DEFINING THE POTENTIAL REPOSITORY SITING BLOCK YUCCA MOUNTAIN, NEVADA

Robert W. Elayer
Morrison Knudsen Corporation
101 Convention Center Drive
Las Vegas, NV 89109
(702) 794-1960

Richard M. Nolting III
Morrison Knudsen Corporation
101 Convention Center Drive
Las Vegas, NV 89109
(702) 794-1833

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BACKGROUND

Siting activities for the potential high-level nuclear waste repository at Yucca Mountain focused on locating a suitable host geologic horizon above the water table. The Topopah Spring Tuff of the Paintbrush Group was identified as the most suitable geologic unit. Sandia National Laboratories (Sandia) identified six areas as potential repository sites¹. Area 1, known as the Primary Area, is the site of the present characterization and design activities².

To support current repository Advanced Conceptual Design, a reevaluation of the Primary Area was conducted by the Yucca Mountain Project's Management and Operating Contractor (M&O). The purpose of the study was to more precisely define the block volume that would be suitable for siting the repository³. The Lynx Geoscience Modeling software (Lynx) was selected to be used in this work because of its three-dimensional modeling and visualization capability for geology and underground excavation design. The Lynx model YMP.MO2 was developed in the study. The model includes surfaces that were constructed to represent each of the following limiting criteria: faults, overburden, repository host horizon, and groundwater. The resulting potential repository siting block is the useable volume within these limiting criteria.

FAULTS

The limits of the Primary Area generally coincide with the Solitario Canyon fault on the west, Drill Hole Wash fault on the north, western limit of the Imbricate fault system on the east, and Abandoned Wash fault on the south. Identified faults located within the Primary Area include the Ghost Dance fault and Sundance fault. For modeling, fault characteristics were taken from the Lynx

geology model YMP.R1.1, which was developed by the U.S. Geological Survey⁴. For design purposes, the repository standoff from Quaternary faults (active within last 2-million years) is assumed to be adequate by using 60 meters². For current design, the Solitario Canyon fault, Drill Hole Wash fault, western limit of the Imbricate fault system, Abandoned Wash fault, and Ghost Dance fault all are assumed to require a 60 meter standoff. The only exception is the Ghost Dance fault, which, for design considerations, has a 120 meter standoff on the west².

OVERBURDEN

Based on the postclosure guidelines specified in the *General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories* (10CFR960), a minimum emplacement overburden of 200 meters is assumed for the repository area⁵. This criteria is a long-term waste isolation consideration intended to prevent erosion from exposing the underground facility and emplaced waste packages.

REPOSITORY HOST HORIZON

The volcanic ashflow tuff units at Yucca Mountain have been subdivided into thermal/mechanical units to address engineering properties of the rock⁶. These units group rocks that have similar thermal and mechanical properties based on correlation with their grain density and porosity. These properties are reflected, to a large extent, by the general degree of welding and the content of lithophysal cavities. Lithophysae are bubble-like structures composed of concentric zones of vapor-phase mineralization. Commonly, they contain a central cavity that may be a few millimeters across to as large as a meter, and are concentrated in stratigraphic zones separated by zones generally void of lithophysae.

The repository host horizon was originally identified by Sandia as the TSw2 unit, which consists of densely welded, devitrified, ashflows of the Topopah Spring Tuff that contains less than approximately ten percent of lithophysal cavities by volume⁶. Overlying the TSw2 unit is TSw1, a densely welded, devitrified, ashflow tuff with generally greater than ten percent of lithophysal cavities by volume in the part directly overlying the TSw2 unit. Underlying the TSw2 unit is TSw3, a densely welded vitrophyre.

In the M&O investigation for defining the potential repository block, it was found that the lower 5 to 40 meter section of the overlying TSw1 unit may be similar in thermal and mechanical characteristics to the TSw2 unit, and therefore may be suitable for repository development³. The top of this section corresponds to a noticeable change in density, as revealed in down-hole geophysical density logs, and a significant change in lithophysal cavity content, based on estimates from core. Investigation of the repository host horizon is continuing, but preliminary indications favor this upper limit within the TSw1 unit as the most suitable top of the repository host horizon.

For the M&O Lynx model YMP.MO2, the repository host horizon was defined as including the TSw2 unit plus the overlying 5 to 40 meter section of the TSw1 unit, as identified above³. For engineering considerations, a 5-meter standoff from the top of the repository host horizon is used as the upper limit for repository siting⁷. For the lower limit, a 30-meter standoff was used because of thermal design requirements².

GROUNDWATER

In the *Environmental Assessment* document⁸, it is stated that the repository must be sufficiently above the groundwater table such that the groundwater does not encounter the emplacement host rock. The groundwater level used in the model was developed by the U.S. Geological Survey⁹. Within the Primary Area, the groundwater table is about 110 to 400 meters below the bottom of the repository host horizon, therefore, the groundwater table is not a limiting factor.

POTENTIAL REPOSITORY SITING BLOCK

The potential repository siting block is delineated spatially by the following physical limits:

Upper Limits:

- 200-meter overburden
- 5-meter standoff below top of repository host horizon

Lower Limits:

- 30-meter standoff above bottom of repository host horizon
- top of groundwater surface

Lateral Limits:

- 60-meter standoff from major faults (120-meters from the west side of the Ghost Dance fault)

Based on these limits, the potential repository siting block was defined within the Lynx model. A plan view of this volume, projected to a horizontal plane, is illustrated in Figure 1. Because the Primary Area is divided by the Ghost Dance fault, the block consists of an upper and lower subunit.

To illustrate this 3-dimensional volume in 2-dimensions, plan view sections were developed through the block within the planes of the current, two-level repository design, and at various distances above and below these repository levels. The resulting plan views reveal the potential repository siting areas at specific positions within the potential repository siting block. The potential repository siting areas at the repository levels are illustrated in Figure 2.

IMPLICATIONS TO DESIGN

The new potential repository siting block is a more precise definition of the available volume for repository siting than the previous, more general Primary Area. It has proven to be a valuable tool for locating the optimal position for the repository, and enabled the evaluation of a potential multi-leveled repository system. Since the Lynx system was used in the evaluation, it is relatively easy to modify the model to reflect updated geology, revised criteria, or refined engineering requirements.

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Figure 1. Plan view of potential repository siting block. The Primary Area, Exploratory Studies Facility, and the upper and lower repositories are shown for reference.

Figure 2. Potential repository siting areas within planes through the upper and lower repositories. The Primary Area, Exploratory Studies Facility, and the upper and lower repositories are shown for reference.

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