

SAFETY PROTOCOL: URANIUM

Use of radioactive materials requires a safety protocol be submitted to the UNL Radiation Safety Committee (RSC) for approval. This is a safety protocol. To obtain RSC approval:

- Submit an Authorization for Radioactive Material Use request for approval to the UNL RSC. Contact the UNL Radiation Safety Officer (RSO) for specific instructions.
- Agree to use this safety protocol or submit an alternative and equivalent procedure that you develop to meet your unique needs.

All radiation workers must be at least 18 years of age and have completed required radiation safety training. **Never handle radioactive material prior to the completion of radiation safety training.**

All research protocols involving the radioactive material must be approved by the RSC.

Physical Data

Physical data for isotopes of uranium and primary decay products are provided in the following table.

Table 1. Physical Properties of Uranium Isotopes.

Isotope	Half-Life	Natural Abundance (%)	Specific Activity (Ci/g)	Primary Decay Mode	Radiation Energy (MeV)		
					Alpha (α)	Beta (β)	Gamma (γ)
U-232	72 yr	0	22	α	5.3	0.017	0.0022
U-233	160,000 yr	0	0.0098	α	4.8	0.0061	0.0013
U-234	240,000 yr	0.0055	0.0063	α	4.8	0.013	0.0017
U-235	700 million yr	0.72	0.0000022	α	4.4	0.049	0.16
²³¹ Th-231	26 hr		540,000	β	-	0.17	0.026
U-236	23 million yr	0	0.000065	α	4.5	0.011	0.0016
U-238	4.5 billion yr	>99	0.00000034	α	4.2	0.010	0.0014
²³⁴ Th-234	24 days		23,000	β	-	0.060	0.0093
^{234m} Pa-234m	1.2 min		690 million	β	-	0.82	0.012

²³¹Th-231, ²³⁴Th-234, and ^{234m}Pa-234m are included here because these radionuclides accompany the uranium decays. Source: Argonne National Laboratory, EVS – HHFS, August 2005

At UNL several of the research activities involve the use of natural or depleted uranium. Natural isotopes of uranium are U-238, U-235 and U-234 (see Table 1 for natural abundances). Depleted uranium contains less of the isotopes: U-235 and U-234. The specific activity of depleted uranium ($5.0E-7$ Ci/g) is less than that of natural uranium ($7.1E-7$ Ci/g).

Certain uranium compounds, such as mass spectroscopy standards, uranyl acetate and uranyl nitrate, may be acquired in small quantities without RSC approval. However, such compounds shall be disposed through EHS. Contact the UNL RSO for further instructions regarding these compounds.

Radiation Protection Procedures

1. Special equipment or procedures
 - Uranium is primarily an alpha particle emitter, as well as a toxic heavy metal. Therefore, internal exposure through ingestion, inhalation or injection through wounds is of primary concern.
 - Dusty or volatile chemical forms should be handled in a radiation posted fume hood.
 - Use lab coats, eye protection, and disposable gloves.
 - Regularly monitor and promptly decontaminate gloves and work surfaces to maintain contamination and exposures As Low As Reasonably Achievable (ALARA).
 - Select gloves appropriate for chemicals handled. Never handle uranium without gloves.
 - Uranium metal can corrode – if corrosion occurs, any removable corrosive material should be treated as contamination.
 - Fine particles or shavings of uranium can be pyrophoric. The use of uranium fines should be avoided.
2. Shielding requirements
 - Shielding is typically not required for depleted uranium. In fact, depleted uranium is often used as shielding material for other radionuclides and sources of radiation.
 - Natural uranium sources greater than 5 mCi (7 kg) should be stored in a shielded container, preferably of lead.
3. Surface contamination survey schedule
 - A survey meter should be used to monitor work surfaces after use.
 - A removable contamination (swipe) survey utilizing a smear and appropriate counter must be performed each month in which radioactive material is used (including sewer disposal). The RSC may require a higher contamination survey frequency depending on the amount of material in process.
 - The action limit for cleanup of removable contamination is 1000 dpm/100cm². Any indication above this limit on a swipe survey or above

(Created 5/09)

two times background with a survey instrument is considered to be contamination. Any accessible area found to be contaminated above this limit shall be decontaminated.

4. Bioassay requirements

- None routinely required.

5. Dosimetry

- Uranium can pose a slight external hazard mainly from low-energy gamma and beta radiation when directly handling the material (potential skin effects).
- Uranium can pose an internal hazard if ingested, inhaled or injected through a wound.
- The bone surfaces and kidneys are the critical organs for internal exposure to uranium compounds. Chemical toxicity to the kidney may be of greater concern than the radiation dose to bone surfaces for ingestion of soluble forms of uranium.
- The annual limit of intake (ALI) through ingestion is 11 μCi . The ALI through inhalation depends on the solubility of the inhaled aerosol and ranges from 0.05 to 1 μCi , where insoluble compounds have the lowest ALI.

Waste Disposal

EHS procedures for disposal of hazardous and /or radioactive wastes are to be followed. Uranium waste should be segregated from other radioactive waste.

Survey Meters

A survey meter is required to work with uranium. A thin window Geiger-Mueller tube or a thin window NaI detector is necessary to detect uranium.

Personnel Monitoring

Dosimeters are required when any individual will receive or is likely to receive in any period of one year an occupational dose in excess of 10% of the applicable limits. At UNL all users of uranium are issued whole-body and ring dosimeters.