Evaluation of Materials for Interim Storage of Spent Fuel for More Than 100 Years

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ABSTRACT

The Fiscal Year (FY) 2011 budget proposed by the Obama administration eliminates all funding for Yucca Mountain and states that "Yucca Mountain, Nevada, is not a workable option for a nuclear waste repository." Given this, sound scientific research is needed to demonstrate that interim storage is a suitable option while a long-term used nuclear fuel management program is developed.

The primary barrier to extending the licensing lifetime of used fuel storage concepts is material degradation and corrosion. This applies to the used fuel pool as well as in dry storage casks. Since the long-term integrity of a thermal neutron poison is essential for effective criticality control of used nuclear fuel during storage, boron-containing alloys or composites have been used in both used fuel pool storage racks and dual-purpose (storage/transportation) canisters and casks.

This study will investigate the properties of boron-containing composite materials, e.g., Boral and Al/B4C metal matrix composite (MMC), which are currently used in dry storage casks and (or to be implemented) in used fuel pools. Boral is currently in used fuel pools and storage/transportation casks with a Nuclear Regulatory Commission (NRC) license for only 20 years. Al/B4C MMC, as an innovative new material, has greater thermal conductivity, which can be very beneficial for casks that will be loaded with mixed oxide fuel (MOX) or highly enriched fuel, but because the B4C is uniformly distributed throughout the matrix with no cladding layers, there are concerns about surface leaching. Leaching is not a concern in dry storage but would reduce the lifetime of the neutron absorber if used in used fuel pools.

The overall objective of this study is to use accelerated tests to evaluate the chemical and mechanical durability of the boron-containing alloys used or to be used in both wet storage pool and dry storage casks for the spent nuclear fuel in the environment with heat and radiation for 100 years and beyond. Radiation, temperature effects on boron leaching, corrosion, and mechanical properties of the materials will be studied. Detailed microstructure analyses will be conducted to establish a structure-property relationship. The results will be used as the basis for extending the licensing period of the currently used materials or for the designing of more durable materials in the future that can satisfy the requirement of the interim storage of spent nuclear fuel for more than 100 years.