

**U<sub>nat</sub>**

# Uranium (natural and depleted composition)

## Radioisotope Fact Sheet

**Half life** 4.47 x 10<sup>9</sup> years

### General information

Commercially available uranium compounds are prepared from what is termed *depleted* uranium, i.e. natural uranium which has had the concentration of the fissile isotope <sup>235</sup>U reduced.

Samples of uranyl acetate have shown the following isotopic compositions:

Isotope	Sample concentrations Bq/gram	Natural U concentration Bq/gram
<sup>238</sup> U	6900	6900
<sup>234</sup> U	900 to 3300	6900
<sup>235</sup> U	90 to 185	323
<sup>234m</sup> Pa	6900	6900
<sup>234</sup> Th	6900	6900

The process used to extract <sup>235</sup>U also lowers the concentration of <sup>234</sup>U. In natural (unprocessed) uranium ores, <sup>234</sup>U is in secular equilibrium with <sup>238</sup>U. Uranium 234 has a long half-life (244 000 years) and consequently there is no appreciable in-growth of the isotope in normal time scales.

Protactinium-234m and <sup>234</sup>Th are very short-lived isotopes that grow in rapidly after the separation of uranium from its ores and reach secular equilibrium with <sup>238</sup>U in about 300 days. Commercially purchased uranium chemicals will have the thorium and protactinium isotopes in secular equilibrium given the time scales involved in ore processing and refining.

### Radiations emitted

Consist essentially of three uranium isotopes: <sup>238</sup>U, <sup>234</sup>U and <sup>235</sup>U, with <sup>238</sup>U having a proportion by mass of between 99.6% and 99.8% depending on the degree of depletion of <sup>235</sup>U and <sup>234</sup>U.

Radiation	Energy (keV)	Yield (%)
Beta ray	2281 – max, 81 - average	99 from <sup>234m</sup> Pa
Beta ray	466 – max, 149 - average	53.1
Gamma ray	1200 - average	< 1

### Safety precautions

Safety measures should aim at preventing ingestion, inhalation, or skin contact. Standard laboratory PPE should always be used. A fume cupboard should be used for processes that could produce an inhalation hazard, e.g. mixing of dry chemicals. Work areas and equipment should be monitored using a suitable survey meter. Because of the very low specific activity and low gamma ray yield, there are no significant external hazards. There is no requirement for shielding when using or storing commercially available quantities of uranium chemicals.

### Radiotoxicity data

Since uranium chemicals contain alpha emitters they present significant internal hazards and this is reflected in the low annual limits on intake.

The Annual Limit on Intake by ingestion (ALI<sub>ing</sub>) is 450 kBq and the most restrictive inhalation limit (ALI<sub>inhal</sub>) is 2.7 kBq. The chemical toxicity effects are more significant than the radiological ones and consist chiefly of damage to the kidneys (nephrotoxicity) and the production of necrotic arterial lesions.

### Licensing requirements

Under the *Radiation Safety Regulation 2021*, a licence is required for the possession of <sup>238</sup>U sources with concentrations of greater than or equal to 1 Bq per gram and with activities of 1 kBq or greater. A use licence is also required for any persons who use such sources for research purposes.

### Disposal data

The maximum concentration of uranium in aqueous wastes released to a sewerage system is given in the Regulation as 3.11 kBq per m<sup>3</sup> i.e. 3.11 Bq per litre. The concentration of uranium in solid wastes disposed of to the general waste stream must be less than 0.5 Bq per gram (500 Bq per kg) – i.e. half the concentration limit for licensing.

Wastes containing uranium should not be placed in a decay store as there will be no significant diminution in activity and

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accountability for the waste may be lost. Users should consult with the RSO to determine the most appropriate method of waste disposal.

**Radiation detection and monitoring**

A Geiger Muller tube monitor is the most suitable type of meter for contamination control. Personal monitoring is not required.

**Laboratory requirements**

Indicative maximum activities:

Low level	Bench	500 kBq
	Fume cupboard	5 MBq
Medium level	Bench	1 MBq
	Fume cupboard	10 MBq