

22.251 Systems Analysis of the Nuclear Fuel Cycle
Fall 2005
PROBLEM SET #3

- 1) Consider three reactor types, a current large PWR, a CANDU fueled with slightly enriched U (SEU), and a small modular pebble-bed HTGR, having the following characteristics:

	<u>PWR</u>	<u>PBMR</u>	<u>CANDU-SEU</u>
Electric Power, MWe	1150	114	881
Thermal Power, MWth	3411	265	2798
FUEL ENRICHMENT, w/o U-235	4.5	8.0	1.20
DISCHARGE BURNUP, MWd/kg	50	80	19.75
FUEL Management	3-BATCH	CONTINUOUS ON-LINE REFUELING	CONTINUOUS ON-LINE REFUELING

- (1a) Compare their uranium and separative work utilization: MWde/kg U_{NAT} and MWde/kg SWU for an enrichment plant tails of 0.25 w/o.
- (1b) Explain why the PBMR fuel cycle might be expected to be (and is or is not) superior to the PWR and/or CANDU.
- 2) Suppose that we are interested in recycling the uranium in the spent fuel of PWRs. The three components isotope separation problem can be represented by those used in the attached page 693 - 697 of Benedict & Pigford. The desired U-235 enrichment for the new fuel is 4.5%. What is the ratio of U^{236}/U^{238} in the new fuel? (hint see section 15.3 for an example that enriches the uranium to a level of 3.2%).

If the reactivity penalty of U^{236} in the discharged spent fuel is $\sim 25\%$ of that of U^{235} , What would it be relative to U^{235} in the recycled new fuel with 4.5% U^{235} ?

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Benedict, M., T. H. Pigford, and H. W. Levi. *Nuclear Chemical Engineering*.
2nd ed. New York, NY: McGraw-Hill, 1981, pp. 693-697.