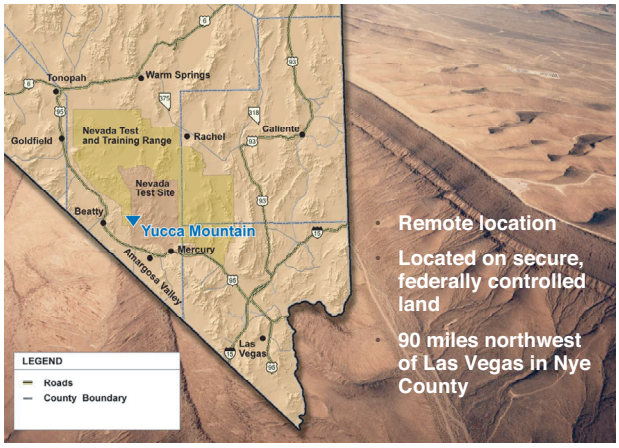
NUCLEAR ENERGY:

Safe Source or Radioactive Risk?

GoldSim evaluates the risks and benefits of storing spent fuel at the first U.S. site proposed for permanent storage

U.S. demand for electricity is expected to increase by more than 25 percent over the next 20 years, posing significant economic, environmental and political concerns and underscoring the need to find alternative ways to sustain energy consumption.

One such alternative is nuclear power, which accounts for only 19 percent of current U.S. electricity use but 74 percent of national carbon-free energy generation. Last year alone, nuclear power plants prevented 691 million tons of carbon dioxide (CO_2) from entering the atmosphere—the equivalent of taking nearly all U.S. passenger cars off the roads for the entire year.



Scientists use modeling to demonstrate how Yucca Mountain's natural features act as barriers.

While the use of nuclear energy—the only large-scale, CO_2 -free source of electricity available—has its undeniable benefits, the waste produced once it's consumed poses significant challenges. Right now, there are more than 58,000 metric tons of high-level radioactive waste, enough to cover a football field seven yards deep, stored in 120 sites in 39 states around the country.

Legislation enacted by the U.S. Congress in 1982 sought to address such issues, charging the Department of Energy (DOE) with finding a suitable underground repository that could safely store high-level radioactive waste for thousands of years. Five years later, officials identified Yucca Mountain, a federally-controlled site in the Nevada desert, as the site for the country's first permanent repository for nuclear waste.

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>
> – Patrick Mattie, Sandia National Laboratories

Data Evaluation

How does the repository design, including depth and width, affect public safety?

How will waste emplacement change the natural system over tens of thousands of years?

Scientists and engineers at Sandia National Laboratories (Sandia), among numerous other organizations, have performed thousands of studies at Yucca Mountain over the past 25 years to evaluate the potential repository's long-term performance. It was up to Sandia's performance assessment team to combine the results from these disparate studies, which remained largely independent of one another, to provide officials with an understanding of the overall behavior of the project in its entirety.

"The only way to predict such behavior is to consider every feature, event, and process that could potentially impact the repository and weighing its likelihood and consequences," said Patrick Mattie, a senior member of Sandia's technical staff. "Building a total system performance assessment model of the magnitude required is an unprecedented technical challenge," he said, one they turned to GoldSim Technology Group (GoldSim) for help with.

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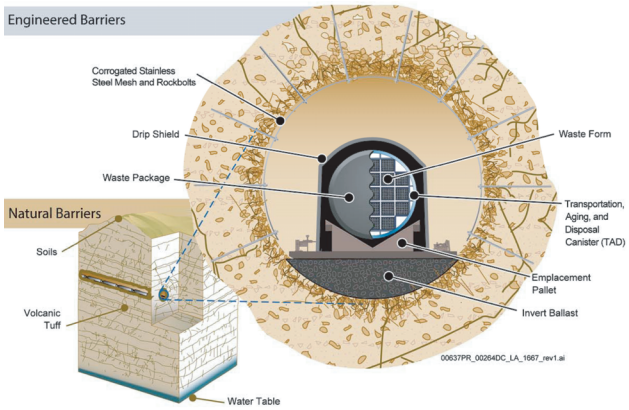
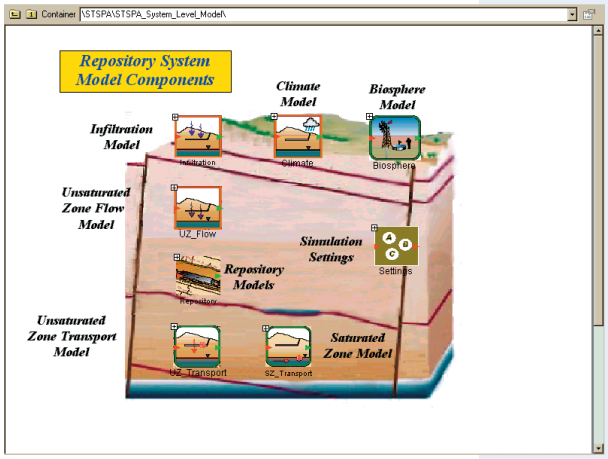
Sophisticated Modeling

Scientists and engineers demonstrate how natural and engineered barriers work together.





GoldSim enables scientists to simulate individual model components as well as the system as a whole.

Using the GoldSim software for integrating data from the myriad sources and analyzing corresponding cause-effect relationships, the GoldSim/Sandia total system model can predict the likely fate of high-level radioactive waste at Yucca Mountain for thousands of years to come crucial to conducting a thorough safety assessment required for a safe high-level radioactive waste disposal solution, which is essential to meeting our nations current and future clean energy needs.

Imperative to the model's success was its ability to meet all specifications and requirements mandated by the Nuclear Regulatory Commission (NRC), the federal agency that regulates the use of nuclear materials. How deep does the repository need to be? How long will it be effective? When and where will releases from the facility most likely occur? How will an earthquake or volcanic eruption affect the stored radioactive waste? What is the impact on future human populations?

The Sandia/GoldSim model successfully addressed these and numerous other complex questions, providing officials with invaluable insight into site design, ensuring its regulatory compliance and minimizing long-term impact on human health and the environment.

The proof of such success is the DOE's successful submission of a formal license application to the NRC on June 3, 2008, the first such application anywhere in the world. Based on the information contained therein, the NRC will determine the ability to safely construct and operate the repository while complying with its regulations.

GoldSim/Sandia's model will be used throughout the exhaustive technical review process by both the DOE and NRC to evaluate and clarify findings. The tool is valued by experts and laymen alike, the former for its sophisticated modeling capabilities and the latter for its user-friendly interface that presents information in understandable, graphical terms. "The power is in the versatility, the power is in the framework," Mattie said. "GoldSim was a valuable partner and was integral to our success."

The initial success of GoldSim/Sandia's model has spurred numerous additional GoldSim-enabled modeling projects throughout the DOE, as well as NASA and other government agencies, to evaluate risks and predict the likely performance of extremely complex systems.

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