



# Tools and Guidance for Independently Evaluating the Safety of a Potential High-Level Nuclear Waste Repository at Yucca Mountain, Nevada

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## ABSTRACT

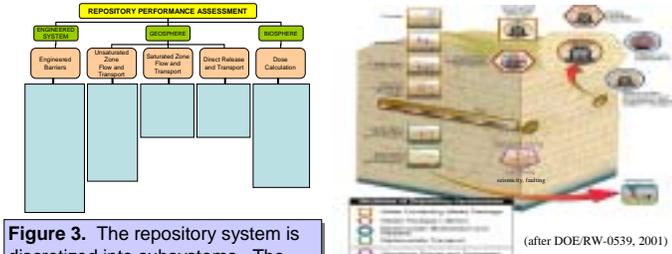
Disposal of high-level nuclear waste requires a U.S. Nuclear Regulatory Commission (NRC) license. Part 63 under Title 10 of the U.S. Code of Federal Regulations ("Disposal of High-Level Radioactive Wastes in a Proposed Geologic Repository at Yucca Mountain, Nevada") contains the governing regulations. These governing regulations are risk-informed and performance-based, and contain performance objectives for safety both before and after permanent repository closure. The NRC will determine whether to issue a construction authorization and license for the repository at Yucca Mountain based, in part, on whether the U.S. Department of Energy (DOE) has demonstrated compliance with the performance objectives. The NRC staff have developed specific guidance (Figure 1) and tools to aid in conducting a risk-informed and performance-based regulatory program, including its licensing review. The tools allow risk information to be developed which will then be used in conjunction with the guidance to conduct a risk-informed review of a potential license application.

## GUIDANCE (continued)

with reasonable assurance for the preclosure period and reasonable expectation for the postclosure period, that the corresponding performance objectives at 10 CFR Part 63 will be met.

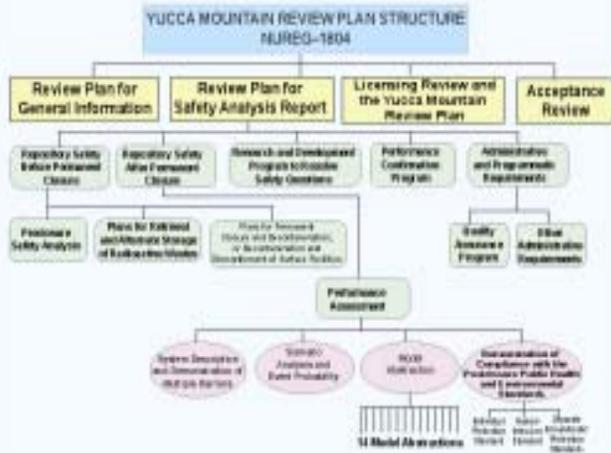
For preclosure safety, the staff review is focused on items that preclosure safety analysis determines to be important to safety. The rigor of staff review and the level of attention to detail depend on relative safety significance.

A performance assessment is required to be used to demonstrate the performance objectives for postclosure safety will be met. The DOE performance assessment is a systematic analysis that answers the three risk questions: what can happen?; how likely is it to happen?; and what are the consequences? Because the performance assessment encompasses such a broad range of issues, the staff will use risk information throughout the review process. Using risk information will ensure that the review focuses on those items most important to health and safety.



**Figure 3.** The repository system is discretized into subsystems. The features, events, and process in each of these subsystems and interactions among the components of the subsystems are modeled in the TPA code.

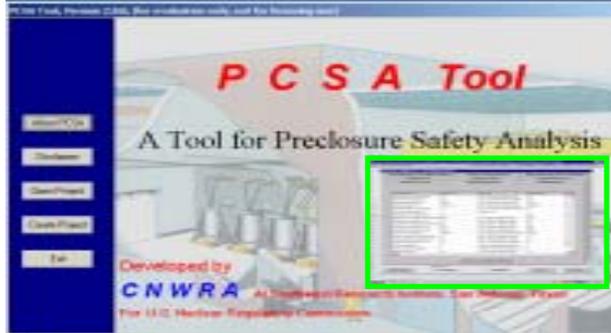
**Figure 4.** Conceptualizations of undisturbed (base case) and disturbed scenarios (faulting, seismicity, and igneous activity) modeled in the TPA code.



**Figure 1.** Structure of Yucca Mountain Review Plan guidance document.

## GUIDANCE

The Yucca Mountain Review Plan (Figure 1) is guidance to the NRC staff for conducting a risk-informed review of any license application from the DOE for a geologic repository for disposal of high-level radioactive waste at Yucca Mountain, Nevada. The review plan has separate sections for reviews of repository safety before permanent closure and repository safety after permanent closure. The staff's preclosure and postclosure safety reviews will focus on whether the DOE safety analysis report demonstrates,



**Figure 2.** The Preclosure Safety Analysis tool. The green inset box is the consequence analysis worksheet contained in the PCSA tool.

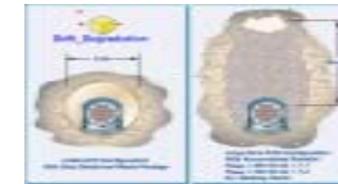
## TOOLS - SAFETY BEFORE PERMANENT CLOSURE

The NRC staff, along with its contractor, the Center for Nuclear Waste Regulatory Analyses (CNWRA), have developed the PreClosure Safety Analysis (PCSA) tool for use in the review of repository safety before permanent closure. The PCSA tool (Figure 2) combines parts of the integrated safety analysis methods used in the chemical industry and the risk assessment capabilities and tools used in the safety assessment of nuclear power reactors. The tool allows NRC staff to independently assess safety before permanent closure and will allow staff to conduct a risk-informed audit review of the DOE's license application by facilitating review of the systems most important to safety.

## TOOLS - SAFETY AFTER PERMANENT CLOSURE

The NRC staff and CNWRA have also developed the Total-system Performance Assessment (TPA) code for use in the review of repository safety after permanent closure. The TPA code (Figure 3) is a probabilistic performance assessment tool designed to simulate various natural and repository-induced processes that are expected to affect the long-term performance of the proposed repository (Figure 4). The results and findings from our assessments (risk insights) assist the staff in conducting a risk-informed review of the DOE's performance assessment, which is a GOLDSIM (an object-oriented code) model.

The NRC staff also use other codes (such as GOLDSIM, MULTIFLO, ABAQUS, MODFLOW, and UDEC) to develop models and independently assess complex processes (Figures 5 and 6) which may not be explicitly incorporated in either the TPA code or DOE's performance assessment model.



**Figure 5.** GOLDSIM model of drift degradation is used to independently assess the potential impact on drip shield failure. (FLIP UP FOR MODEL DETAILS)



**Figure 6.** GOLDSIM irrigation recharge model assesses iodine concentration in aquifer. (FLIP UP FOR MODEL DETAILS)

References: DOE/RW-0539, Yucca Mountain Science and Engineering Report, U.S. Department of Energy, 2001.