22.351 Systems Analysis of the Nuclear Fuel Cycle
Spring 2003
Problem #9

If you review Sections 3.4 and 3.8 of the "Linear Reactivity Model for Nuclear Fuel Management", you will find that if the reactivity is assumed to follow a linear function of burnup, B:

$\rho = \rho_0 - A B$, where A is a constant

The equilibrium batch discharge for equal power sharing among assemblies can be approximated by:

$B = [2n/(n+1)] [\rho_0 / A]$, where n is the number of batches. (See pp. 73-79 and 88 – 90 in Excerpts from "Linear Reactivity" that is separately posted)

An approximate power sharing ratio (local assembly power to core average power) relation is given by:

$F_i = 1 + \Theta \rho_i$

Where ρ_I = average reactivity over cycle i and Θ is a linearized constant that is dependant on the region size containing assemblies of similar power

For BWRs, with smaller unit assemblies than a PWR, $\Theta\rho_0 = 0.35$

Question: Compare the steady-state cycle burnups of four-batch BWRs operated in the following two modes:

(1) Uniform power throughout irradiation
(2) A power sharing sequence of 1.2, 1, 1, 0.8 (freshest to oldest batches) for the remainder.

Assembly reactivity, including leakage, is given by

$\rho = 0.20 - 10^{-2} B.$