Indoor Worker Dose Calculations For Hot Cell Leakage

The U.S. Department of Energy (DOE) is currently considering design options for the preclosure facilities that will handle high-level radioactive waste at the potential nuclear waste repository at Yucca Mountain, Nevada. Assessment of dose to occupational workers during preclosure operations may be a significant aspect of the license application. Workers may be involved in manual and remote operations in handling transportation casks, canisters, waste packages, or bare spent nuclear fuel assemblies inside facility buildings. There is a potential for indoor airborne radioactive material if a hot cell is used to open canisters or handle bare fuel. Leakage of contaminated air from the hot cell into adjacent occupied areas, therefore, represents a potential exposure pathway for indoor workers that could be considered during normal operations and potential event sequences. The objective of this study is to develop modeling capabilities for estimating this potential type of exposure to indoor workers. In the absence of final design information, a generic mass-balance model is developed for estimating radionuclide concentrations and dose consequences to indoor workers in a control room adjacent to the hot cell. The two-compartment model computes internal and external worker doses in the control room from inhalation and submersion in a finite cloud of contaminated air. An illustrative example is presented for a hypothetical scenario associated with failure of the hot cell ventilation system and subsequent leakage of residual airborne radioactive material, present during normal handling operations in the hot cell, into the control room. Dependence of indoor worker dose on ventilation and leakage flow rates and worker exposure duration is also presented. Although the facility design and handling operations have not been finalized by DOE, the model can be applied to potential handling accidents that result in the breach of bare fuel assemblies or canisters. The presented model for indoor worker doses is incorporated into the PCSA Tool, developed to aid in the regulatory review of a potential U.S. Department of Energy license application, including associated independent assessments that may be needed. This paper is an independent product of CNWRA and does not necessarily reflect the view or regulatory position of U.S. Nuclear Regulatory Commission.