NBL Program Office
U. S. Department of Energy

SAFETY DATA SHEET
PLUTONIUM METAL

SECTION 1: CHEMICAL PRODUCTS & COMPANY IDENTIFICATION

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1 Science.gov Way,
Oak Ridge, TN 37830
1-240-780-6842

Emergency Phone Numbers: 1-240-780-6842

Substance: Plutonium Metal

Trade Names/Synonyms: CRM 126, CRM 126-A, Plutonium-239, Plutonium

Chemical Family: Transuranic actinide. Radioactive.

Use and Restriction: This material is prepared for use as a standard or in inter-laboratory comparison programs at analytical laboratories, which routinely handle uranium and/or plutonium. NBL expects that recipients of their material are in compliance with 29 CFR 1910.1200(h) which requires employers to provide employees with effective information and training on hazardous chemicals in their work area.

SECTION 2: HAZARDS IDENTIFICATION

Pu Metal Chemical Hazard

Classifications/Hazards:

OSHA HAZARDS: Toxic by inhalation. Flammable solid.

TARGET ORGANS: Kidneys

GHS Label Elements

Revision Date: June 23, 2020

Pictogram: 

Signal Word: DANGER

Hazard Statement(s):

May cause damage to kidneys through prolonged or repeated exposure (Category 1)

Dust or powder is flammable or explosive when exposed to heat or flames (Category 1)

May form pyrophoric products on exposure to air and moisture (Category 1)

Precautionary Statement(s):

Do not breathe dust

Wash thoroughly after handling

Do not eat, drink or smoke when using this product

If exposed seek medical attention

Keep away from heat/sparks/open flames/hot surfaces - No smoking

Do not allow water to get into container

In case of fire

CERCLA RATINGS (SCALE 0-3): HEALTH=U FIRE=3 REACTIVITY=2 PERSISTENCE=3

NFPA RATINGS (SCALE 0-4): HEALTH=U FIRE=3 REACTIVITY=2

EMERGENCY OVERVIEW: Handle with caution, normally in a glove box type enclosure. Inhalation, ingestion, or absorption through skin abrasions may lead to heavy metal toxicity or radiation poisoning.

Fine particles are flammable and may catch fire if exposed to air. They may form flammable or explosive dust-air mixtures. Keep away from all ignition sources. Do not allow water to get in container. Avoid creation of dust.

INHALATION:

Short Term Exposure - May cause irritation. May cause kidney damage, yellowing of the skin and eyes, lack of appetite, nausea, vomiting, diarrhea, dehydration, blood in the urine, weakness, drowsiness, incoordination, twitching, sterility, blood disorders, convulsions and shock.

Long Term Effects - In addition to effects from short term exposure, anemia, cataracts, lung damage, liver damage and bone effects may occur.

SKIN CONTACT:

Short Term Exposure - No information available on significant adverse effects.

Long Term Effects - May cause effects as reported in other exposures.

EYE CONTACT:

Short Term Exposure - May cause irritation, redness and swelling. Additional effects may include sores and eye damage.

Long Term Effects - In addition to effects from short term exposure, cataracts may occur.

INGESTION:

Short Term Exposure - No information available on significant adverse effects.

Long Term Effects - Same effects as short term exposure.

CARCINOGEN STATUS:

OSHA:	N
NTP:	N
IARC:	N

Note: Due to ionizing radiation Plutonium materials may cause cancer when internally deposited.

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Component: Plutonium metal, primarily Plutonium-239
CAS Number: 15117-48-3
Percentage: 99.9% Plutonium
Other Contaminants: Americium-241 and 0.04% Uranium (as decay products)

SECTION 4: FIRST AID MEASURES

INHALATION: Remove from exposure area to a restricted area with fresh air as quickly as possible. If breathing has stopped, perform artificial respiration by administering oxygen; mouth-to-mouth resuscitation should be avoided to prevent exposure to the person rendering first aid. Get medical attention immediately.

SKIN CONTACT: Remove victim to a suitable area for decontamination as quickly as possible. Remove clothing and shoes immediately. Thoroughly wash the victim with soap and water, paying particular attention to the head, fingernails and palms of the hands.

EYE CONTACT: Remove victim to a restricted area for decontamination. Thoroughly wash eyes with large amounts of water, occasionally lifting the upper and lower lids (approximately 15 minutes). Following the water treatment, provide an isotonic solution

INGESTION: In the case of ingestion of radioactive substances, the mouth should be rinsed out immediately after the accident, care being taken not to swallow the water used for this purpose. Vomiting should be induced either mechanically, or with syrup of ipecac. Do not induce vomiting in an unconscious person. Care should be taken to avoid aspiration.

SECTION 5: FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARD: Negligible fire hazard in bulk form; however, dust, powder, or fumes are flammable or explosive when exposed to heat or flames.

EXTINGUISHING MEDIA: Small fires - *Metal-X* (Class D) fire extinguisher. See also: the latest edition of the *Emergency Response Guidebook*, (ERG), developed jointly by Transport Canada (TC), the U. S. Department of Transportation (DOT) and the Secretariat of Transportation and Communications of Mexico (SCT).

FIREFIGHTING: Do not move damaged containers; move undamaged containers out of fire zone. (*Emergency Response Guidebook*, ERG).

Contact the local, State, or Department of Energy radiological response team. Use suitable agent for surrounding fire. Cool containers with flooding amounts of water, apply from as far a distance as possible. Avoid contamination of water sources and sewers. Avoid breathing dusts or vapors, keep upwind. Keep unnecessary people out of area until declared safe by radiological response team.

SECTION 6: ACCIDENTAL RELEASE MEASURES

OCCUPATIONAL SPILL: Do not touch damaged containers or spilled material. For large spills, dike far ahead of spill for later disposal. For dry spills, cover with plastic sheet or tarp to minimize spreading. Keep unnecessary people at least 150 feet upwind of spill. Isolate hazard area and deny entry. Limit entry to shortest time possible. Clean-up should be performed only by qualified radiation worker(s).

SECTION 7: HANDLING AND STORAGE

Handle under proper radiologically-controlled conditions at all times. Consult the Health Physicist at your facility for specific, appropriate procedures.

Observe all Federal, State, and local regulations when storing this substance.

Store in accordance with 10 CFR 20.

Store in a designated radioactive materials area.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

EXPOSURE LIMITS: Occupational exposure to radioactive substances must adhere to standards established by the Occupational Safety and Health Administration, 29 CFR 1910.96, and/or the Nuclear Regulatory Commission, 10 CFR Part 20. For ACGIH occupational exposure limits see International Commission on Radiological Protection guidelines.

VENTILATION: At a minimum, provide process enclosure ventilation. Depending upon work activities, a more stringent ventilation system may be necessary to comply with exposure limits set forth by law (10 CFR 20.103). In particular, a High Efficiency Particulate Air (HEPA) filtration system may be required for handling and storing this material.

One method of controlling external radiation exposure is to provide adequate shielding. The absorbing material used and the thickness required to attenuate the radiation to acceptable levels depends on the type of radiation, its energy, the flux and the dimensions of the source.

ALPHA PARTICLES: For the energy range of alpha particles usually encountered, a fraction of a millimeter of any ordinary material is sufficient for absorbance. Thin rubber, acrylic, stout paper, or cardboard will suffice.

BETA PARTICLES: Beta particles are more penetrating than alpha, and require more shielding. Materials composed mostly of elements of low atomic number such as acrylic, aluminum and thick rubber are most appropriate for the absorption of beta particles. For example, 1/4 inch of acrylic will absorb all beta particles up to 1 MeV.

GAMMA RAYS: The most suitable materials shielding gamma radiation are lead and iron. The thickness required will depend on whether the source is producing narrow or broad beam radiation. Primary and secondary protective barriers may be required to block all radiation.

EYE PROTECTION: Employee must wear appropriate eye protection that will not allow the introduction of particles into the eyes. Contact lenses should not be worn.

Clothing, glove and eye protection equipment will provide protection against alpha particles, and some protection against beta particles, depending on thickness, but will not shield gamma radiation.

CLOTHING: Overgarments, including head coverings and foot covering, should be worn by any employee engaged in handling radioactive substances. These garments are also recommended even if the employee is working with a "glovebox" containment system. Certain clothing fibers may be useful in dosimetry so clothing should be kept.

In the event of an accident, large scale release or a large scale clean-up, full protective clothing will be necessary.

GLOVES: Employee must wear appropriate protective gloves to prevent contact with this substance. Used gloves may present a radioactive contamination hazard and should be disposed of as radioactive waste.

RESPIRATOR: Respirators should provide protection for the respiratory tract against inhalation of most of the radioactive particles encountered in the workplace. Respirators will not offer protection against beta and gamma radiation, but will block alpha particles. (For additional information see: 10 CFR 20.103 Appendix A.) Respiratory equipment must be jointly certified by NIOSH/MSHA. The following respiratory protection is recommended. Lower levels of protection may be appropriate depending on containment systems. Consult a qualified health physicist for more information.

General conditions: Type 'C' supplied-air respirator with a full facepiece operated in pressuredemand or other positive pressure mode or with a full facepiece, helmet or hood operated in continuous-flow mode.

Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

For firefighting and other immediately dangerous to life or health conditions:

Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode.

Supplied-air respirator with full facepiece and operated in pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.

Description: grayish white, dense silvery, radioactive solid that is strongly electropositive. It is ductile and malleable and small particles may ignite spontaneously in air.

Molecular weight: Approximately 239 (varies with isotopic abundances)
Molecular formula: Pu
Melting point : 1186°F (641°C) (alpha form)
Boiling point: 5850°F (3232°C) (alpha form)
Specific gravity: 19.84 (alpha form)
Water solubility: insoluble
Solvent solubility: Soluble in hydrochloric acid; insoluble in nitric acid, concentrated sulfuric acid

Specific activity - The specific activities of the various plutonium isotopes (and ^{241}Am) are as follows:

^{238}Pu = 6.3 X 10^{5} MBq/g (17 Ci/g)

^{239}Pu = 2.3 X 10^{3} MBq/g (6.2 X 10^{-2} Ci/g)

^{240}Pu = 8.5 X 10^{3} MBq/g (2.3 X 10^{-1} Ci/g)

^{241}Pu = 4.1 X 10^{6} MBq/g (1.1 X 10^{2} Ci/g)

^{242}Pu = 1.4 X 10^{2} MBq/g (3.9 X 10^{-3} Ci/g)

^{241}Am = 1.2 X 10^{5} MBq/g (3.2 Ci/g)

Half Life - The half lives of the various plutonium isotopes are as follows:

^{238}Pu = 87.74 y; ^{239}Pu = 2.41 X 10^{4} y; ^{240}Pu = 6.56 X 10^{3} y; ^{241}Pu = 14.29 y;
^{242}Pu = 3.73 X 10^{5} y.

Critical Mass: >5.0 kg for Pu metal;
>500 g for Pu in any form

SECTION 10: STABILITY AND REACTIVITY

Reactivity: May form pyrophoric products on exposure to air and moisture which may present a fire hazard with subsequent spread of radioactive material.

Conditions to Avoid: Radiation hazard, do not allow material to spread or contaminate water sources.

Care must be taken in the handling of plutonium to avoid unintentional formation of a critical mass (see SECTION 9, above). Plutonium in liquid solutions poses a greater criticality hazard than solid plutonium.

Incompatibilities: Carbon Tetrachloride: May ignite or explode.

Polymerization: Hazardous polymerization has not been reported to occur under normal temperature and pressures.

SECTION 11: TOXICOLOGY INFORMATION

PLUTONIUM-239:

CARCINOGEN STATUS: As a chemical none. However, exposure to ionizing radiation may cause cancer and plutonium may be carcinogenic when internally deposited.

ACUTE TOXICITY LEVEL: No data available.

TARGET EFFECTS: Plutonium in the body most often accumulates in the lungs, lymph nodes, liver and skeleton. Lesser, yet significant, quantities may also be found in the spleen, gonads, and thyroid. The biological half-lives have been reported to be 40 years in the liver and 100 years in the bone. Radioactive materials present the greatest hazard to those parts of the body in which they are most concentrated. Plutonium is also a toxic metal, and may cause damage to the kidneys.

AT INCREASED RISK FOR EXPOSURE: Persons with chronic obstructive lung disease cannot clear inhaled materials, resulting in above average doses to the tissues of the lung and bronchi. Persons with iron deficiency anemia may take up plutonium more readily than the general population, as biologically, plutonium acts in a similar fashion to iron.

ADDITIONAL DATA: Plutonium-239 is an emitter of alpha particles and some gamma rays in the range of 100 - 600 keV. Exposure to radioactive plutonium may result in significant whole-body irradiation.

HEALTH EFFECTS:
INHALATION

ACUTE EXPOSURE - When inhaled, plutonium is retained in the lung with an effective half-life that varies from hundreds of days for plutonium oxides to tens of days for more soluble forms. Plutonium solubilized within the lungs is translocated to the liver and skeleton where it is retained.

Following an inhalation of an aerosol containing plutonium, the pattern of its deposition and clearance from the respiratory tract and the fraction eliminated from the body, as well as the fraction deposited in the target organ, depends on a variety of factors. These factors include the size, shape and density of the particles inhaled, as well as the chemical form. Large insoluble particles may remain at or near the site of deposition, and cause local damage. Soluble compounds may rapidly enter the bloodstream. The damage depends on how quickly they are eliminated, and the susceptibility of the tissue in which they are stored. Heavier inhaled particles will be brought up to the throat by ciliary action, and may then be swallowed. Lighter inhaled particles may become lodged in the alveolar air sacs and remain there for some time. Alpha radiation will kill cells immediately adjacent to the source of contact. Animals exposed to single high doses of soluble plutonium compounds died from radiation pneumonitis characterized by edema, fibrosis and respiratory damage. Death occurred in 1-3 years. The livers of exposed animals were congested, pigmented and granular.

CHRONIC EXPOSURE - No clinical illness has been attributed to long-term internally deposited plutonium as a result of occupational exposure, and a mortality study of 224 plutonium workers has shown no excess deaths from any cause. One study with a small number of subjects showed a statistically significant increase in multiple myelomas. Long term exposure of dogs to plutonium oxide resulted in radiation pneumonitis, pulmonary fibrosis, and death due to primary neoplasia. The effects of chronic exposure by internally deposited alpha active material are dependent upon the amount, isotopic distribution, and tissue. If large amounts become internally deposited, lung cancer, sterility, anemia, leukemia, or bone cancer may occur.

SKIN CONTACT:

ACUTE EXPOSURE - Alpha radiation is not usually an external hazard and penetration of soluble plutonium compounds through healthy skin has never been reported. Contamination may occur through broken skin. The lens of the eye may also be affected if eye contact occurs, and local damage may occur at the site of a wound. In extreme cases, absorption or penetration through damaged skin may result in radiation sickness.

CHRONIC EXPOSURE - No specific data are available. However, exposure to radiation may result in delayed effects. The delayed effects of radiation may be due either to a single large overexposure or continuing low-level overexposure. Delayed effects of exposure may include cancer, genetic effects, life span shortening and cataracts. At least one researcher has postulated that chronic exposure to low levels of radiation may result in life span lengthening.

Cancer is observed most frequently in the hematopoietic (blood forming) system, as well as the thyroid, bone and skin. Leukemia is among the most likely forms of malignancy. Lung cancer may also occur due to insoluble radioactive materials residing in the lungs (see inhalation section above). Genetic effects may range from point mutations to severe chromosome damage such as strand breakage, translocations, and deletions (occurring in cases of extremely large doses). Theoretically, if the germ cells have been affected, the effects of the mutation may not become apparent until following generations. In humans there has never been a confirmed genetic effect caused by radiation exposure.

EYE CONTACT:

ACUTE EXPOSURE - No specific data available. Repeated or prolonged exposure to alpha radiation may result in cataract formation. Of the well-documented late effects of radiation on man, leukemia and cataracts have been observed at doses lower than those producing skin scarring and cancer or bone tumors. The lens of the eye is considered to be a critical organ for exposure to radiation. Because alpha particles do not travel far in air, long term exposure of the eye to alpha radiation will only occur under conditions of extremely poor work practice.

CHRONIC EXPOSURE - No specific data available. Repeated or prolonged exposure to alpha radiation may result in cataract formation. See acute exposure.

INGESTION:

ACUTE EXPOSURE - Intestinal absorption is virtually zero; 0.003% for soluble compounds such as plutonium sulfate.

CHRONIC EXPOSURE - No specific data available.

SECTION 12: ECOLOGICAL INFORMATION

Environmental Impact Rating (0-4): No data available

Acute Aquatic Toxicity: No data available

Degradability: No data available

Log Bioconcentration Factor (BCF): No data available

Log Octanol/water partition coefficient: No data available

SECTION 13: DISPOSAL INFORMATION

Observe all Federal, State and local Regulations when disposing of this substance.
Disposal must be in accordance with 10 CFR 20 and 60.

SECTION 14: TRANSPORTATION INFORMATION

The U.S. Department of Transportation (D.O.T.) Code of Federal Regulations (49 CFR Parts 100-185), the International Air Transportation Association (IATA), International Civil Aviation Organization (ICAO) and International Maritime Organization (IMDG) are all factored into the classification and transport of material.

Proper Shipping Name:
Hazard Class:
UN/ID Number: To be determined on a case by case basis.
Special Information:
Packing Group:

Classification of substances with multiple hazards must be determined in accordance with the criteria presented in the above mentioned regulations. Due to the various quantities/combinations of materials being shipped at one time, the information above must be determined based on the characteristics of the specific shipment.

SECTION 15: REGULATORY INFORMATION

TSCA STATUS:	N
CERCLA SECTION 103 (40 CFR 302.4):	N
SARA SECTION 302 (40 CFR 355.30):	N
SARA SECTION 304 (40 CFR 355.40):	N
SARA SECTION 313 (40 CFR 372.65):	N
OSHA PROCESS SAFETY (29 CFR 1910.119):	N
CALIFORNIA PROPOSITION 65:	N

SARA HAZARD CATEGORIES, SARA SECTIONS 311/312 (40 CFR 370.21)

ACUTE HAZARD:	N
CHRONIC HAZARD:	N
FIRE HAZARD:	N
REACTIVITY HAZARD:	N
SUDDEN RELEASE HAZARD:	N

SECTION 16: OTHER INFORMATION

This material is prepared for use as a standard or in interlaboratory comparison programs at analytical laboratories that routinely handle uranium and/or plutonium. The New Brunswick Laboratory (NBL) assumes that recipients of this material have developed internal safety procedures to guard against accidental exposure to radioactive and toxic materials, contamination of the laboratory environment, or criticality. NBL further expects that personnel who handle radioactive materials have been thoroughly trained in the safety procedures developed by and for their Laboratory.

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