**22.251 Systems Analysis of the Nuclear Fuel Cycle**
**Fall 2009**

## Laboratory Exercise #3: Spent Fuel Characteristics Using ORIGEN-2

Investigate the in-situ spent fuel characteristics using ORIGEN-2 for the following cases:

Case 1: 4.2% enriched, 3-cycle PWR, 50 MWd/kg
Case 2: 4.2% U-233 in (U-233+Th-232), 3-cycle PWR, 50MWd/kg
Case 3: 6.0% enriched, 3-cycle PWR, 75 MWd/kg
Case 4: 0.7% enriched, CANDU, 7.5 MWd/kg
Case 5: 1.2% enriched, CANDU, 20.9 MWd/kg

a) Compute radioactivity, decay heat and radiotoxicity for the spent fuel, including only actinides and fission products, over the post-irradiation period that was recommended by the National Academy of Sciences for the Yucca Mountain repository and compare them based on per metric ton initial heavy metal (MTIHM) and per GW-year(electricity).

b) For all cases, identify the radionuclides which account for more than 90% of the radiotoxicity beyond the 10,000 years timeframe.

c) What other factors beyond in-situ radiotoxicity should be considered in evaluating repository performance for these fuels?

d) Based on your assessment, is thorium fuel a significantly better waste product than uranium fuel in a PWR? Furthermore, assuming the same electricity production, which of the analyzed cases produces the least radioactive waste?

   Additional Information: The thermodynamic efficiencies can be assumed as 33.7% for PWRs and 32.2% for CANDUs. The specific power values can be assumed as 38.1 W/gU for PWRs and 25.6 W/gU for CANDUs.

e) Compare Pu production rate (kg of Pu/GWe-Year) for the considered cases. Discuss the effect of high burnup on Pu production and isotopics. Comment on the accuracy of predicting Pu amount and composition by comparing results of Case 1 obtained with ORIGEN and CASMO codes.