

DEPLETED URANIUM (DU) WASTE

What is depleted uranium waste?

What does a depleted uranium hexafluoride cylinder look like?

- A picture is worth a thousand words! The pictures below show typical depleted UF_6 storage cylinders. The picture on the left shows a new cylinder; the picture on the right shows cylinders that exhibit external corrosion from outdoor storage.



- Text and photos above retrieved 5 Nov 2013 from <http://web.ead.anl.gov/uranium/fsu/storage/fsq14.cfm>
- Note: a relatively small fraction of depleted uranium is also stored in smaller (e.g., 55-gal or 80-gal) metal drums.

- Large quantities of depleted uranium (DU) waste are being considered for disposal at EnergySolutions' Low-Level Waste Disposal Facility at Clive, Utah. This DU waste is mildly radioactive uranium oxide produced as a waste product during uranium processing.
- DU has lower radioactivity in it than natural uranium (about 60%), and much lower radioactivity than the enriched uranium used in power reactors; this difference arises from the fraction of uranium isotopes (particularly U-235, and U-234) found in the different types of uranium:

Isotope	Natural Uranium	Enriched Uranium*	Depleted Uranium
U-234	0.0055%	0.05%	0.001%
U-235	0.72%	3-5%	0.2-0.3%
U-238	99.275%	95-97%	99.7-99.8%

An isotope is a form of an element that has the same chemical properties as other forms of the element but different physical properties. As seen above, natural uranium is estimated to contain about five to six times as much U-234 and two to four times as much U-235 as DU.

Ingrowth of DU Daughter Products

- Uranium decays and forms decay products that increase in radioactivity over time. This is called ingrowth.
- Uranium isotopes have long half-lives (e.g., millions or billions of years), so DU itself retains its radioactivity for very long times.
- As DU slowly decays, however, daughter products that it generates include thorium-230, radium-226 and radon.
- These daughter products initially grow and increase in radioactivity at a rate faster than they decay. The total daughter-product radioactivity will gradually increase over time until it peaks after about one to two million years. At that point, each daughter product will be decaying as fast as it is generated. Its radioactivity then will equal that of the long-lived uranium. This condition is called secular equilibrium.
- The radioactivity at the time of secular equilibrium may be about 14 times the initial radioactivity of the DU. Although waste classification is performed prior to shipment and disposal, radium-226 concentrations may increase beyond Class A and Class C values after a lengthy time.
- Since DU daughter products experience ingrowth, it is important for a Licensee to assess how much exposure risk may exist over that time as a result of potential environmental releases from a waste embankment. Environmental releases may potentially occur through air, water, soil or biota. The radiation dose that a representative person could potentially receive can be simulated or modeled with a computer to some extent. The modeling done here will be based on a probability approaches.

*Estimated values based on reported percentages for natural uranium and depleted uranium, and reported enriched uranium U-235 percentages. It is assumed that, as generally reported, 10 pounds of depleted uranium are produced per pound of enriched uranium produced.

How are depleted uranium cylinders currently stored?

- Depleted uranium hexafluoride cylinders are generally stacked two high in concrete, outdoor yards for storage.



- Text and photo above retrieved 5 Nov 2013 from <http://web.ead.anl.gov/uranium/guide/prodhand/t16042.cfm>

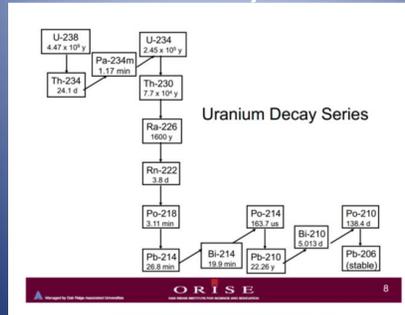
What substances are currently in the DU cylinders?

- Uranium hexafluoride [UF_6] is a white crystalline solid that resembles rock salt.



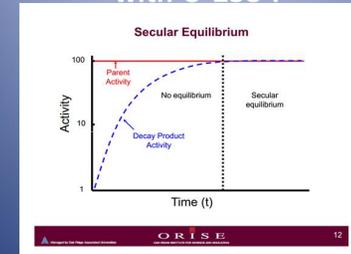
- Text and photo above retrieved 5 Nov 2013 from <http://web.ead.anl.gov/uranium/guide/prodhand/t16042.cfm>
- The uranium hexafluoride must be "deconverted" to uranium oxide before it can be disposed of in a low-level waste (LLW) disposal facility. Note: most drums from the Savannah River SC Site and a small fraction of cylinders at the Portsmouth, OH and Paducah, KY sites contain other radioactive contaminants, some of which are long-lived and mobile, which must be assessed for suitability for shallow embankment burial.

What does DU decay over time?



- Diagram retrieved 5 Nov 2013 from <http://ghadupws.nrc.gov/docs/ML1122/ML11227A233.pdf>
- The numbers represent half lives in microseconds (us), minutes (min), days (d), and years (y).

How long before secular equilibrium with U-238?



- Diagram retrieved 5 Nov 2013 from <http://ghadupws.nrc.gov/docs/ML1122/ML11227A233.pdf>
- The parent in the case of DU would largely be depleted uranium-238, and the representative decay product would be one of DU's daughter products. Secular equilibrium is not attained until about one or two million years. Note: at secular equilibrium, the activity of each daughter product equals that of the parent. There are over a dozen daughter products.