

**Q:** *How can the DOE be certain that its calculations of events thousands of years in the future are accurate?*

**A:** After more than 20 years of study, some of the nation's best scientists are confident in their understanding of the natural processes at Yucca Mountain and any changes to those processes that might result from waste disposal. The 10,000-year regulatory period is sufficiently long, however, that many people question how the DOE can be sure it understands the science well enough to be confident in using computer models to forecast what can happen that far into the future. Exactly that concern was a fundamental consideration as the regulations were being developed. For just this reason, the Environmental Protection Agency and the Nuclear Regulatory Commission require that the geologic repository rely on both the natural and engineered barriers. Having multiple barriers helps provide confidence that some uncertainty in an attribute of the performance of one barrier is acceptable, because other barriers are also acting to isolate the radionuclides.

Although the research has produced an extensive scientific record, ranging from thousands to millions of years into the past, this record is subject to interpretation and includes uncertainties. The rocks themselves are millions of years old, and are not expected to change in 10,000 years. Some parameters, however, such as climate, for example, will change. The DOE's calculations assume such changes will occur in the future. While it is not known exactly when climate will change, there is very good data about climate and rainfall, covering more than the past 40,000 years, derived in part from the ancient, preserved nests of pack rats found at Yucca Mountain. For the 10,000-year period, the models use the current climate for the next 400 to 600 years, and then the models switch to what are called monsoon and glacial transition climates, during which the precipitation is increased by about 2 times and the infiltration is increased by about 4 times. Scientists also run what are called sensitivity studies on these and many other numbers used in the models to find out what hap-



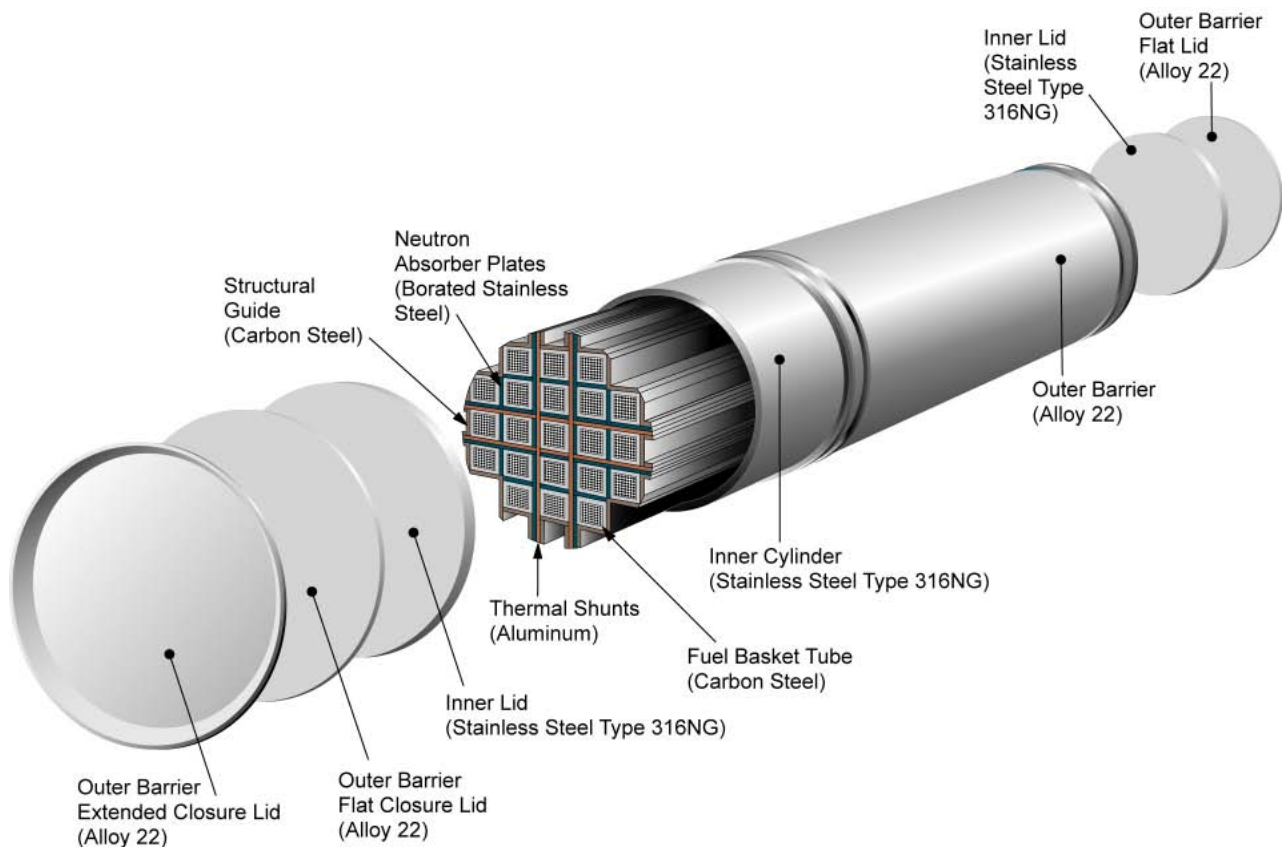
**S**cientists base their projections of future performance on more than 20 years of tests and studies. Uncertainty is expected and treated in the regulations and multiple barriers are used to ensure safety.

pens if they were wrong. With the climate models, for example, the scientists examine ranges of rainfall and infiltration numbers to see how varying the inputs affects their forecasts of releases of radionuclides.

By doing this, the performance assessment results examine the capability of the repository barriers to perform under a range of conditions representing both likely and unlikely future conditions. The analysts deliberately use combinations of parameters causing less favorable performance, in order to provide confidence the repository will perform well.

The regulations established by the Nuclear Regulatory Commission and the Environmental Protection Agency require an engineered barrier system in addition to the natural barriers

provided by the geologic setting. The engineered system would be built to complement the natural system. Project scientists have an understanding of how the natural and engineered systems change over time, and how they interact, based on scientific principles, tests, and evaluation of natural analogues. To be sure that its calculations for the Total System Performance Assessment were appropriate and sound as an approach to supporting a site recommendation decision, the DOE asked for and received a peer review that reflects an international perspective on the adequacy of its performance assessment approach to support a site recommendation decision. The review panel found the work done by the DOE for the Site Recommendation to be competent, consistent with sound international practices, and



Waste packages use multiple layers of highly corrosion-resistant Alloy 22 and stainless steel, along with multiple welded lids, to provide confidence that water will be kept away from the solid waste forms contained inside. By way of comparison, waste package walls are about 20 times thicker than a propane tank wall.

appropriate for a site recommendation decision. They also observed many conservative aspects of the calculations.

Over the past several years, the Nuclear Waste Technical Review Board has stated that it is appropriate for decision makers to consider the full range of outcomes in performance assessment calculations, and has recommended additional performance assessment analyses to better understand uncertainties. In response, the full range of outcomes in performance assessment calculations, as well as the results of the additional performance assessment analyses to better understand uncertainties, have been examined.

There is a strong basis for confidence in the outcome of safety evaluations to support the Site Recommendation. Project scientists believe the majority of the important data and model inputs used in the Total System Performance Assessment accurately reflect the current state of knowledge, which is considerable. In other

cases, the scientists used deliberately and demonstrably cautious estimates to accommodate those things that are not presently well known. The Nuclear Waste Technical Review Board, the Nuclear Regulatory Commission, and the DOE recognize that additional information will be collected before the Nuclear Regulatory Commission could issue a license to construct. Also, information will be collected during the entire time the repository is operational if it is constructed. The plans to collect this new information will be guided by oversight groups and will reflect how best to continue to reduce uncertainty. The nation can have confidence that safety will be assured because the entire repository development process will bring in the formal licensing requirements of the Nuclear Regulatory Commission. The Nuclear Regulatory Commission will thoroughly review, question, and oversee every scientific and engineering aspect of the repository, including the collection of additional information, for many decades to come.