

## **High-Burnup of Spent Nuclear Fuel and Its Implications for Disposal Performance Assessments**

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A variety of characteristics of spent nuclear fuel (SNF) is considered for postclosure performance assessments for high-level nuclear waste disposal. In developing methods for evaluating radionuclide release, it is important to consider the characteristics of the waste forms that will affect release and radiological dose. Burnup of SNF is a factor that influences those characteristics. Projections from the literature indicate an upward trend in SNF burnup and enrichment levels in the United States. A variety of potentially performance-altering factors (e.g., actinide and fission product inventory, thermal output, cladding degradation rate, instant release fraction, and SNF degradation) are associated with higher SNF burnup. The objective of this study is to quantitatively assess the relative impacts of these factors on the performance of a hypothetical disposal system.

Analyses are being carried out using the computer code Scoping of Options and Analyzing Risk (SOAR), a generic, non-site-specific geologic disposal system performance assessment model developed as a tool to increase the U.S. Nuclear Regulatory Commission's (NRC) preparedness for regulating alternative disposal systems and geologic disposal sites. SOAR is being used to risk inform staff on factors and components that may be novel and may significantly impact NRC's regulatory readiness. Prior to using SOAR, ORIGEN-ARP is used to compute radionuclide inventories in the representative rim region of the high burn-up fuel pellets. The SOAR model then uses the radionuclide inventory data to compare the relative effects of high-burnup SNF on radiological dose. Preliminary analyses conducted to date involved only the inventory effects on radiological risk. The analyses suggest approximately 6 percent change to the peak expected dose from the high-burnup SNF (i.e., 60 GWd/MTU; 5 percent enrichment) when compared to the lower burnup (i.e., 40 GWd/MTU; 4 percent enrichment). Other analyses being carried out involve consideration of (i) fuel rod cladding failure time; (ii) increased fission products in the early or instantaneous release fraction of the radionuclide inventory; and (iii) potential effect of microstructural changes (e.g., formation of submicron-sized grains, development of high-pressured micro-pores in the rim region, and fragmentation due to thermal cycling) on SNF dissolution rate, and (iv) potential chemical reactivity changes (e.g., catalytic effect on dissolution of some fission products). The impact of higher thermal output of the high-burnup SNF resulting from higher content of actinides and long-lived fission products will be discussed only qualitatively.

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