SAFETY DATA SHEET

PLUTONIUM NITRATE

SECTION 1: CHEMICAL PRODUCTS & COMPANY IDENTIFICATION

New Brunswick Laboratory
U. S. Department of Energy
9800 South Cass Avenue
Argonne, IL 60439
1-630-252-2442
Emergency Phone Numbers: 1-630-252-6131 or 1-630-252-5731

Chemical Name: Plutonium Nitrate, 100%

Other Identifiers: Plutonium in Nitrate Form; Plutonium Isotopic Standard; CRM 128; CRM 130; CRM 131; CRM 144

Use and Restriction: This material is prepared for use as a standard or 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 in hazardous chemicals in their work area.

Chemical Family: Metal nitrate. Radioactive.

SECTION 2: HAZARDS IDENTIFICATION

Radiological Hazard (Pu)

Warning: THIS MATERIAL SHOULD ONLY BE USED BY PERSONS QUALIFIED TO HANDLE RADIOACTIVE MATERIAL! This product contains licensed radioactive material and is therefore subject to the requirements of 10 CFR Part 20 (e.g., public and occupational exposure limits, waste disposal). At a minimum, the basic radiation safety principles of time, distance, and shielding, and appropriate radiation contamination control should be practiced to avoid/minimize any external and/or internal exposure. Consult with your Radiation Safety office for your facility's radiation safety requirements/precautions specific to the radionuclide(s) (including its activity and chemical/physical form) in this Radioactive CRM.

This CRM is a radioactive material. The specific activities of the various plutonium isotopes (and ^{241}Am) are described in Section 9. The CRM is in a nitric acid solution. During the decay of plutonium, three types of radiation are released—alpha, beta, and gamma. Alpha radiation

can travel only a short distance and cannot travel through the outer, dead layer of human skin. Beta radiation can penetrate human skin, but cannot go all the way through the body. Gamma radiation can go all the way through the body. Alpha, beta, and gamma radiation are all forms of ionizing radiation. Either acute or longer-term exposure carries a danger of serious health outcomes including radiation sickness, genetic damage, cancer, and death. The danger increases with the amount of exposure

Chemical Hazard (Nitric Acid)

Health Hazard:

Skin Corrosion/Irritation Category 1
Serious Eye Damage/Irritation Category 1

GHS Label Elements

Pictogram:

Signal Word: DANGER

Hazard Statement(s)
H314 Causes severe skin burns and eye damage

Precautionary Statement(s)
P280 Wear Protective gloves, protective clothing, and eye protection.
P305 + P351 + P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P303 + P353 If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P310 Immediately call a doctor.
P410 Store locked up.

CERCLA Ratings (SCALE 0-3): HEALTH=U FIRE=0 REACTIVITY=0 RERSISTENCE=3

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

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name: Plutonium in nitric acid solution (HNO3.xPu)

Common Names/Synonyms: Nitric Acid: Auqa fortis, hydronitrate; azotic acid; engraver's acid. Plutonium: Not applicable.

CAS Number: 14913-29-2.

Component: Plutonium Nitrate Percentage: 100%

Other Contaminants: None

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, preferably by administering oxygen; alternatively, mouth-to-mouth resuscitation may be performed, however this may result in exposure to the person rendering first aid.

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).

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. Lavage may be useful. Care should be taken to avoid aspiration.

SECTION 5: FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARD: Dangerous due to fire or explosion hazard in bulk form. Dusts, powders, or vapors are flammable or explosive when exposed to heat or flames.

EXTINGUISHING MEDIA: Dry chemical, carbon dioxide, water spray or regular foam. Refer to most recent *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).)

Contact the local, State, or Department of Energy radiological response team. Use suitable agent for surrounding fire. Cool containers with flooding quantities of water applied from as

far a distance as possible. Avoid breathing dusts or vapors, keep upwind. Keep unnecessary people out of area until declared safe by proper authorities.

SECTION 6: ACCIDENTAL RELEASE MEASURES

OCCUPATIONAL SPILL: Do not touch damaged containers or spilled material. Call radiation safety personnel for assistance. For small liquid spills, use absorbent pads or other non-dispersible absorbent materials. Isolate the area to prevent unnecessary access by nonessential personnel. Enter spill area only to save life; use all practical means to control the spread of possibly contaminated materials. Uninjured persons and possibly contaminated equipment and materials should be kept from leaving until monitored by qualified radiation authority. Cleanup should not be attempted except at the instruction of qualified radiation authority.

SECTION 7: HANDLING AND STORAGE

Precautions for Safe Handling: Avoid contact with skin, eyes and clothing. Avoid breathing. Observe all local regulations when handling and storing this substance. Store in accordance with 10 CFR 20.

Conditions for Safe Storage: Store in radioactive materials area.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Limits:

Pu

NRC: See NRC 10 CFR 20
ACGIH: See International Commission on Radiological Protection guidelines.

Nitric Acid:

NIOSH (REL)	5 mg/m3 (2ppm; TWA)
	10 mg/m3 (4 ppm; STEL)
	65 mg/m3 (25 ppm, IDLH)
ACGIH (TLVE)	5 mg/m3 (2ppm, TWA)
	10 mg/m3 (4ppm, STEL)
OSHA (PEL)	5mg/m3 (2ppm; TWA)

VENTILATION: At a minimum, provide process enclosure ventilation. Depending upon work place 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.

RADIATION EXPOSURE: Radiation exposure is typically lessened by reducing the time one spends in proximity to radioactive materials, increasing one's distance from the source of radiation, or shielding one's self from the source of radiation. While time and distance are self-explanatory, the proper material and thickness used for shielding is dependent on the type of radiation, its energy, and the dimensions of the source. Plutonium nitrate (as Pu239, 242 or 242), in gram quantities is considered an alpha emitter for most radiation protection purposes. Over a period of years however, any Pu-241 (a beta emitter) present will cause a buildup of Americium (Am-241), which is both an alpha and gamma radiation emitter. See the *Certificate of Analysis* provided with each Certified Reference Material for details on isotopic composition.

ALPHA PARTICLES: For the energy range of alpha particles usually encountered, a fraction of a millimeter of any ordinary material or a few inches of air is sufficient for absorbance.

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, and thick rubber are most appropriate for the absorption of beta particles. Except in the case of Pu-241, plutonium does not emit significant amounts of Beta particles.

GAMMA RAYS: The most suitable materials for shielding gamma radiation are lead and iron. In gram quantities, plutonium is not a usually considered a gamma emitter. However, if Pu-241 is present, it will, over a period of years, decay via beta emissions to Americium 241 (Am-241). Am241 is considered an alpha as well as a gamma emitter (approximately 60 KeV gamma). Consult a radiation protection specialist or health physicist for more information.

EYE PROTECTION: Employee must wear appropriate eye protection that will not allow the introduction of foreign material into the eyes. The use of contact lenses, even when worn under appropriate eye protection equipment, is prohibited by some laboratories. Their use should be evaluated on a case-by-case basis by an experienced Industrial Hygienist.

CLOTHING: Disposable overgarments, including foot covering (and head covering as necessary), should be worn by any employee engaged in handling plutonium-containing materials. These garments are recommended even if the employee is working with a glovebox containment system.

In the event of a large scale release or a large scale clean-up, full protective clothing and selfcontained breathing apparatus should be used.

GLOVES: Employee must wear appropriate protective gloves to prevent contact with this substance. Generally, gloves are worn even when working in a glove box containment system. Used gloves 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 work place. Respirators offer no protection against external beta and gamma radiation, but will block alpha particles. (For additional information see: 10 CFR 20.103 Appendix A). Respiratory equipment must be certified by 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 pressure demand 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.

EMERGENCY OVERVIEW: The toxicological properties have not been fully investigated. Handle with caution, normally in a glove box type enclosure.

POTENTIAL HEALTH EFFECTS:

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: Plutonium materials as a radioactive substance may cause cancer when internally deposited.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Descriptive Properties:

Molecular weight: Approximately 364 (varies with isotopic abundance)
Molecular formula: HNO3.xPu
Boiling point: Unknown
Melting point: Unknown
Specific Gravity: Unknown
Solvent Solubility: Soluble in alcohol, alkalis and ammonia, insoluble in concentrated acids.
Viscosity: Unknown
Particle Size: Unknown
Auto-ignition Temperature: Unknown
Explosive Limits: Unknown
Flash Point: Unknown

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)

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

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

^{238}**PU** = 87.74 y; ^{2}"Pu = 2.41×10^4 y; **240p$_u$** = 6.56×10^3 y; **241p$_u$** = 14.4 y;
$^{242}Pu = 3.73 \times 10^5$ y.

Critical Mass: >1.0 kg for Pu(NO3)2

SECTION 10: STABILITY AND REACTIVITY

REACTIVITY

CONDITIONS TO AVOID - Radiation hazard, do not allow material to spread or contaminate water sources.

Care must be taken in the handling of large quantities of plutonium compounds to avoid unintentional formation of a critical mass . Plutonium in liquid solutions is more apt to become critical than plutonium contained in solid forms.

INCOMPATIBILITIES:
No specific incompatibilities could be found. Nitrates are powerful oxidizing agents that may cause violent reactions with reducing materials.

HAZARDOUS DECOMPOSITION:
When heated to decomposition it emits toxic fumes of NO_R.

POLYMERIZATION:
Hazardous polymerization has not been reported to occur under normal temperature and pressure.

SECTION 11: TOXICOLOGY INFORMATION

PLUTONIUM NITRATE:

CARCINOGEN STATUS – None as a chemical. 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 gonads, spleen, and

thyroid. The biological half-lives of plutonium 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 it is most concentrated.

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 abronchi. 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 nitrate is an emitter of alpha particles and some very soft gamma rays. Internal exposure to radioactive plutonium may result in significant whole-body irradiation.

HEALTH EFFECTS:

INHALATION
PLUTONIUM NITRATE:

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.

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 is dependent upon the amount, enrichment, 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 plutonium nitrate 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 is 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.

EYE CONTACT:
PLUTONIUM NITRATE:

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:
PLUTONIUM NITRATE:

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

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:
N/ID Number:
Special Information:
Packing Group:

} To be determined on a case by case basis.

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

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

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

SECTION 16: OTHER INFORMATION

This material is prepared for use as a standard or in inter-laboratory 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 that 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.

The information and recommendations set forth herein are presented in good faith and believed to be correct as of the revision date. However, recipients of this material should use this information only as a supplement to other information gathered by them, and should make independent judgment of the suitability and accuracy of this information. This statement is not intended to provide comprehensive instruction in developing an appropriate safety program and does not include all regulatory guidelines.

This information is furnished without warranty, and any use of the product not in conformance with this Safety Data Sheet, or in combination with any other product or process, is the responsibility of the user.

Creation Date: March 3, 1994 Revision Date: January 23, 2017