



SAFETY DATA SHEET
URANIUM TETRAFLUORIDE (UF₄)

SECTION 1: CHEMICAL PRODUCTS & COMPANY IDENTIFICATION

NBL Program Office
U. S. Department of Energy,
1 Science.gov Way,
Oak Ridge, TN 37830
1-865-576-0598

Off Hours Emergency Numbers:
1-865-576-0598
CAS Number: 10049-14-6

Substance: Uranium Tetrafluoride

Trade Names/Synonyms: Uranium Perfluoride; Uranium Fluoride;
Green Salt; Tetrafluorouranium; CRM 17-B

Chemical Family: Inorganic salt, Radioactive, Halogen

SECTION 2: HAZARDS IDENTIFICATION

OSHA Hazards

Highly toxic by inhalation, Highly toxic by ingestion. Corrosive.

Target Organs

Kidney, Liver, Lungs, Brain, Skin, Eyes.

GHS Classification

Acute toxicity, Oral (Category 1) Acute toxicity, Inhalation (Category 1)
Specific target organ toxicity - repeated exposure (Category 2) Skin Corrosion (Category 1A)
Serious eye damage (Category 1) Acute aquatic toxicity (Category 2) Chronic aquatic toxicity
(Category 2)

GHS Label elements, including precautionary statements

Pictogram



Signal Word: Danger

Hazard statement(s)

H300 + H330 Fatal if swallowed or if inhaled 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

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

NFPA RATINGS (SCALE 0-4): HEALTH = 4 FIRE = 0 REACTIVITY = 1

EMERGENCY OVERVIEW: Nonvolatile, green triclinic crystalline solid.

May be fatal if inhaled. May cause blood disorders. May cause convulsions. May damage kidneys. May affect the central nervous system. May cause adverse reproductive effects. May cause eye damage. May affect the liver. May react with water.

Avoid breathing dust. Do not get in eyes, on skin, or on clothing. Keep container tightly closed. Wash thoroughly after handling. Use only with adequate ventilation. Handle with caution.

POTENTIAL HEALTH EFFECTS:

INHALATION:

Short Term Exposure: May cause lack of appetite, nausea, vomiting, diarrhea, dehydration, kidney damage, blood in the urine, liver damage, weakness, drowsiness, incoordination, twitching, sterility, blood disorders, convulsions, and shock. May also cause death. Exposure to radioactive substances increases one's risk of developing cancer.

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

SKIN CONTACT:

Short Term Exposure: May cause skin irritation.

Long Term Effects: May cause burns.

EYE CONTACT:

Short Term Exposure: May cause irritation. Additionally, eye damage, including ulcerations, may occur.

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

INGESTION:

Short Term Exposure: May cause yellowing of the skin and eyes, drooling, nausea, vomiting, diarrhea, stomach pain, weakness, twitching, kidney damage, and convulsions. May cause increased cancer risk.

Long Term Effects: May cause tooth discoloration, lack of appetite, weight loss, digestive disorders, anemia, and liver damage.

CARCINOGEN STATUS:

OSHA:	N
NTP:	N
IARC:	N

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Component: Uranium Tetrafluoride (normal uranium)
CAS Number: 10049-14-6
Percentage: 99.0
Other Contaminants: UO₂ - 1.0%

SECTION 4: FIRST AID MEASURES

Uranium tetrafluoride (UF₄) reacts slowly with moisture at ambient temperature forming UO₂ and HF. Hydrogen fluoride gas is highly toxic and corrosive. Symptoms of exposure to hydrogen fluoride can be delayed up to 24 hours. Conditions such as hypocalcemia, hypomagnesemia and cardiac arrhythmias should be monitored for.

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; mouth-to-mouth resuscitation may be performed in the event that oxygen is not available; however, exposure to the person rendering first aid will most likely result. Get medical attention immediately. Medical problems take priority over radiologic concerns.

SKIN CONTACT: Hydrofluoric acid burns require immediate first aid and medical treatment. 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. Skin exposures can be treated with calcium gluconate. Upon completion of washing, monitor the victim for radioactivity. Medical problems take priority over radiologic concerns.

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). Medical problems take priority over radiologic concerns.

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. Medical problems take priority over radiologic concerns.

SECTION 5: FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARD: Unknown fire and explosion hazard.

EXTINGUISHING MEDIA: Dry chemical, carbon dioxide, water spray, or regular foam. (*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).)

For larger fires, use water spray, fog, or regular foam. (*Emergency Response Guidebook*, ERG).

FIREFIGHTING: Move container from fire area if you can do it without risk. Apply cooling water to sides of containers exposed to flames until well after fire is out. Stay away from ends of tanks. If this is impossible, withdraw from area and let fire burn (*Emergency Response Guidebook*, ERG).

Contact local, State or Department of Energy radiological response team. Use suitable agent for surrounding fire. Cool fire exposed containers with flooding quantities of water applied from as far a distance as possible. Avoid breathing dust and fumes; keep upwind.

HAZARDOUS COMBUSTION PRODUCTS: Thermal decomposition products may include corrosive fumes of hydrogen fluoride and toxic and hazardous oxides of uranium.

SECTION 6: ACCIDENTAL RELEASE MEASURES

OCCUPATIONAL SPILL: Do not touch spilled material. Keep unnecessary people away; isolate hazard area and deny entry. Stay upwind; keep out of low areas. Delay clean up until arrival or instruction of qualified radiation authority.

SECTION 7: HANDLING AND STORAGE

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

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

EXPOSURE LIMITS:

Uranium, insoluble compounds (As U):

0.2 mg/m³ OSHA TWA; 0.6 mg/m³ OSHA STEL; 0.05 mg/m³ OSHA TWA (soluble)

0.2 mg/m³ ACGIH TWA; 0.6 mg/m³ ACGIH STEL

0.2 mg/m³ NIOSH recommended TWA; 0.6 mg/m³ NIOSH recommended STEL

0.25 mg/m³ DFG MAK TWA (total dust);

2.5 mg/m³ DFG MAK 30-minute peak, average value, 1 time/shift

Hydrogen Fluoride

6ppm OSHA STEL (15 minutes), 3 ppm OSHA PEL

0.5 ppm ACGIH TWA, 2ppm ACGIH Ceiling

6 ppm NIOSH Ceiling, 3 ppm NIOSH REL TWA (10 hours)

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.

VENTILATION: At a minimum, provide local exhaust or process enclosure ventilation. Depending upon the specific work place activity and the radioactivity of the isotope, a more stringent ventilation system may be necessary to comply with exposure limits set forth by law (10 CFR 20.103)

Exposure levels should be maintained As Low As Reasonably Achievable

(ALARA). SHIELDING:

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. Uranium tetrafluoride, in quantities used for Certified Reference Materials, does not emit significant amounts of beta particles.

GAMMA RAYS: The most suitable materials shielding gamma radiation are lead and iron. Uranium tetrafluoride, in quantities used for Certified Reference Materials, does not emit significant amounts of gamma radiation. Consult a radiation protection specialist or health physicist for more information.

ALPHA-NEUTRON REACTION: Neutrons of approximately 2 MeV are generated by the interaction of alpha particles from uranium with the nuclei of fluorine and other low-Z atoms. The magnitude of the neutron flux will vary based on the total activity of uranium (which is a function of enrichment) and the chemical compound in question (mixing of U and F). In the case of quantities of uranium tetrafluoride used in Certified Reference Materials, the total neutron dose rate is very low.

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: Laboratory uses only protective clothing should be utilized.

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 should be disposed of as radioactive waste.

RESPIRATOR: The following respirators and maximum use concentrations are recommendations by the U.S. Department of Health and Human Services, NIOSH Pocket Guide to Chemical Hazards; NIOSH criteria documents; or by the U.S. Department of Labor, 29 CFR 1910 Subpart Z.

The specific respirator selected must be based on contamination levels found in the work place, must not exceed the working limits of the respirator, and must be jointly approved by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration (NIOSH-MSHA).

URANIUM, INSOLUBLE COMPOUNDS (As U); HALIDES: AT ANY DETECTABLE CONCENTRATION:

Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.

Any supplied-air respirator that has a full facepiece and is operated in a 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.

Escape - any air-purifying, full-facepiece respirator having a high-efficiency particulate filter. Any appropriate escape-type, self-contained breathing apparatus.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive pressure mode.

Any supplied-air respirator that has a full facepiece and is operated in a 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.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

DESCRIPTION: Nonvolatile, green triclinic crystalline solid.

MOLECULAR WEIGHT: 314 (for normal uranium)

MOLECULAR FORMULA: UF₄

MELTING POINT: 1760oF (960oC) BOILING POINT: 1417oC

SPECIFIC GRAVITY: 6.7

WATER SOLUBILITY: insoluble

SOLVENT SOLUBILITY: Alkalis (decomposes), concentrated acids. Insoluble in dilute acids and alkalis.

FLAMMABILITY: No data

FLASH POINT: No data
AUTOIGNITION DATA: No data
ODOR: No data

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

$^{233}\text{U} = 1.59 \times 10^5 \text{ y}$; $^{234}\text{U} = 2.47 \times 10^5 \text{ y}$; $^{235}\text{U} = 7.04 \times 10^8 \text{ y}$; $^{236}\text{U} = 2.39 \times 10^7$; $^{238}\text{U} = 4.51 \times 10^9 \text{ y}$.

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

$^{233}\text{U} = 3.6 \times 10^2 \text{ MBq/g}$ ($6.2 \times 10^{-3} \text{ Ci/g}$)
 $^{234}\text{U} = 2.3 \times 10^2 \text{ MBq/g}$ ($6.2 \times 10^{-3} \text{ Ci/g}$)
 $^{235}\text{U} = 7.8 \times 10^{-2} \text{ MBq/g}$ ($2.1 \times 10^{-6} \text{ Ci/g}$)
 $^{236}\text{U} = 2.3 \text{ MBq/g}$ ($6.3 \times 10^{-5} \text{ Ci/g}$)
 $^{238}\text{U} = 1.2 \times 10^{-2} \text{ MBq/g}$ ($3.3 \times 10^{-7} \text{ Ci/g}$)

SECTION 10: STABILITY AND REACTIVITY

REACTIVITY:

URANIUM TETRAFLUORIDE:

Produces hydrofluoric acid in reaction with water. Reacts slowly with moisture at ambient temperature, forming UO_2 and HF. HF is a corrosive and poisonous gas.

CONDITIONS TO AVOID: May ignite combustible materials such as paper, wood, and oil. Container may explode in heat or fire.

INCOMPATIBILITIES

: URANIUM

TETRAFLUORIDE:

No specific data available for this compound.

HAZARDOUS DECOMPOSITION: Thermal decomposition products may include corrosive fumes of hydrogen fluoride and toxic and hazardous oxides of uranium.

POLYMERIZATION:

Hazardous polymerization has not been reported to occur under normal

temperature and pressure.

SECTION 11: TOXICOLOGY INFORMATION

URANIUM TETRAFLUORIDE:

CARCINOGEN STATUS: None as chemical. Long-term radioactive exposure is associated with increased cancer of lymphatic and blood-forming tissues in man.

Uranium tetrafluoride is highly corrosive to the skin, eyes, and the respiratory tract. Uranium tetrafluoride upon exposure to moisture in air will release hydrogen fluoride which is poisonous and corrosive. Poisoning affects the kidneys, liver, lungs, and hematopoietic system, and causes disorders in protein and carbohydrate metabolism. Fluoride poisoning affects the skin, digestive, circulatory, respiratory, and central nervous systems. Fluoride may bind blood calcium and magnesium to inhibit some enzyme systems.

HEALTH EFFECTS INHALATION:

URANIUM TETRAFLUORIDE: RADIOACTIVE/NEPHROTOXIN

30 mg (U)/m³ Immediately Dangerous to Life or Health. 500 mg (F)/m³ Immediately Dangerous to Life or Health.

ACUTE EXPOSURE: Inhalation of uranium dust or fumes may irritate the entire respiratory tract and cause coughing, dyspnea, pulmonary edema, pneumonia or emphysema.

Symptoms of systemic uranium poisoning may be delayed 1-4 days. Inflammation of the kidney is the primary result of uranium poisoning. Liver damage may result. Fluoride dusts are extremely irritating to nose, throat, and respiratory tract and may cause pulmonary edema and irritation of the bronchial mucosa. Exposure to high levels is usually fatal.

Lower levels may cause coughing, choking, and chills lasting 1-2 hours after exposure. Following an asymptomatic period of 1-2 days, fever, cough, dyspnea, rales, and cyanosis from pulmonary edema may progress for 1-2 days. Recovery may require 10-30 days.

Systemic effects may result from absorbed fluoride ions binding calcium and magnesium and inhibiting vital enzyme systems.

CHRONIC EXPOSURE: Uranium may be absorbed to cause pulmonary and renal damage and may increase the risk of carcinogenesis of lung, lymphatic, and hematopoietic tissues. Repeated or prolonged exposure to fluoride ions may cause cough, shortness of breath, weight loss, anorexia, anemia, cachexia, bone and dental defects, eosinophilia, impairment of growth, hyperthermia, cyanosis and,

pulmonary fibrosis.

ALPHA RADIATION:

ACUTE EXPOSURE - 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 - The effects of chronic exposure by internally deposited alpha active material are 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:

URANIUM TETRAFLUORIDE: RADIOACTIVE/NEPHROTOXIN.

ACUTE EXPOSURE - Insoluble salts of uranium, including uranium tetrafluoride, was not lethal by skin absorption, and produced no signs of poisoning. The dust may irritate the skin or cause rashes.

CHRONIC EXPOSURE - Prolonged skin contact with uranium compounds should be avoided due to potential radiation damage to basal cells. Prolonged exposure to uranium or fluoride dusts may cause dermatitis.

EYE CONTACT:

URANIUM TETRAFLUORIDE:

RADIOACTIVE.

ACUTE EXPOSURE - Dust may irritate the eyes and may cause moderate to severe injury to the eyes. Uranium compounds are protein precipitants; in general, this reaction is lessened by presence of bicarbonate and citrate ions. One human exposure to uranium tetrafluoride caused reversible chemical conjunctivitis and corneal necrosis. Contact lenses should not be worn when handling this, or any other, uranium compound.

CHRONIC EXPOSURE - Repeated or prolonged eye contact may result in irritation and conjunctivitis.

ALPHA RADIATION:

ACUTE EXPOSURE - 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 uranium tetrafluoride would most likely result in serious damage to the cornea before cataracts would be formed. Normal usage of Certified Reference

Materials will not result in significant eye exposures except in cases of accidents or poor laboratory practice.

CHRONIC EXPOSURE - Repeated or prolonged exposure to alpha radiation may result in cataract formation. See acute exposure.

INGESTION:

URANIUM TETRAFLUORIDE: RADIOACTIVE/NEPHROTOXIN.

ACUTE EXPOSURE - Fluoride poisoning may cause excessive salivation, nausea, vomiting, diarrhea, and abdominal cramps. Later, weakness, tremor, shallow respiration, carpopedal spasms, and convulsions may occur as a result of fluoride binding calcium and magnesium. Death may result from respiratory paralysis. If victim survives, jaundice and oliguria may occur later. Once absorbed, uranium rapidly leaves the blood and is deposited in the tissues. Uranium compounds are protein precipitants and may cause inflammation of the liver and kidneys within 1-4 days after exposure.

CHRONIC EXPOSURE - Intake of more than 6 mg of fluoride per day may cause fluorosis which is characterized by weight loss, brittleness of bones, stiff spine, calcification of the ligaments of the ribs and pelvis, painful movement of joints, anemia, eosinophilia, anorexia, cachexia, and impaired growth and discoloration of the teeth in children. Risk of cancer of lymphatic and blood-forming tissues may be increased by uranium exposure.

ALPHA RADIATION:

ACUTE EXPOSURE - The fate of ingested alpha emitters depends on their solubility and valence.

CHRONIC EXPOSURE - Repeated ingestion of alpha emitters may increase cancer risks.

FIRST AID FOR URANIUM COMPOUNDS: 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 (one bottle of 250 mL at 1.4%).

SECTION 12: ECOLOGICAL INFORMATION

Environmental Impact Rating (0-4): 2

Acute Aquatic Toxicity: Acute and chronic aquatic toxicity (Category 2)

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.

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:	}	To be determined on a case by case basis.
Hazard Class:		
UN/ID Number:		
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: Y

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 PREPOSITION 65:	N

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

ACUTE HAZARD:	Y
CHRONIC HAZARD:	Y
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 inter-laboratory comparison programs at analytical laboratories, which routinely handle uranium and/or plutonium. The NBL Program Office (NBL PO) assumes that recipients of this material have developed internal safety procedures, which guard against accidental exposure to radioactive and toxic materials, contamination of the laboratory environment, or criticality. NBL PO 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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Creation Date: December 28, 1994

Revision Date: June 23, 2020