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Abstract

Modeling the Inhalation Exposure Pathway in Performance Assessment of Geologic Radioactive Waste Repository at Yucca Mountain

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Inhalation exposure pathway modeling has recently been investigated as one of the tasks of the BIOPROTA Project (BIOPROTA 2005). BIOPROTA was set up to address the key uncertainties in long term assessments of contaminant releases into the environment arising from radioactive waste disposal. Participants of this international Project include national authorities and agencies, both regulators and operators, with responsibility for achieving safe and acceptable radioactive waste management.

The objective of the inhalation task was to investigate the calculation of doses arising from inhalation of particles suspended from soils within which long-lived radionuclides, particularly alpha emitters, had accumulated. It was recognized that site-specific conditions influence the choice of conceptual model and input parameter values. Therefore, one of the goals of the task was to identify the circumstances in which different processes included in specific inhalation exposure pathway models were important.

This paper discusses evaluation of processes and modeling assumptions specific to the proposed repository at Yucca Mountain as compared to the typical approaches and other models developed for different assessments and project specific contexts.

Inhalation of suspended particulates that originate from contaminated soil is an important exposure pathway, particularly for exposure to actinides such as uranium, neptunium and plutonium. Radionuclide accumulation in surface soil arises from irrigation of soil with contaminated water over many years. The level of radionuclide concentration in surface soil depends on the assumed duration of irrigation. Irrigation duration is one of the parameters used on biosphere models and it depends on a specific assessment context. It is one of the parameters addressed in this paper from the point of view of assessment context for the proposed repository at Yucca Mountain.

The preferred model for the assessment of inhalation exposure uses atmospheric mass loading approach, which is based on the mass of airborne particulates per unit volume of air that is inhaled by the receptor. This type of model was used by the majority of the BIOPROTA inhalation task participants and is also used in the Yucca Mountain model. Although the mass loading model is conceptually straightforward, there are some considerations that need to be included when using this model.

Small particles have larger surface to volume ratio than large particles and this ratio increases in inverse proportion to the particle size. This is particularly important for elements such as plutonium, which have high sorption coefficients, and thus are preferentially attached to small particles of soil. Suspended particulates originating from soil are composed of particles smaller than average soil particles and thus, on average, have larger available surface area, and consequently activity, per unit mass than that of

soil. The increase of radionuclide concentration of suspended particulates compared with that of underlying soil is quantified in terms of the enhancement factor, which is included in the inhalation model for the Yucca Mountain repository.

In this paper, the use of the enhancement factor in the inhalation exposure models is discussed. Then, enhancement factor values used in the Yucca Mountain model are discussed from the perspective of site-specific conditions as well as the micoroenvironmental approach to modeling inhalation exposure of the receptor. The receptor can spend specified time in several environments, each of them characterized by an occupancy time, suspended particulate level, enhancement factor and breathing rate. The environment where inhalation exposure is the highest is associated with the receptor being active outdoors and involved in activities that generate high levels of dust by using farm equipment, walking, or conducting other outdoor activities.

In summary, it is important to recognize that site-specific conditions play an important role in constructing conceptual and mathematical models of inhalation exposure.

Reference:

BIOPROTA 2005. Modelling the Inhalation Exposure Pathway. A report prepared within the international collaborative project BIOPROTA: Key Issues in Biosphere Aspects of Assessment of the Long-term Impact of Contaminant Releases Associated with Radioactive Waste Management. Published on behalf of the BIOPROTA Steering Committee by BNFL (Nexia Solutions Ltd), UK.