

DATE: December 1, 2008  
TO: Sue Tierney, Phil Niedzielski-Eichner, Skila Harris  
FROM: Chris Kouts  
SUBJECT: Information Request

As requested, enclosed is the additional information you requested last week regarding use of engineered barriers.

Please let me know if you need additional information or have any questions.

*RW*

*Lori Morman*  
*4A-107*

## **The Suitability of the Yucca Mountain Site and the Issue of Natural Barriers as the Principal Barriers for Demonstrating Safety**

This paper addresses two issues that are frequently raised concerning the suitability of the Yucca Mountain site for development as a repository. The first issue is that the Yucca Mountain site is technically unsound and that an engineered barrier system is required because the site is not capable of protecting public health and safety. The second issue is that the Nuclear Waste Policy Act requires that all waste isolation capability be provided by the natural barrier system

The conclusion that an engineered barrier system is required at the Yucca Mountain site because the site is not capable of protecting public health and safety is not valid, and can be shown to be invalid by an examination of the technical analyses presented in project documents.

*Issue # 1      An engineered barrier system is required because the site is not capable of protecting public health and safety*

DOE selected the Yucca Mountain site and designed the repository to take advantage of the attributes of the natural setting at Yucca Mountain. Because water is the primary medium by which radionuclides could be released from the repository, the beneficial characteristics of the repository primarily relate to the ability of the site and the design to limit the movement of water into and out of repository emplacement drifts.

The repository system is composed of natural and engineered features. The Upper Natural Barrier prevents or substantially reduces the rate of movement of water into the repository, and prevents or substantially reduces the rate of movement of radionuclides from the repository. The Engineered Barrier System prevents or substantially reduces the rate of movement of water to the waste, and the release rate of radionuclides from the waste, and prevents or substantially reduces the rate of movement of radionuclides from the repository. The Lower Natural Barrier prevents or substantially reduces the rate of movement of radionuclides from the repository to the accessible environment.

Environmental Protection Agency and Nuclear Regulatory Commission regulations require DOE to identify those design features of the engineered barrier system, and natural features of the geologic setting, that are considered barriers important to waste isolation. All three of the barrier functions are shown to be important in assessing the performance of Yucca Mountain. In other words, both the natural and engineered components contribute to safety.

The Total System Performance Assessment (TSPA) is required to consider low probability events that could disrupt the repository and lead to releases of radionuclides. For Yucca Mountain, two low probability events dominate the release of radionuclides from the repository: an intrusion of igneous magma into the repository; and relatively rare, large seismic ground motion. In the igneous intrusion modeling case, magma from a dike that intersects one or more repository drifts is assumed to engulf all drip shields

and waste packages in the repository, rendering them incapable of protecting their contents. In that case, the waste packages no longer act to prevent or slow the rate of transport, and do not contribute to performance.

These results show that even if the waste packages in the repository are all engulfed by magma, rendering them incapable of protecting their contents, and waste packages are cracked open by large seismic accelerations, the mean annual dose is still only about 1 or 2 percent of the allowable release specified by EPA.

*Issue #2            All waste isolation capability must be provided by the natural barrier system*

The second issue, that the NWPA requires that all waste isolation capability be provided by the natural barrier system, is also not valid. An examination of historical documents, waste isolation regulations, and international practice, shows that multiple barriers (i.e., a combination of natural and engineered barriers), have historically been required for repositories and no basis exists to conclude that safety of the repository must be demonstrated using only the natural barriers.

#### **a) Nuclear Waste Policy Act**

The Nuclear Waste Policy Act, in Section 121(b), directs the NRC to promulgate technical requirements and criteria that it will apply and requires that: "Such criteria shall provide for the use of a system of multiple barriers in the design of the repository and shall include such restrictions on the retrievability of the solidified high-level radioactive waste and spent fuel emplaced in the repository as the Commission deems appropriate."

#### **b) Nuclear Regulatory Commission Regulation 10 CFR part 60**

In 10 CFR part 60, the NRC emphasizes a need for reliance on both natural and engineered barriers. The staff noted in its analysis of public comments (NUREG-0804) that "... requiring both engineering and geology to contribute to isolation can be used to limit the consequences of an unanticipated process or event, which could lead to the failure of one barrier to properly perform its function." An important conclusion in the staff analysis is that "no one involved in the formulation of national policy for the disposal of HLW ..... has suggested exclusive reliance on either geology or engineering for the isolation of HLW."

#### **c) Nuclear Regulatory Commission Regulation 10 CFR part 63**

The NRC's regulation governing the licensing of Yucca Mountain includes a provision, at 10 CFR 63.113(a), that requires that the geologic repository include multiple barriers, both natural and engineered.

**d) Environmental Protection Agency Standard 40 CFR part 197**

EPA standards often contain Assurance Requirements, which provide guidance about how regulatory requirements are to be met. In promulgating the Yucca Mountain specific rule, EPA did not include assurance requirements because NRC's licensing criteria contain requirements similar to the assurance requirements for multiple barriers. This is an endorsement of the multiple barrier approach used by NRC.

**e) Nuclear Waste Technical Review Board**

The Nuclear Waste Technical Review Board stated that “no matter where a repository is located and no matter what the geology of the site, the Board believes an engineered barrier system that includes a robust, long-lived waste package should reduce overall uncertainties about the performance of a repository.

**f) International Practice**

The multiple barrier approach is common to many international programs. A survey of requirements related to engineered barriers for international disposal programs reveals that many programs place long performance requirements on the engineered barrier systems. Canada and Finland have functional goals for waste package performance of containment for 100,000 years or more. France and Switzerland have functional goals for the waste form matrix to resist leaching for 100,000 years or more. Japan, Switzerland, and the United Kingdom have functional goals for the buffer or backfill to function as a diffusion barrier for 100,000 years or more (up to 1,000,000 years).

Prior to passage of the Nuclear Waste Policy Act, the Swedish Agency KBS had published detailed conceptual designs for geologic repositories. These designs are of significant historical importance because they influenced thinking about how repositories should be designed and constructed. The KBS conceptual designs for geologic repositories relied on the use of multiple barriers with a very strong reliance on the engineered components.

**g) DC Circuit Court of Appeals**

The state of Nevada sued the federal government contending that Yucca Mountain's geologic features must serve as the repository's *primary* means of isolating radioactive waste from the human environment. The Court found that: “... In section 121 Congress specifically directs NRC to issue “technical requirements and criteria” that “provide for the use of a *system of multiple barriers* in the design of the repository.” Further, the Court found that the NWPA contains no language indicating that NRC is to assign a rating to any single barrier – whether natural or artificial – in a repository with a “system of multiple barriers.”