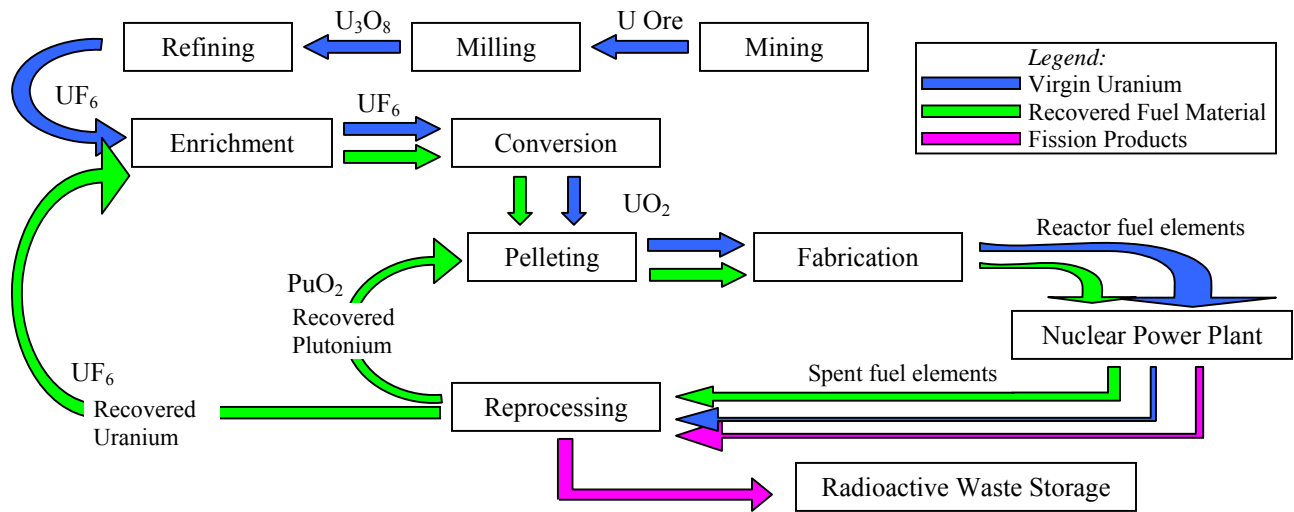


NUCLEAR FUEL CYCLE



Decay Heat

The fission product decay heat production after shutdown from generating at a power level of P_0 is

$$P_{decay}(t) = P_0 (0.066) t^{-0.2}$$

where t is time in seconds.

Cooling Time	Decay Heat Source	Burnup Parameter of Interest
Short	From short-lived fission products that have reached equilibrium/saturation values during operation	Operating Fuel Specific Power (P_s)
Long	From accumulation of long-lived fission products which is more dependent of length of operation	Discharge Fuel Burnup (B)

Nuclear Fuel Waste

Waste Category	Source	Radiation	Needs
High-Level (HLW)	fission products (mid-Z), liquid waste from first step solvent extraction during reprocessing	beta (β) & gamma (γ) dominate for the first 500-1000 years in HLW	<ul style="list-style-type: none"> • high energy radiation and rapid decay • requires heavy shielding • heat producing
Transuranic (TRU)	activation products ($Z \geq 92$)	alpha (α) radiation dominates thereafter from the transuranics	<ul style="list-style-type: none"> • medium energy radiation and slow decay • do not require heavy shielding • not heat producing

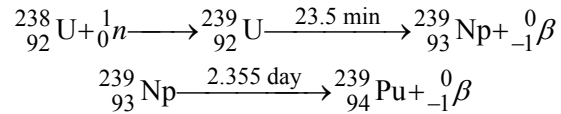
Fuel Enrichment

The fuel enrichment is normally expressed as a weight percent (w/o) according to the following equation:

$$\text{Fuel enrichment} = \frac{\text{Mass of fissile material}}{\text{Mass of fissile and fertile material}} = \frac{M_{U-235}}{M_U}$$

Fuel Conversion

While fertile fuel (e.g., Th-232 and U-238) resides in an operating reactor, those atoms inevitably capture neutrons and are changed into a fissile atom. Consider the formation of Pu-239 from U-238:



where neutron absorption by U-239 and Np-239 have been neglected compared to the loss by radioactive decay given their relatively short half-lives. On the other hand, Pu-239 has a half-life of 2.4×10^4 yrs. If the Pu-239 remains in the reactor, it may either absorb a neutron or it can decay. To determine the amount of Pu-239 present at any time, the basic balance equation can be utilized.