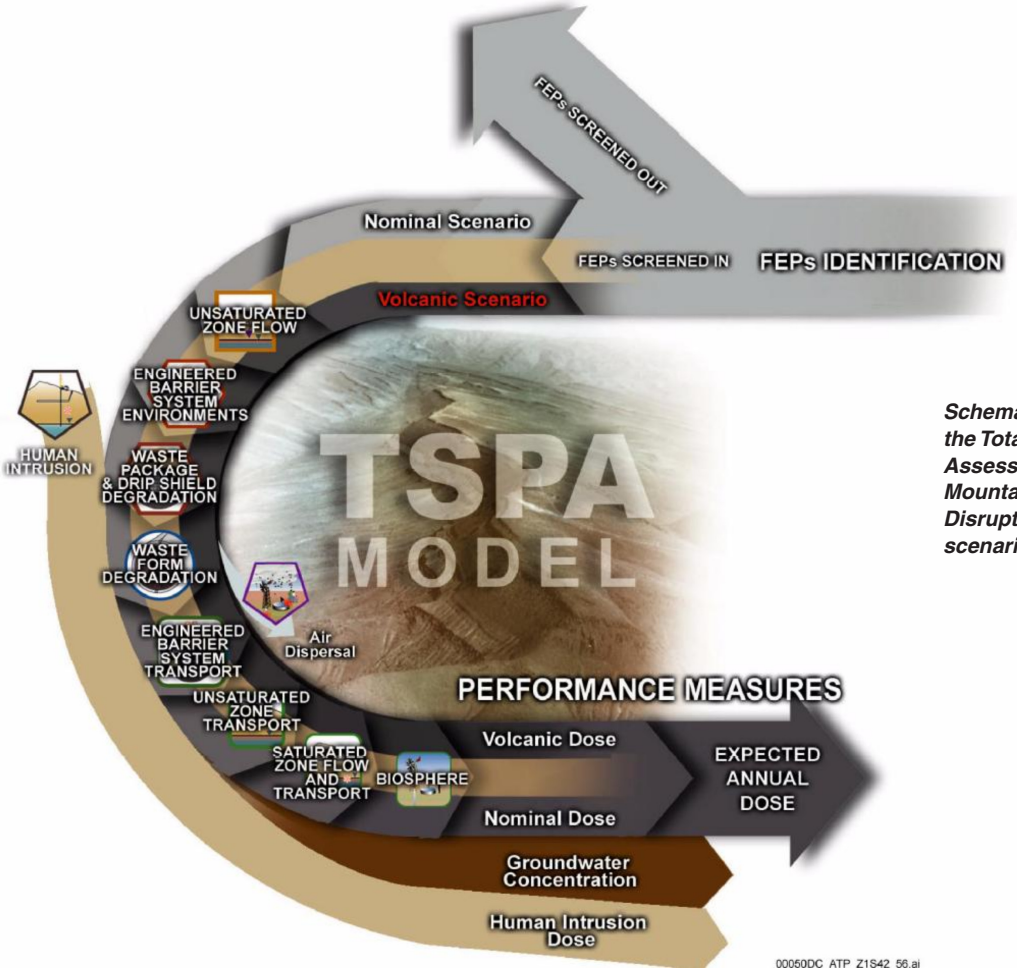


Schematic representation of the Total System Performance Assessment Model of Yucca Mountain including the Normal, Disruptive, and Human Intrusion scenarios.

Total System Performance Assessment

Total System Performance Assessment (TSPA) provides predictive modeling that forecasts how well the Yucca Mountain repository's engineered and natural system will contain nuclear waste. TSPA provides insights into characteristics of spent nuclear fuel and other waste forms, treatment processes and barrier performance (such as fuel cladding and containers) relative to geologic repository compliance requirements. These insights allow the nuclear material owner to manage nuclear materials, considering both interim storage and long-term disposal needs.

Science

INL Idaho National Laboratory

Overview

TSPA forecasts how a repository's engineered and natural design will contain spent nuclear fuel (SNF) and high-level waste (HLW). This iterative process demonstrates compliance with regulatory requirements and determines the relative influence of the characteristics of SNF and HLW on the repository system's performance. Scientists use this information to determine research priorities, based on high-risk and significant variables.

TSPA includes several steps. First, the Department of Energy (DOE) develops an engineering design for the repository based on SNF characteristics and the potential repository location. Next, scientists and engineers determine the interaction among the SNF and HLW, engineered barriers, natural geologic medium, biosphere, and humans during a reasonable range of circumstances. They then study the behavior and evolution of the repository system, identify scenarios, and develop molds to simulate the repository system behavior.

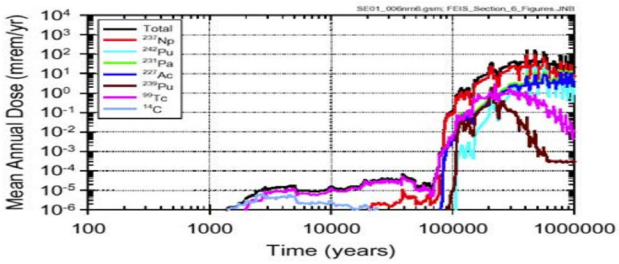
Continued on back

Scientists and engineers document the safety of the repository design regarding potential radiological consequences and their likelihood to occur. The analyst then performs uncertainty analyses to refine the assessment. These analyses account for possible omission of important features, events and processes, faulty interpretation of geology, and failure to realistically estimate probabilities of occurrence.

Finally, scientists and engineers validate all components of the TSPA, comparing results with the regulatory requirements and design goals. DOE performs the TSPA with and without the DOE-owned SNF and HLW for the proposed national repository. These assessments determine how DOE-owned SNF and HLW may affect the repository system's performance. The TSPA for the repository at Yucca Mountain has been refined over different stages of development from viability assessment through site recommendation, to the current license application. The repository model is available to conduct various TSPA analyses. A TSPA model could also be developed for specific needs and repository types if required.

INL Capabilities

The National Spent Nuclear Fuel Program (NSNFP) at INL has both experienced personnel and computer systems to conduct TSPA modeling runs. INL's staff has been involved with performing TSPA analyses for many years. Capabilities include analyzing new waste forms and their impact to the repository system chemistry, such as pH, Eh, ionic strength and materials solubility; determining how waste forms behave in the repository environment and how they impact the repository dose at the accessible environment. The multiprocessors computer system (with 64 dedicated Pentium Xeon processors) allows multirealization TSPA runs to be completed in a matter of hours and days. Some of the waste forms evaluated included DOE SNF, HLW and calcines. The NSNFP is currently providing TSPA analysis to help the DOE Office of Environmental Management determine alternatives for the disposition of cesium and strontium capsules.



Typical mean annual dose plot versus time of a deep geologic repository showing the major radinuclide contribute to the total dose

Benefits

TSPA modeling could provide decision insights at various stages of the nuclear fuel cycle as well as evaluation of other, nonnuclear-related, material disposition. As an example, it allows the SNF or HLW owner who is planning for disposal to see how the waste will affect the repository's performance. Such information provides the owner insights into managing the material by giving the owner the cost and benefit of a specific treatment process, packaging scenario or additional barrier.

The TSPA could also provide information that would allow optimization of the nuclear fuel cycles. With the recent announcement of funding for nuclear energy programs (Next Generation Nuclear Plant and Advance Fuel Cycle Initiative), the TSPA modeling could be used to help select the best fuel form and partitioning scheme by maximizing potential repository acceptance of the final waste materials/form, while at the same time minimizing total materials that will be destined for the repository (by recycling certain radionuclides in the fuel when possible). This kind of information allows the project manager to select the most beneficial path forward while minimizing cost. Thus, management of SNF, HLW or other materials could be considered from both interim storage and final disposition perspectives. The project manager would not only be able to minimize the project's total life-cycle cost by selecting the best option, but also ensure the selected material treatment or packaging for interim storage will be acceptable at final disposition.

For more information

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INL is a U.S. Department of Energy national laboratory operated by Battelle Energy Alliance