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A DESCRIPTION AND STATUS OF THE YUCCA MOUNTAIN PROJECT REPOSITORY SEALING PROGRAM*

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EXTENDED ABSTRACT

INTRODUCTION

Yucca Mountain is being characterized to determine its suitability as a site for a high-level nuclear waste repository. The repository would be located in the unsaturated zone in fractured, welded tuff. Sealing of the repository is one element of the Yucca Mountain Project (YMP). This paper presents a description of the repository sealing program including the sealing design options, design requirements, design constraints, and the identification of the proposed sealing materials and field tests. Design options for the shafts include anchor-to-bedrock seals, shaft fill, and settlement plugs; in the underground facility options include drift seals, drainage channels, sumps, and bulkheads. Design requirements are those quantitative requirements imposed on the sealing design options to achieve a desired level of performance. Constraints are restrictions placed on the repository design by the sealing design. As (1) additional hydrogeologic data are obtained through site characterization, (2) approaches to

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allocating performance to various subsystems within the YMP are refined, and (3) the exploratory shafts and the associated testing results are developed, the design requirements and constraints may be modified and used in developing the License Application Design.

SEALING DESIGN OPTIONS

Sealing is part of the permanent closure of the underground facility, shafts, ramps, and exploratory boreholes. It includes emplacing backfill, seals, or plugs in shafts, ramps, drifts, and boreholes and isolating discrete, water-producing zones from the waste packages. The sealing components discussed below are based mostly on the concepts first presented by Fernandez and Freshley (1984). The concepts were modified during the development of the Site Characterization Plan Conceptual Design Report (SNL, 1987). Because of the distinction made in 10 CFR 60 (NRC, 1986) between the shaft and borehole seals and sealing in the underground facility, the sealing components can be organized according to their locations. Figure 1 identifies specific sealing components according to their location; i.e., shafts and ramps, the underground facility, and the exploratory boreholes.

DESIGN REQUIREMENTS

Design requirements for sealing originate from several primary regulations contained in 10 CFR 60. The quantitative criteria in Section 60.113 are used to develop the hydrologic design requirements for the underground facility and the shafts and ramps. The qualitative design criteria for seals in shafts and boreholes are given in 10 CFR 60.134 and

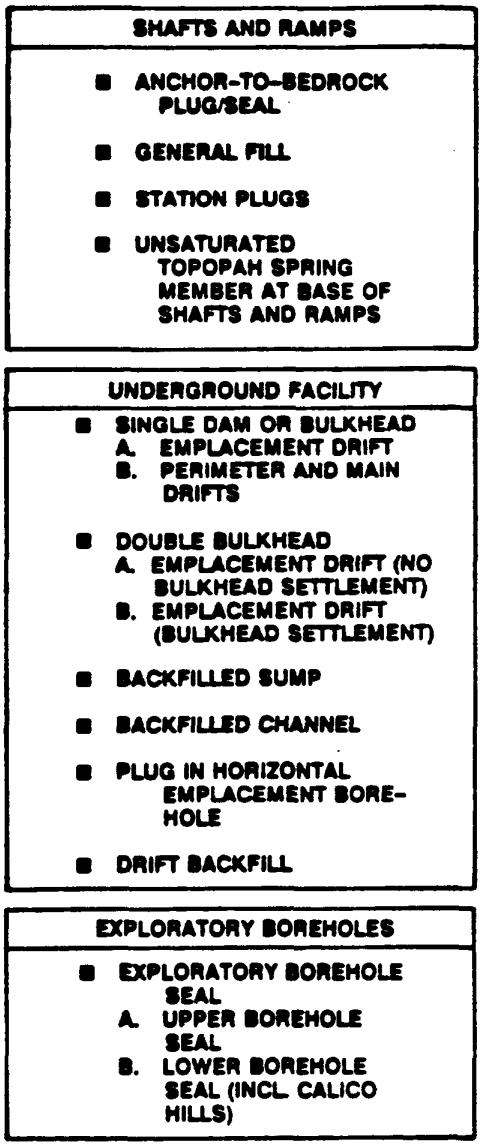

Figure 1. Sealing Component Categorized by Location

are used to develop the air flow design requirements for shafts and ramp seals and the hydrologic design requirements for borehole seals.

The hydrologic design requirements typically fall into two categories: (1) a requirement that specifies a maximum allowable, equivalent hydraulic conductivity for a specific sealing component and (2) a requirement that specifies a maximum water storage volume and drainage capacity. The purpose of the first requirement is to restrict the water flow past the sealing component to a specific value that can achieve the criteria in 10 CFR 60.113. The purpose of the second requirement is to control the water flow and drainage in the shafts, ramps, and underground facility. The purpose of defining air flow design requirements for the shaft and ramp fill is to establish a situation in which the shafts and ramps would not be considered preferential pathways.

In addition to developing design requirements for sealing components in the underground facility, shafts, and ramps, a design requirement is also developed for borehole seals. The development of a design requirement for a borehole seal was based on the 10 CFR 60 requirement that "boreholes be designed so that following closure they do not become pathways that compromise the geologic repository's ability to meet the performance objective."

CONSTRAINTS

Because of the uncertainties in the site characteristics and the performance of the sealing components, it is necessary to maintain flexibility in the design of the sealing component. This flexibility is maintained by proposing multiple design options that incorporate the

uncertainties in the site properties including the hydrology. An additional way to maintain flexibility is to impose logical constraints on the repository design so that the repository design can complement the sealing design and concepts.

The most immediate area in which to impose design constraints is the Exploratory Shaft Facility (ESF). Because the ESF is planned to be incorporated into the repository, it is necessary to impose several seal-related constraints regarding the design and operation of the ESF and the repository. Constraints that apply to the ESF as well as the repository involve restricting flow into and away from the repository, draining water into the bulk rock, and preventing complicating conditions associated with seal evaluations and emplacement.

MATERIALS SELECTION

The selection, development, and characterization of sealing materials for use in the repository sealing program at Yucca Mountain is an integral part of the repository design process. The material selection process involves determining the suitable criteria to select the appropriate sealing material. The process involves repeated examination of the materials. Each material evaluation examines whether materials possess several physical and chemical properties that must be met by the candidate seal materials, as determined from seal functional and design requirements. It is also important to note that as functional and design requirements are modified, the material adequacy will be reevaluated. Further, specific combinations of materials (such as reinforcement) will be evaluated as designs are modified. The material selection criteria become increasingly quantitative and objective in more advanced material evaluations.

Currently, both an initial and a secondary materials evaluation have been completed. From these evaluations, the YMP Sealing Program is focusing attention on both cementitious and earthen materials. The authors' current preference is to propose earthen materials for as many applications as possible to minimize potential degradation of physical properties and potential adverse effects on ground-water chemistry in the repository environment.

FIELD TESTING

Definition of field tests depends on data obtained from the site characterization activities and an evaluation of the role that the sealing subsystem plays in the overall repository performance. Although this information is not presently available, initial assessments in the sealing program indicate several areas in which field tests may be performed to reduce uncertainties in seal performance. These areas are verification of emplacement techniques and seal behavior under anticipated and unanticipated hydrogeologic conditions. Examples of potentially appropriate tests are siltation-infiltration tests, borehole seal tests, and a shaft seal test.

REFERENCES

Fernandez, J. A. and M. D. Freshley, 1984, Repository Sealing Concepts for the Nevada Nuclear Waste Storage Investigations Project, SAND83-1778, Sandia National Laboratories, Albuquerque, NM.

U.S. Nuclear Regulatory Commission (NRC), 1986, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," Code of Federal Regulations, Energy, Title 10, Part 60, U.S. Government Printing Office, Washington, D.C.

Sandia National Laboratories (SNL), 1987, Site Characterization Plan-Conceptual Design Report, SAND84-2641, compiled by H. R. MacDougall, L. W. Scully, and J. R. Tillerson, Albuquerque, NM.

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