

**22.251 Systems Analysis of the Nuclear Fuel Cycle
Fall 2005**

Lab #1: CASMO-4 Pin Cell Calculations

A sample PWR unit cell burnup calculation using CASMO-4 for a standard case of UO₂ fuel enriched to 5 w/o U-235 (in total U) (the current US licensed limit) has been given in the class.

Perform burnup calculations for the following cases (without regard to actual practicality):

Case No.	Fissile (all ~5 w/o in HM)	Fertile or (Inert Matrix)
1	U-235	Th-232
2	U-233	U-238
3	U-233	Th-232
4	Pu-239	U-238
5	Pu-239	Th-232
6	U-235	(ZrO ₂)
7	Pu-239	(ZrO ₂)

For simplicity, assume all fissile and fertile number densities are the same as for the reference case. The fuel remains as dioxide in the form of (HM)O₂. For the inert matrix (ZrO₂), use a mass density of 5.85g/cc. Convert all densities to number densities.

Burn the fuel to 80 MWd/kg

(a) Plot reactivity, $\rho_{\infty} = \frac{k_{\infty} - 1}{k_{\infty}}$ vs. burnup for all cases and determine B_1 at $\rho_{\infty} = 0.03$

(Note that a 3% percent leakage is assumed);

(b) Qualitatively explain the relative behavior of the plots as determined by the relevant nuclear properties of the fissile and fertile species involved.