Due Oct. 7, 2004

22.251 System Analysis of the Nuclear Fuel Cycle
Fall 2005

Lab #2: Spent Fuel Characteristics Using ORIGEN-2

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

Case 1: 4.2 w/o enriched, 3-cycle PWR, 50 MWd/kg
Case 2: 4.2 w/o U-233 in (U-233+Th-232), 3-cycle PWR, 50 MWd/kg
Case 3: 3.4 w/o enriched, 4-cycle BWR, 40 MWd/kg
Case 4: CANDU, natural uranium, 7.5 MWd/kg
Case 5: CANDU, slightly-enriched uranium (1.2 w/o enriched), 20.9 MWd/kg

1. Compute radioactivity, decay heat, and radiotoxicity (i.e., radioactive ingestion hazard) for the spent fuel (including only actinides and fission products) over the post-irradiation period 0-10^6 years and compare them based on per metric ton initial heavy metal (MTIHM) and per GW-year(electricity)*;

2. For all cases, identify the radionuclides which account for >90% of radiotoxicity in the >10,000 years time frame;

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

4. Based on your assessment, is thorium fuel a significantly better waste product than uranium fuel in a PWR? Furthermore, assume the same electricity production, which reactor produces least radioactive waste among typical PWR, BWR, and CANDU?

∗ The thermodynamic efficiencies can be assumed as 33.7% for PWRs, 33.4% for BWRs, and 32.2% for CANDUs.

† The specific power values are 38.1347 W/gU for PWRs (given), 25.9 W/gU for BWRs, and 25.57 W/gU for CANDUs.