SAFETY DATA SHEET

URANYL NITRATE SOLUTION

SECTION 1: CHEMICAL PRODUCT & COMPANY IDENTIFICATION

New Brunswick Laboratory
U.S. Department of Energy
9800 South Cass Avenue
Argonne, IL 60439
1-630-252-CRMS (2767)

Emergency Phone Numbers: 1-630-252-6130 or 1-630-252-5731

Chemical Name: Uranyl Nitrate Solution, $UO_2(NO_3)_2$

Other Identifiers: Certified Reference Material (CRM) standard or Safeguards Measurement Evaluation (SME) sample

Use and Restrictions: 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

OSHA HAZARDS: Skin Corrosion/Irritation Category 1B. Serious Eye Damage/Irritation Category 1

TARGET ORGANS: Skin, Eyes, Kidneys.

GHS Label elements, including precautionary statements

Signal Word: DANGER

Pictogram:

Hazard Statement(s)
H314 Causes severe skin burns and eye damage
H373 May cause damage to organs through prolonged or repeated exposure.
H411 Toxic to aquatic life with long lasting effects.

Precautionary statement(s)
P260 Do not breathe dust/ fume/ gas/ mist/ vapors/ spray.
P262 Do not get in eyes, on skin, or on clothing.
P264 Wash skin thoroughly after handling.
P273 Avoid release to the environment.
P280 Wear protective gloves/protective clothing/eye protection/face protection
P310 Immediately call a POISON CENTER or doctor/ physician if swallowed or inhaled.

Other Hazard(s): Radioactive

NFPA RATINGS (SCALE 0-4):
Health=3
Fire=0
Reactivity=0
Special Hazard= OX

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name: Uranyl Nitrate Solution

Common Names/Synonyms: CRM U045; CRM 135; CRM 145; CRM 145-B; CRM U930-D; Safeguards Measurement Evaluation (SME) Low Enrichment, Normal Enrichment, or High Enrichment Solutions; Uranyl Nitrate in Nitric Acid Solution.

CAS Number: 10102-06-4

MIXTURE:

Chemical Name: Uranium, UO_2
CAS Number: 1344-57-6
Concentration: 0.1-2.0% (1 - 20 mg Uranium/g Solution); Enrichment: 0.711%-99.8% ^{235}U

Chemical Name: Nitric Acid, HNO_3
CAS Number: 7697-37-2

Concentration: <8%(Approximately 1 *M*)

Chemical Name: Water
Concentration: Approximately 90%

SECTION 4: FIRST-AID MEASURES

Indication of Immediate Medical Attention: In all routes of exposure, seek medical treatment immediately. See treatment/first-aid measures below.

Necessary 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 or administer oxygen. Any evidence of serious contamination indicates that treatment must be instituted. (Inhalation of radioactive material may indicate that other parts of the body were also contaminated, such as the digestive tract, skin and eyes.) If time permits, wipe the face with wet filter paper, force coughing and blowing of the nose. Get medical attention immediately. The victim may be contaminated with radioactive material. Any personnel involved in rendering first aid must be monitored for radioactivity and thoroughly decontaminated if necessary. Treat symptomatically and supportively. Decontaminate any radiological contamination after individual is stabilized from initial medical treatment.

INGESTION: Never give anything by mouth to an unconscious person. Rinse mouth, spitting out the first rinse. Subsequently, the victim should drink large quantities of water or milk to dilute the acid. If vomiting occurs, the head should be kept below the hips to reduce the likelihood of aspiration. Following vomiting, more water or milk should be consumed. The victim should be immediately transferred to a medical facility to have his stomach pumped. Stomach contents should be saved for monitoring. The victim must be monitored for radioactivity. If contaminated, decontamination should be begun at once, but should not be allowed to delay access to medical treatment.

SKIN CONTACT: Remove clothing and shoes immediately. Remove victim to a suitable area for decontamination as quickly as possible. Thoroughly wash the victim with soap and water, paying particular attention to the head, fingernails and palms of the hands. Upon completion of washing, monitor the victim for radioactivity. It is imperative that the skin should be decontaminated as quickly as possible. Minute skin injuries greatly increase the danger of isotope penetration into the victim; shaving should not be attempted. If water and soap have been inadequate in removing the radioactive compound, decontaminating compounds consisting of surfactants and absorbent substances may be effective. Complexing reagents may also be of use. The use of organic solvents is to be avoided. Organic solvents are incompatible with nitric acid and they may increase the solubility and absorption of the radioactive substance. Skin contamination with radiation may be an indication that other parts of the body have been exposed. Contaminated clothing must be stored for later decontamination or disposal. The water used to wash the victim must be stored for later disposal. Any personnel involved in rendering first aid to the victim must be monitored for radioactivity and decontaminated if necessary. In case of chemical burns, cover area with sterile dry dressing. Bandage securely, but not tightly. Get medical attention immediately.

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 (at least 15-20 minutes). Get medical attention immediately. Following the water treatment, continue irrigating with normal saline for 30-60 minutes. Cover with sterile bandage. Monitor the victim for radioactivity. If activity is present, rewash the eyes, and remonitor until little or no radioactivity is present. Any water used to wash the victim's eyes must be stored for later disposal. Any other articles that are used to decontaminate the victim must also be stored for later decontamination or disposal. Any personnel involved in rendering first aid to the victim must be monitored for radioactivity and decontaminated if necessary.

Note to Physician: Although chelating agents act on uranium, they should not be used because the increased migrant fraction leads through renal precipitation to a greater kidney burden than would be received if there were no treatment at all; there is thus the risk of serious toxic nephritis. The basic treatment should be administration of a bicarbonate solution given locally and in intravenous perfusion.

Most important Symptoms/Effects, Acute and Delayed: May cause severe burns to mucous membranes. May cause respiratory tract, skin and eye burns. May damage the lungs. May affect the central nervous system. May cause adverse reproductive effects. Also See Section 11.

SECTION 5: FIRE-FIGHTING MEASURES

Suitable Extinguishing Media: Use dry chemical, carbon dioxide, water spray or regular foam for smaller fires. For larger fires, use water sprays or fog (flooding amounts). (2012 *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).

Fire and Explosion Hazard: Negligible fire hazard when exposed to heat or flame. Contact with organic or combustible materials may result in violent reaction. Oxidizer: Oxidizers decompose, especially when heated, to yield oxygen or other gases which will increase the burning rate of combustible matter. Contact with easily oxidizable, organic, or other combustible materials may result in ignition, violent combustion or explosion.

Hazardous Combustion Products: Thermal decomposition products may include toxic oxides of nitrogen. Vapors may be corrosive. Wear NIOSH/MSHA approved self-contained breathing apparatus and acid resistant clothing, boots and gloves.

Special Protective Equipment and Precautions for Fire-Fighters: Move container from fire area if you can do it without risk (2012 ERG). Wear self-contained breathing apparatus for firefighting if necessary. Contact local, State, Nuclear Regulatory Commission or Department of Energy radiological response team. Cool containers with flooding quantities of water applied from as far a distance as possible. Avoid breathing vapors, mist or gas; keep upwind. Keep people out of area until area declared safe by proper authorities. Evacuate to a radius of 2500 feet for uncontrollable fires.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Personal Precautions and Protective Equipment: Wear respiratory protection (see Section 8). Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

Emergency Procedures/Methods and Materials for Containment and Clean-up: Call radiation and chemical safety personnel for assistance. Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided. For small spills, neutralize acid and take up with vermiculite, sand, or other absorbent material. Isolate the area to prevent unnecessary access by non-essential personnel. Neutralize acid if there is sufficient ventilation, and take up with absorbent materials. Following any clean-up activities, the area must be monitored for radioactive contamination. Contaminated cleaning supplies must be disposed of as radioactive waste.

SECTION 7: HANDLING AND STORAGE

Precautions for Safe Handling: Avoid contact with skin and eyes. Wash hands thoroughly after handling.

Conditions for Safe Storage: Store in radioactive materials area. Keep storage container tightly closed. Store separately from incompatible materials (see Section 10). Observe all Federal, state and local regulations regarding storage of this material.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Limits:

URANIUM, SOLUBLE COMPOUNDS (As U):

0.05 mg/m^3 OSHA TWA
0.2 mg/m^3 ACGIH TLV TWA; 0.6 mg/m^3 ACGIH STEL
0.05 mg/m^3 NIOSH Recommended TWA

NITRIC ACID:

5.2 mg/m^3 (2 ppm) OSHA PEL (TWA)
5.2 mg/m^3 (2 ppm) ACGIH TLV (TWA); 10 mg/m^3 ACGIH STEL
5.2 mg/m^3 (2 ppm) NIOSH recounted TWA; 10 mg/m^3 NIOSH Recommended STEL
100 ppm is considered immediately dangerous to life and health (IDLH)

URANYL NITRATE SOLUTION:

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 and/or CFR Part 8935 Department of Energy.

If purchased by DOE or DOE governed facilities subject to 10 CFR 835. Subject to foreign entity radiation protection regulations.

Engineering Controls:

VENTILATION: Local exhaust or process enclosure ventilation should be provided to reduce nitric acid levels below airborne exposure limits; a more stringent ventilation system may be necessary to comply with exposure limits set forth by law (10 CFR 20.103; 29 CFR 1910.96) or by internal requirements. The concentrations and amounts of uranyl nitrate solutions provided are unlikely to cause detectable external radiation exposure.

RADIATION SHIELDING: 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 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. Uranium does not emit significant amounts of beta particles. The most suitable materials for shielding gamma radiation are lead and iron. These solutions do not emit significant amounts of gamma radiation. Consult a radiation protection specialist or health physicist for more information.

Personal Protection Equipment:

EYE PROTECTION: Wear appropriate eye protection that will not allow the introduction of foreign material into the eyes. Contact lenses should not be worn. Safety goggles are recommended when opening ampoules or if exposure to nitric acid vapors is possible.

SKIN AND BODY PROTECTION: Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Used gloves should be disposed of as radioactive waste. Wear clothing as appropriate to cover skin to prevent skin contact. Follow guidelines contained in NIOSH Pocket Guide Chemical hazards and 29 CFR 1910, Subpart Z.

RESPIRATOR: If exposure to corrosive vapors, toxic oxides of nitrogen, or particulates of uranium material is possible, an air-purifying full facepiece respirator with acid and/or highefficiency particulate cartridges or a self-contained breathing apparatus should be used. Nitric acid is an oxidizer. Do not use cartridges containing oxidizable materials such as activated charcoal.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Yellow aqueous solution
Odor: Odorless to a faint pungent odor
Odor Threshold: None
pH: Acidic
Melting Point: N/A
Freezing Point: Data Not Available
Boiling Point: Approximately 100□C (212□F)

Flash Point: N/A
Evaporation Rate: Data Not Available
Flammability: N/A
Explosive Limits: N/A
Vapor Pressure: Data Not Available
Vapor Density: Data Not Available
Relative Density: Approximately 1.0
Solubility: Easily soluble in cold water, avoid organic solvents
Partition Coefficient: Data Not Available
Auto-Ignition Temperature: Data Not Available
Decomposition Temperature: Data Not Available
Viscosity: Data Not Available

The half-lives of the various uranium isotopes are as follows:

$^{233}U = 1.59 \times 10^{5}$ y; $^{234}U = 2.47 \times 10^{5}$ y; $^{235}U = 7.04 \times 10^{8}$ y; $^{236}U = 2.39 \times 10^{7}$ y;

$^{238}U = 4.51 \times 10^{9}$ y.

The specific activities of the various uranium isotopes are as follows:

$^{233}U = 3.6 \times 10^{2}$ MBq/g (6.2×10^{-3} Ci/g)

$^{234}U = 2.3 \times 10^{2}$ MBq/g (6.2×10^{-3} Ci/g)

$^{235}U = 7.8 \times 10^{-2}$ MBq/g (2.1×10^{-6} Ci/g)

$^{236}U = 2.3$ MBq/g (6.3×10^{-5} Ci/g)

$^{238}U = 1.2 \times 10^{-2}$ MBq/g (3.3×10^{-7} Ci/g)

See 10 CFR Part 71, Appendix A.

SECTION 10: STABILITY AND REACTIVITY

Reactivity: See below.

Chemical Stability: Stable under recommended storage conditions.

Possibility of Hazardous Reactions: Hazardous polymerization has not been reported to occur under normal temperatures and pressures.

Conditions to Avoid: Excessive Heat.

Incompatible Materials: Avoid contact with strong reducing agents, organic materials, metals, strong alkali, and combustible materials.

Hazardous Decomposition Products: Thermal decomposition products may include toxic oxides of nitrogen.

SECTION 11: TOXICOLOGY INFORMATION

Likely Routes of Exposure: Inhalation, Ingestion, Skin and Eye Contact

Uranium is a heavy metal. Soluble compounds of uranium, such as uranyl nitrate, are toxic to the kidneys. Uranium is a radioactive alpha emitter; large amounts of enriched uranium may be a radiation hazard. Radiation may damage the skin, lungs, bone marrow, or the lymphatic system. Because uranium decays by alpha emission, external exposure to this uranyl nitrate solution is unlikely to be a health hazard. However, ingestion or inhalation can cause damage due to the corrosive nature of the solution, the toxicity of the metal or radioactive decay (especially of enriched material).

INHALATION:

Acute Exposure: Uranyl nitrate dusts and corrosive acids are irritating to the respiratory tract. Inhalation of acid vapors can cause fatal breathing difficulties. Decomposition and reaction products of nitric acid include toxic nitrous oxides. Since uranyl nitrate is soluble, inhaled uranium materials may pass into the bloodstream and contribute to kidney damage. The acidosis and azotemia including renal dysfunction may damage the liver. Normal uranium materials are weak alpha emitters; the chemical toxicity may be more relevant than the radioactive hazard.

Chronic Exposure: Chronic inhalation of uranyl nitrate may increase the risk of cancer in the soft body tissues.

Acute Exposure to Alpha Radiation: Alpha radiation will kill cells immediately adjacent to the source of contact. 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.

Chronic Exposure to Alpha Radiation: 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.

Immediate Effects/Symptoms: May cause burns, coughing, drooling, tightness in the chest, low blood pressure, headache, weakness, dizziness, lung congestion, and pulmonary edema. Additional effects from inhalation of soluble uranium compounds include kidney damage, blood disorders, and loss of appetite, nausea, vomiting, diarrhea, and convulsions. Acute exposure may be fatal.

Delayed Effects/Symptoms: In addition to the immediate effects, cancer, anemia and cataracts may occur due to uranium exposure. Tooth decay, digestive disorders and lung damage may result from inhalation of nitric acid vapors and mists.

INGESTION:

Acute Exposure: Ingestion of corrosive acids may permanently damage body tissues and teeth. Ingestion of soluble uranium compounds, such as uranyl nitrate, may result in kidney failure and/or radiation damage. Acute exposure may be fatal.

Chronic Exposure: Chronic ingestion may lead to kidney failure, or radioactive destruction of soft tissues, such as bone marrow and kidneys.

Acute Exposure to Alpha Radiation: See Inhalation above.

Chronic Exposure to Alpha Radiation: See Inhalation above.

Immediate Effects/Symptoms: May cause burns, tooth damage, yellow or brown stains, fever, vomiting, diarrhea, suffocation and kidney damage.

Delayed Effects/Symptoms: Same as Immediate Effects/Symptoms.

SKIN CONTACT:

Acute Exposure: All soluble uranium compounds, such as uranyl nitrate, are lethal when applied in a single dose to the skin of rabbits, either in various vehicles, or in some cases (probably not uranyl nitrate) when applied without vehicle. The toxicity of uranium compounds is to the kidneys. A hot nitric acid solution of uranyl nitrate spilled on the skin caused skin burns, nephritis, and encephalopathy. Prolonged skin contact with uranium compounds should be avoided because of potential radiation damage to basal cells; see following section regarding alpha radiation.

Chronic Exposure: Chronic contact may produce kidney damage, as described above in acute exposure. Prolonged irritation may worsen into dermatitis, result in radiation damage, or increased cancer risk.

Acute Exposure to Alpha Radiation: Alpha radiation is not usually an external hazard. However, local damage may occur at the site of a wound. Absorption or penetration through damaged skin may result in internal deposition and increased cancer risk.

Chronic Exposure to Alpha Radiation: Prolonged or repeated contact may result in blood disorders and increased risk of cancer.

Immediate Effects/Symptoms: May cause burns, redness and swelling of skin. May also cause yellow or brown stains. In extreme cases, kidney damage and neurological effects may result.

Delayed Effects/Symptoms: Same as short-term effects.

EYE CONTACT:

Acute Exposure: Dust may cause irritation and lacrimation. Soluble uranium compounds may be lethal when placed in the conjunctival sac of the rabbit eye with or without a vehicle.

Chronic Exposure: May cause conjunctivitis or cataracts.

Acute Exposure to Alpha Radiation: 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. It is important to note that long-term eye contact with these solutions would most likely result in serious damage to the cornea due to nitric acid long before cataracts would be formed.

Chronic Exposure to Alpha Radiation: Repeated or prolonged exposure to alpha radiation may result in cataract formation. See acute exposure.

Immediate Effects/Symptoms: May cause burns. Additionally, tearing, redness of the eye, and intolerance to light may result.

Delayed Effects/Symptoms: Prolonged exposure of the cornea to radiation may result in cataracts; however, it is expected that the nitric acid component of the solution would limit any radiation exposure of the eye to sub-clinical levels.

Measures of Toxicity:

20 mg/m^3 (Uranyl nitrate, as U) Immediately Dangerous to Life or Health.
100 mg/m^3 (HNO_3) Immediately Dangerous to Life or Health.

Carcinogen Status:

OSHA:	N
NTP:	N
IARC:	N

SECTION 12: ECOLOGICAL INFORMATION

Substance may be harmful to aquatic organisms. May cause long-term adverse effects in the aquatic environment. Do not allow substance to enter sewer system, ground water, or bodies of water.

SECTION 13: DISPOSAL CONSIDERATIONS

Dispose of unused substance and any contaminated packaging in accordance with Federal, state and local regulations.

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
Special Information:
Packing Group:

} 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

A component of this substance (nitric acid) is listed on the Toxic Substances Control Act (TSCA) inventory.

The Superfund Amendments Reauthorization Act (SARA) Section 304 requires that a release equal to or greater than the reportable quantity for this substance be immediately reported to the local emergency planning committee and the state emergency response commission (40 CFR 355.40). If the release of this substance is reportable under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 103, the National Response Center must be notified immediately at (800) 424-8802 or (202) 426-2675 in the metropolitan Washington, D.C. area (40 CFR 302.6).

CERCLA SECTION 103 (40 CFR 302.4): Nitric acid reportable quantity (RQ): 1000 lbs.

SARA SECTION 304 (40 CFR 355.40): Nitric acid reportable quantity (RQ): 1000 lbs.

SARA SECTION 302 (40 CFR 355.30): Nitric acid threshold planning quantity (TPQ): 1000 lbs.

A component of this substance (nitric acid) is subject to the reporting requirements of SARA Section 313 (40 CFR 372.65).

SECTION 16: OTHER INFORMATION

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.

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 judgement of the suitability and accuracy of this information. The government will not be liable for any special, indirect, incidental, or consequential damages, including but not limited to, loss of any kind whatsoever resulting from the use of the information provided in this Safety Data Sheet. The Government expressly includes all warranties, expressed or implied, including warranties of merchantability and fitness for a particular purpose.

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