# THE IMPORTANCE OF QUANTIFYING THE RADIATION SOURCE TERM IN A GEOLOGIC REPOSITORY

*The radiation "source term" sets the boundary condition for assessing the containment capability of the undisturbed geology in a repository system. Knowing the source term accurately is crucial for properly assessing the performance of a repository and the potential radiation dose to the public.*

*Because of the complexity of the source term, designers of geologic repositories have preferred making "bounding" or conservative assumptions to quantify the source term. Comprehensive research and analysis on site-specific factors affecting the radiation source term could result in a better fundamental understanding of the realistic performance characteristics of a proposed repository, thus reducing uncertainties and potentially resulting in a less complex and less costly repository design.*

Geologic repositories for the disposal of high-activity radioactive waste use a combination of natural and engineered barriers to isolate radionuclides from the accessible environment. *Engineered* components of a geologic repository system include the waste forms (e.g., spent nuclear fuel and high-level radioactive waste) and containers for the waste forms, as well as any shielding, packing, and other absorbent materials immediately surrounding individual waste containers. Water-diversion devices (e.g., drip shields) also may be part of an engineered system in a geologic repository. *Natural* components of a geologic repository system include the geology in which the waste forms and containers will be emplaced and the geology below and overlying the host rock. The geology in the immediate vicinity of the emplaced waste is disturbed by the decay heat of the waste and by excavation associated with constructing the repository. The geology farther away from the emplaced waste is undisturbed by these factors. Radionuclides from the waste forms eventually will be transported—primarily by water—through the engineered system and the disturbed geology into the undisturbed natural system below the repository. From this point, the undisturbed geology will determine when and at what levels the radionuclides ultimately will emerge in the accessible environment.

The *radiation source term* must be confined by the undisturbed geologic environment to meet repository performance goals. A technical definition of the radiation source term is: the mass flow rates and the chemical and physical forms of radionuclides that enter the undisturbed geologic environment from the disturbed geology as a function of time. Depending on which radionuclides are in the waste that is emplaced in the repository, the radiation source term may exist for hundreds of thousands or even millions of years before all radionuclides decay to inconsequential amounts.

Quantifying the radiation source term involves more than determining the inventory of radionuclides in the waste form, it also is necessary to understand how the radionuclides interact with environments affected by degrading components of the engineered system and by components of the disturbed natural system.

Scientific studies have confirmed that engineered barriers such as robust (i.e., thick-walled and corrosion-resistant) waste containers and devices that protect and prevent or delay water from contacting the waste containers (e.g., drip shields and backfill materials) are very important in reducing uncertainties related to the performance of the natural system. In addition, corrosion products from degrading waste forms and waste containers together with their interactions with rock materials and other near-field debris can inhibit water flow and alter water chemistry. Engineered features that affect environmental conditions surrounding the waste containers can be critical factors in mobilization of the waste and therefore in quantifying the radiation source term.

With all these factors to consider, quantifying the radiation source term realistically is not an easy task. Designers of geologic repositories have therefore preferred using alternative approaches in demonstrating compliance with repository performance requirements, such as making “bounding” or conservative assumptions about the effects on the radiation source term of events and processes in the engineered barrier system or in the disturbed geology. Although the bounding approach may facilitate the demonstration of compliance with regulations, it can compromise fundamental understanding of the uncertainties associated with the performance of a repository.

More-comprehensive research and analysis than has been performed in the past on site-specific radiation source-term factors could result in a more realistic understanding of how a repository might perform, thus increasing confidence in repository performance estimates. This improved understanding also could reduce the costs and complexity of repository designs.