22.251 Systems Analysis of the Nuclear Fuel Cycle
Fall 2009

Laboratory Exercise #2: CASMO Assembly Calculations

Using the whole-assembly CASMO-4 PWR input given in class, answer the following:

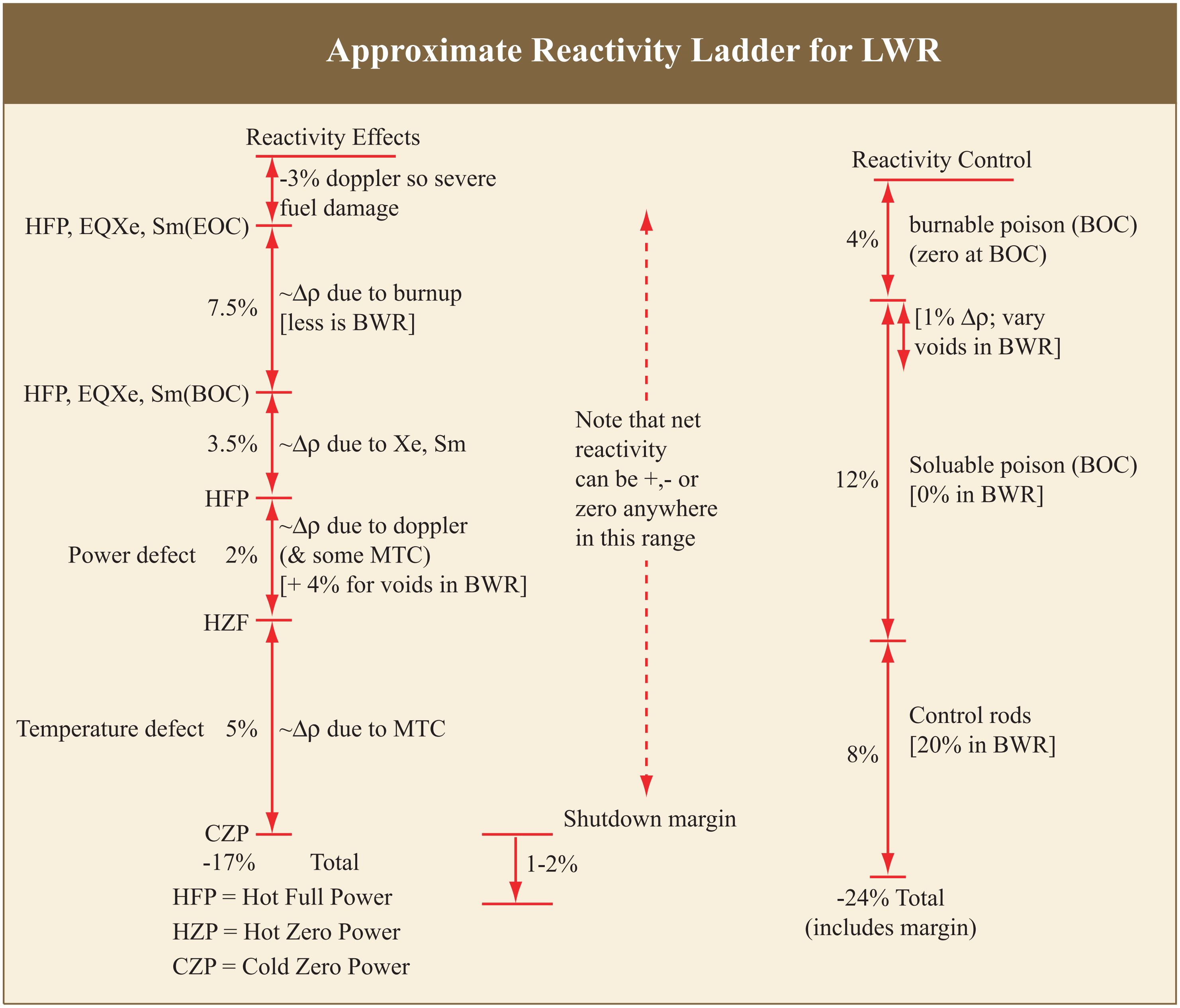
a) Calculate and plot ρ as a function of burnup up to 60 MWd/kg with and without the burnable poison (Gd). Estimate the residual poison Δρ at high burnup (i.e. 60 MWd/kg).

b) At zero burnup calculate the following reactivity feedback coefficients for gadolinium-poisoned fuel assemblies:
   1) Moderator Temperature Coefficient (MTC) in units of Δρ per K by perturbing the temperature of the moderator by 5 K around the reference value. Plot the MTC as a function of coolant temperature in the range between 400 K and 600 K for three different boron concentrations in the coolant: 0 ppm, 1000 ppm, and 2000 ppm. Plot the three MTC vs. temperature curves on the same graph and qualitatively explain the behavior of the curves.
   2) Fuel Temperature Coefficient (FTC or Doppler coefficient) in units of Δρ per K by reducing the reference average fuel temperature to 800 K.
   3) Void Coefficient (VC) in units of Δρ per %void by reducing the moderator density by 10%.

c) Calculate the following additional effects:

Create your own "reactivity ladder" such as attached on the following page by simulating:
   1) Δρ from cold zero power (CZP) to hot zero power (HZP) between 30°C and 300°C with isothermal moderator and fuel.
   2) Δρ from hot zero power to hot full power (HFP)
   3) Δρ due to xenon buildup at HFP by burning for 100 effective full power hours (EFPH)
   4) Calculate the control rod worth by finding the Δρ between water filled and Ag-In-Cd (AIC) rod filled guide tubes. Assuming that only 53 fuel assemblies out 193 in a typical PWR core have control rods, discuss the factors that will affect the individual control rod worth in the full core.

Note: In all parts (except part a) assume poisoned fuel assemblies.



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