name. TELLURIUM, REAGENT Te AW 127.60

5.21.1 Specification. None.

5.21.2 Technical description. Tellurium has atomic number 52 of group 6a of the periodic system. It is a silvery-white lustrous solid with metal characteristics and when crystallized is in rhombic form. The amorphous form is brownish-black. Tellurium has a refractive index of 1.0025, the specific gravity is 6.24, the melting point is  $449.5 \pm 0.3^\circ\text{C}$ , and the boiling point is  $989.8 \pm 3.8^\circ\text{C}$ . It is soluble in sulfuric acid, nitric acid, aqua regia, potassium cyanide solution, or potassium hydroxide. Tellurium, reagent shall be in purified stick form for military use.

5.21.3 Use data. Tellurium, reagent is intended for military use as a general laboratory reagent. Typical commercial applications of tellurium include use in thermoelectric devices (bismuth telluride), as a secondary vulcanizing agent in the rubber industry, and as a coloring agent in glass and ceramics. It improves the machinability of stainless steel and when alloyed with lead, the lead has more strength, hardness, and resistance to corrosion.

5.21.4 Packaging data and labeling. Tellurium, reagent is packaged in  $\frac{1}{4}$ -lb unit quantity glass bottles for military use. There are no DOT shipping regulations for tellurium.

5.21.5 Safety precautions. This material in the form of dust, when exposed to heat or flame or by chemical reaction with oxidizing agents, is a moderate fire hazard. Elemental tellurium, when inhaled as dust, imparts an objectionable garlic odor to the breath. Conditions of exposure may necessitate the use of appropriate protective measures and equipment to be determined by the proper medical or safety authorities.

5.21.6 Storage data. See bismuth (paragraph 5.4.6). Under these ideal conditions the shelf life is indefinite.

5.21.7 Disposal data. See paragraph 4.11.

5.22 Name. TIN, TECHNICAL Sn AW 118.69  
Stannum  
White tin

5.22.1 Specification. MIL-T-458, Tin, Pulverized.

5.22.2 Technical description. Tin is a silver-white, ductile solid (beta form). The density ( $20^\circ\text{C}$ ) is 7.29. It has a melting point of  $232^\circ\text{C}$  and a boiling point of  $2260^\circ\text{C}$ . It changes to brittle grey (alpha) tin at temperatures below  $18^\circ\text{C}$  but the transition is normally very slow. Tin is soluble in acids and in hot potassium hydroxide solution. It is insoluble in water. Elemental tin has low toxicity, but most tin compounds are toxic. Tin covered by this standard shall be powder (pulverized) form and shall have

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99.0 percent minimum purity. Tin shall conform to the following granulation.

TABLE XXII - Granulation requirements

Through Sieve No.	Percent, minimum
80	100.0
100	99.5
200	98.0
230	95.0
325	93.0

5.22.3 Use data. Powdered tin is intended for use in smokeless powder. Commercial uses are hot-dipped coatings, cladding, solders, low melting alloys for fire control, dental amalgams and manufacturing of chemicals.

5.22.4 Packaging data and labeling. Tin shall be packed in steel kegs, steel drums, or steel pails of type, size, and construction to insure acceptance and safe delivery by common or other carrier, at the lowest rate, to the point of delivery. Containers shall be marked in accordance with MIL-STD-129. In addition, each container shall be marked with the name, specification number, manufacturer, lot number, and date of manufacture.

5.22.5 Safety precautions. Tin, technical does not pose a significant hazard, however, normal hygiene measures should be followed when handling this material.

5.22.6 Storage data. Store pulverized tin away from areas of acute fire hazard, open flame, or powerful oxidizing agents. Under these conditions, the shelf life is indefinite.

5.22.7 Disposal data. See paragraph 4.11.

5.23 Name. TITANIUM, TECHNICAL T1 AW 47.90

5.23.1 Specifications. MIL-T-13405, Titanium, Technical, Powdered.

5.23.2 Technical description. Titanium, Technical has atomic number 22 of group 4b of the periodic system. Titanium is a silvery-metal or dark gray amorphous powder. The specific gravity is 4.54; the melting point is 1675°C; the boiling point is 3260°C; the linear coefficient of thermal expansion is  $5.0 \times 10^{-6}/^{\circ}\text{F}$ ; the specific heat is 0.13  $\text{btu} \cdot \text{ft}^2/\text{in.}^2 \cdot ^{\circ}\text{F}/\text{hour}$ ; the tensile strength is up to 125,000 lbs per square inch at room temperature, 96,000 lbs per square inch at 400°F, and 20,000 lbs per square inch at 1000°F. Titanium is very hard and will scratch steel. It has excellent resistance to atmosphere and seawater corrosion. It is resistant to dilute sulfuric or hydrochloric acid, most organic acids, moist chlorine gas, and chloride solution. It is reactive when hot or molten. It is insoluble in cold water and decomposes in hot water. Titanium is ductile only when it is free of oxygen. The metal burns in air and is the only element that burns free of oxygen. The metal is dimorphic. The hexagonal alpha form changes to the cubic beta form very slowly at about 880°C. The metal combines with oxygen at red heat, and with chlorine at 500°C. Titanium, technical grade shall have a minimum assay of 94.0 percent by weight when tested on a dry basis. The material shall burn completely in 40 to 180 seconds when tested as specified in the applicable specification.

5.23.3 Use data. This material is intended for military use in pyrotechnics. Typical commercial applications of titanium include use as metal or alloy (especially ferro-

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titanium), as a structural material in aircraft, jet engines (replacing steel in missile frames), marine equipment, textile, machinery, chemical equipment, surgical instruments, orthopedic appliances, sporting equipment, food handling equipment, in X-ray tube targets, abrasives, ceramics, metal ceramic brazing, and in nickel-cadmium batteries for space vehicles. Titanium compounds are used in pigments (titanium dioxide), electronics, smoke clouds, porcelain enamels, fire retardants, waterproofing agents, and gems.

5.23.4 Packaging data and labeling. For military use titanium shall be packaged in 1-gallon unit quantity cans. Not less than 5-lbs or more than 5-lbs 2-ounces of titanium shall be packaged in a polyethylene bag having a nominal thickness of 0.001 inch. Sufficient water shall be added to the titanium to comply with the Regulations for the Transportation of Explosives and Other Dangerous Articles. The bag shall be heat sealed and placed in a 1-gallon can. The requirement for balls and lugs on the cans may be waived at the discretion of the contracting officer. According to DOT shipping regulations, titanium is shipped as a wet powder (with not less than 20% water) or dry as a flammable solid bearing a yellow label.

5.23.5 Safety precautions. Dry titanium powder ignites in air above 250°C. It can be ignited by static sparks and by grinding. For more specific information the appropriate safety or medical authorities must be consulted in order to determine personal protective and environmental controls.

5.23.6 Storage data. Store titanium in a cool, ventilated area away from acute fire hazards and out of the direct rays of the sun. Containers should be kept closed and plainly labeled. Under these conditions the shelf life is indefinite.

5.23.7 Disposal data. See paragraph 4.11.

5.24 Name. ZINC, TECHNICAL      Zn      AW 65.37

5.24.1 Specification. MIL-E-365, Zinc - Dust.

5.24.2 Technical description. Zinc is a shining white metal with bluish gray luster. It is not found native. Zinc is soluble in acids and alkalis. It is insoluble in water. Zinc has a specific gravity of 7.14; a melting point of 419°C, a boiling point of 907°C. It is malleable at 100 to 150°C and is strongly electropositive. Zinc covered by this standard is in powder form and commercially known as zinc dust. Zinc dust shall conform to the following chemical requirements in Table XXIII.

TABLE XXIII - Chemical requirements

<u>Property</u>	<u>Percent</u>	
	<u>Maximum</u>	<u>Minimum</u>
Total zinc, calculated as Zn		97.5
Metallic zinc		94.0
Zinc oxide	6.0	
Impurities (other than zinc oxides)	2.0	
Moisture & other volatile matter	0.1	
Moisture soluble in organic solvent mixture	0.0	

Zinc - dust shall conform to the granulation requirements of the following.

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TABLE XXIV - Granulation requirements

<u>Sieve No.</u>	<u>Percent through, min</u>
100	99
200	90
230	75

24.3 Use data. Zinc - dust is intended for use in pyrotechnics. Commercial uses are in zinc salts and other zinc compounds, reducing agent, precipitating agent, purifier, catalyst, rust-resistant paints, bleaches, soot removal, pipe thread compounds, deradizing, decorative effect in resins and in autobody coatings.

24.4 Packaging data and labeling. Zinc - dust shall be packaged in clean, dry drums of the size and type specified by the purchase order or contract. Drums shall be marked in accordance with MIL-STD-129. Each drum shall be labeled with the name, specification number, manufacturer, lot number, and date of manufacture.

24.5 Safety precautions. Zinc - dust is a dangerous fire risk. It may form explosive mixtures with air. In bulk when damp, it may heat and ignite spontaneously on exposure to air. Do not expose to flame, sparks or oxidizing materials. Avoid prolonged or repeated breathing of dust. In case of fire, do not use water. Use powdered graphite, dolomite, sodium chloride, etc. Get instructions from the supplier of the zinc-dust.

24.6 Storage data. Store in a cool dry area away from heat, flame, or oxidizing materials. Under these conditions, the shelf life is indefinite.

24.7 Disposal data. See paragraph 4.11.

25. Name. ZIRCONIUM, TECHNICAL      Zr      AW 91.22

25.1 Specification. MIL-Z-399, Zirconium (Granular and Powdered).

25.2 Technical description. Zirconium is a hard, lustrous, grayish, crystalline metal or gray amorphous powder; specific gravity is 6.4; melting point is about 1850°C; boiling point is 4377°C; and is soluble in hot, very concentrated acids, but insoluble in water and cold acids. It has corrosion-resistance, low neutron absorption, and low toxicity. Zirconium covered by this standard shall be granular form of three (3) classes, and powdered form of four classes. Type I zirconium shall conform to the particle size requirements specified in Table XXV, and Type II zirconium shall conform to the particle size requirements specified in Table XXVI.

TABLE XXV - Particle size requirement for  
 Type I Zirconium

Sieve	Percent by weight		
	Class 1	Class 2	Class 3
Through No. 20 sieve (840-microns)	99 min		
Through No. 60 sieve (250-microns)	5 max		
Through No. 80 sieve (177-microns)		100	
Through No. 100 sieve (149-microns)		98 min	
Through No. 170 sieve (88-microns)			100
Through No. 200 sieve (74-microns)		50 max	98 min
Through No. 325 sieve (44-microns)		25 max	

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TABLE XXV (CONT'D)

Sieve	Percent by weight		
	Class 1	Class 2	Class 3
<u>Subsieve</u>			
Less than 20 microns			10.0 max
Less than 10 microns		2.0 max	

TABLE XXVI - Particle size requirements for  
 Type II Zirconium

Sieve	Percent by weight			
	Class 1	Class 2	Class 3	Class 4
Through No. 120 sieve (125 microns)	100	100	99.5min	100
Through No. 200 sieve (74 microns)	99 min	99 min		99 min
Through No. 26 sieve (Buckbee Mears)	96 min	96 min		96 min
<u>Subsieve</u>				
Less than 9 microns	85 min	85 min		85 min
3 microns	70-90	70-90		33 - 100
0.75 microns	12-30	12-30		20 max
Average particle size, microns	2.5 ± 1.0	2.0 ± 0.3	3.0 ± 1.0	
Surface area (B.E.T.)				1.10 - 1.60 sq meters per gram

The zirconium shall conform to the chemical requirements as specified in Table XXVII.

TABLE XXVII - Chemical requirements

Requirement Percent	Type II				
	Type I	Class 1	Class 2	Class 3	Class 4
Total zirconium, min	96.0	94.0	95.0	95.0	94.0
Calcium, max	0.05	0.10	0.05	0.05	0.10
Iron, max	0.30	0.20	0.03	0.05	0.20
Aluminum, max	0.10	0.30	0.15	0.10	0.30
Hydrogen, max	0.20	0.20	0.20	--	0.17
Chloride, (as Cl), max	0.03				
Silicon, max	0.10				
Tin, max	0.75				
Ignition gain		30.2 - 33.0	30.2 - 33.0	30.2 - 33.0	30.0 - 33.0

5.25.3 Use data. Zirconium is intended for military use in pyrotechnic and special ignition compositions. Commercial uses are in nuclear technology, corrosion-resistant

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alloys, photoflash bulbs (foil), pyrotechnics, metal to glass seals, special welding fluxes, getter in vacuum tubes, explosive primers, acid manufacturing plants, deoxidizer and scavenger in steel manufacture.

5.25.4 Packaging data and labeling. The zirconium shall be thoroughly mixed with water to form a slurry containing not less than 25% by weight of water. It must be packed in wooden boxes, DOT specification 17A or 15B, with inside containers of glass or non-carbon polyethylene having net weight of not over 10-lbs each. In order to prevent freezing during shipment or storage in low temperature climates, the zirconium slurry shall contain not less than 25% by weight of methyl alcohol-water solution or other anti-freeze mixture approved by the contracting officer, and which has a freezing point of  $-30^{\circ}\text{F}$  ( $-34^{\circ}\text{C}$ ). The zirconium shall be packed for shipment in accordance with the latest DOT rules and regulations for the transportation of hazardous materials. Each container should be durably and legibly marked to read:

Zirconium Metal Powder (Minimum 25% water).  
DANGER! Flammable solid. May explode if water content is 10% or below. Keep wet in storage - dry powder may be ignited by friction, static electricity, or heat. Do not attempt to loosen or remove material from container with any tool. Keep away from heat, sparks, and open flame. Keep from freezing. In case of spillage, keep wet and remove carefully. In case of fire, smother with foam-type fire extinguisher or sand. Do not use carbon tetrachloride,  $\text{CO}_2$ , extinguishers or water. Wear goggles or face shield and fire-retardant clothing when handling.

Each container shall be marked with specification number, type number, and class number, manufacturer, lot number, and date of manufacture.

5.25.5 Safety precautions. See marking instructions in paragraph 5.25.4 for appropriate safety precautions.

5.25.6 Storage data. Store in accordance with instructions listed in marking requirements in paragraph 5.25.4. Under these conditions, the shelf life is indefinite.

5.25.7 Disposal data. See paragraph 4.11.

NOTICE. - Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.

ASSIGNEE ACTIVITY: GS

PREPARING ACTIVITY: ARMY - EA

CUSTODIANS: ARMY - EA  
NAVY - AS  
AIR FORCE - 68

REVIEW ACTIVITIES: ARMY - MD, ME, WC  
NAVY - AS, OS  
AIR FORCE - 68

USER ACTIVITIES: ARMY - MU, WV  
NAVY - MC, SH

Project No. 6810-0932



**STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL**

OMB Approval  
 No. 22-R255

**INSTRUCTIONS:** The purpose of this form is to solicit beneficial comments which will help achieve procurement of suitable products at reasonable cost and minimum delay, or will otherwise enhance use of the document. DoD contractors, government activities, or manufacturers/vendors who are prospective suppliers of the product are invited to submit comments to the government. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. Attach any pertinent data which may be of use in improving this document. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity.

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A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

COMMENTS ON ANY DOCUMENT REQUIREMENT CONSIDERED TOO RIGID

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YES     NO (If "Yes", in what way?)

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