22.351 Systems Analysis of the Nuclear Fuel Cycle
Spring 2003
Problem Set #8

Problem 1

In the design of a next generation PWR, the total power of the reactor is to increase from 1200MWe to 2000MWe, while the core volume is to remain constant. It was suggested that this can be accomplished in two ways:

(A) Increasing the initial enrichment of the fuel and keeping the operating neutron flux at its current value.

(B) Keeping the initial enrichment of the fuel at its current value and increasing the neutron flux level.

Answer the following questions.

(1) How would you design a new fuel and coolant core conditions to withstand 65% increased power density while satisfying the thermal requirements? How would a new fuel pin differ from a current pin? What are the implications for the flow in the core?

(2) Can a newly designed fuel pin and bundle for option A also be satisfactory for option B? Why?

(3) What are the implications of the two options for the reactor operation, control and safety of the reactor? Explain your answer.

Problem 2

(2.1) If in the uranium pellet manufacturing plant, the average fuel density is 9,700 kg/m^3 and the density standard deviation is 500 kg/m^3 what is the probability of a pellet having a density of 8,500 kg/m^3 ?

(2.2) If the average enrichment of the fuel is 4.2%, with a standard deviation of 0.1%, what is the probability of finding a pellet with an enrichment of 4.4%?

(2.3) Given the above two variable conditions, what is the hot spot factor of the linear heat generation rate if calculated via a deterministic approach? What is it if calculated via a probabilistic approach?