Comparison of Performance Evaluation Approaches for Various Waste Management Strategies

J. Guttmann, T. Ahn and J. Davis

U.S. Nuclear Regulatory Commission,

Office of Nuclear Material Safety and Safeguards, Washington, DC 20555, USA

Contact: Tae Ahn, tae.ahn@nrc.gov, +1-301-492-3150

Abstract

This paper compares performance evaluation approaches for various nuclear waste management strategies. It focuses on waste forms, reactor generated spent nuclear fuel (SNF), high-level waste (HLW), and the waste package, in the context of: (i) extended storage and transportation (EST) and long-term geological disposal of SNF and HLW, and (ii) operational safety associated with EST and disposal. Performance evaluation methods could be either deterministic or probabilistic. A deterministic modeling technique typically consists of bounding analyses that obtain their basis from engineering and scientific methods and experimental test results. Process-level modeling might also be incorporated in assessing the performance of SNF and HLW under various postulated conditions. Deterministic modeling techniques have been widely used to support design-based regulatory requirements. Often, consensus standards or regulatory guides complement the technology by providing an example of an acceptable approach to meeting a deterministic regulatory requirement. The probabilistic modeling technique, on the other hand, is an extension of deterministic methods. It is based on event(s) identification and associated failure mechanisms, probability and probability cut-off to the failure mechanisms, and incorporates consequence analysis. The probabilistic modeling is consistent with risk-informed performance-based regulation, as well as allowing for optimizing and identifying risk-mitigation techniques for the design and operation of a waste management system. Probabilistic modeling techniques will also help with the early identification of potentially risk-significant issues. Overall, these two modeling techniques can be complementary. This paper presents a few example cases comparing the strengths or weaknesses of deterministic and probabilistic techniques, including waste package corrosion, degradation of SNF or HLW, and their effects on the system performance of SNF and HLW management. The example studies consider (i) various events and sequences under nominal and accident conditions, (ii) various methods in assessing probability cut-off and dose exposure (e.g., dose to the worker or dose to the public), (iii) radionuclide release path, (iv) radionuclide release fraction, and (v) criticality and shielding control.

Disclaimer