



SAFETY RULES FOR A POTENTIAL HIGH-LEVEL WASTE GEOLOGIC REPOSITORY AT YUCCA MOUNTAIN, NEVADA:

**What does the
U.S. Nuclear Regulatory Commission
require?**

The Department of Energy
must convince the
Nuclear Regulatory Commission
that a proposed repository at
Yucca Mountain, Nevada will:

- **Protect the public**
- **Protect site workers**
- **Protect the environment**

Introduction

The U.S. Nuclear Regulatory Commission (NRC) will only allow construction of a geologic repository at Yucca Mountain, Nevada, if the U.S. Department of Energy (DOE) is able to convince NRC that DOE can build and run the repository safely and securely, and in a way that complies with NRC rules. That means DOE must build and operate the repository in a way that protects the public, site workers, and the environment from the potentially harmful effects of spent nuclear fuel and high-level radioactive wastes.

What standards and regulations will NRC use to decide?

To show that a potential repository at Yucca Mountain would be safe, DOE will have to comply with regulations set by NRC and with environmental standards set by the U.S. Environmental Protection Agency (EPA). NRC published its rules for safe and secure construction, operation, and closure of a potential repository at Yucca Mountain in Chapter 10 of the *Code of Federal Regulations* as Part 63 (10 CFR Part 63). These rules are often referred to as NRC's "Part 63 regulations" or simply "Part 63." By law, NRC's Part 63 regulations must be consistent with EPA's standards for Yucca Mountain. EPA's standards appear in Chapter 40 of the *Code of Federal Regulations* as Part 197 (40 CFR Part 197). NRC's Part 63 regulations also include detailed licensing requirements that DOE must meet before DOE can receive NRC permission to build a repository at Yucca Mountain.

What do NRC regulations require?

Dose Limits During Repository Operations

DOE must comply with dose limits set by EPA for the repository at Yucca Mountain and those incorporated in NRC's licensing regulations. DOE must show that, during operation and before DOE closes the repository, no members of the public would receive doses greater than 15 millirem each year due to normal repository operations. This amount of radiation exposure equates to less than 5 percent of the average radiation exposure people across the nation normally experience from natural sources every year. Repository operations include all preclosure activities necessary for receipt, storage and emplacement of waste for disposal. DOE must provide a comprehensive preclosure safety analysis showing that EPA's preclosure dose limits will be met. DOE must also show that it will protect repository workers to the same standards that apply to workers at all other nuclear facilities licensed by the NRC.

Dose Limits After the Repository is Closed

DOE must show that there is a reasonable expectation that, for 10,000 years after disposal, the reasonably maximally exposed individual receives a dose no greater than 15 millirem each year from the repository, when undisturbed by human intrusion. DOE must also show that these same limits would be met in the event of an assumed human intrusion disruption as specified by EPA and incorporated in NRC's licensing regulations. In 2005, EPA proposed additional standards that would constrain potential doses that could occur beyond 10,000 years, until the time when peak doses are expected to occur. NRC will modify its regulations to be consistent with EPA's additional constraints as soon as they are formally issued. DOE must show compliance with EPA's standards and NRC's requirements by providing a comprehensive performance assessment. NRC regulations specify detailed requirements for the content of both the preclosure safety analysis and the postclosure performance assessment.

Retrieval

The repository must be designed so that DOE can retrieve the waste packages throughout the period during which they are being emplaced, and throughout the completion of a performance confirmation program. Also during this period, NRC must be able to review and evaluate any new information obtained. NRC regulations provide that DOE must be able to retrieve the waste for up to 50 years after the waste is put in the repository.

Groundwater Protection Limits

DOE must also show that releases from the undisturbed repository system do not cause radioactivity in groundwater to exceed numerical limits specified by EPA and incorporated in NRC's licensing regulations. Separate standards for groundwater are designed to protect the groundwater resources near Yucca Mountain. To comply with these limits, DOE must estimate the concentrations of radioactive elements in a representative volume of groundwater using an analysis similar to the performance assessment.



Physical Protection and Security

NRC requires that DOE establish detailed security measures for physical protection of spent fuel and high-level waste (HLW) comparable to those required for other large nuclear installations licensed by NRC. DOE must show how it will protect the repository against physical threats, theft of radioactive materials, and potential acts of sabotage.

Monitoring and Testing

If NRC authorizes construction, and later authorizes emplacement of waste, DOE must continue to monitor the site, make observations, and conduct studies. DOE must use the results of these activities to show that assumptions made in the license application about the expected performance of the repository system remain consistent with data gathered from the repository. Should any significant differences arise, DOE must conduct comprehensive analyses to find out how the safety of the repository might be affected.

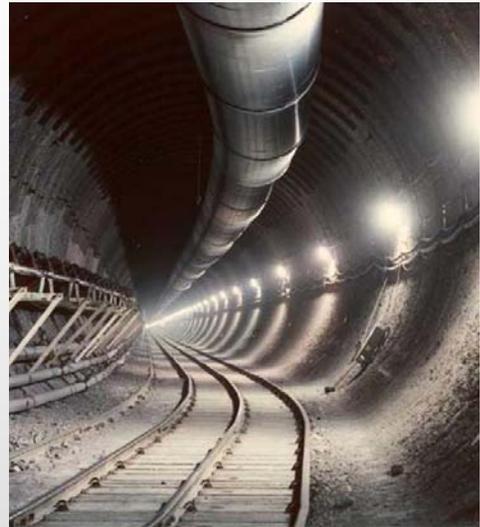


What do NRC regulations require?

Multiple Barriers Requirements

NRC requires that the repository rely on multiple barriers to ensure the repository system is robust and the safety it provides does not depend on any single barrier. A barrier is any material, structure, or feature that prevents or slows movement of radioactive waste from the repository to the environment. A barrier may be a geologic feature, an engineered structure, a canister, or a waste form with physical or chemical characteristics that significantly slow down movement of water or radionuclides. A barrier may also be some material placed over and around the waste, provided the material substantially delays movement of water or radionuclides.

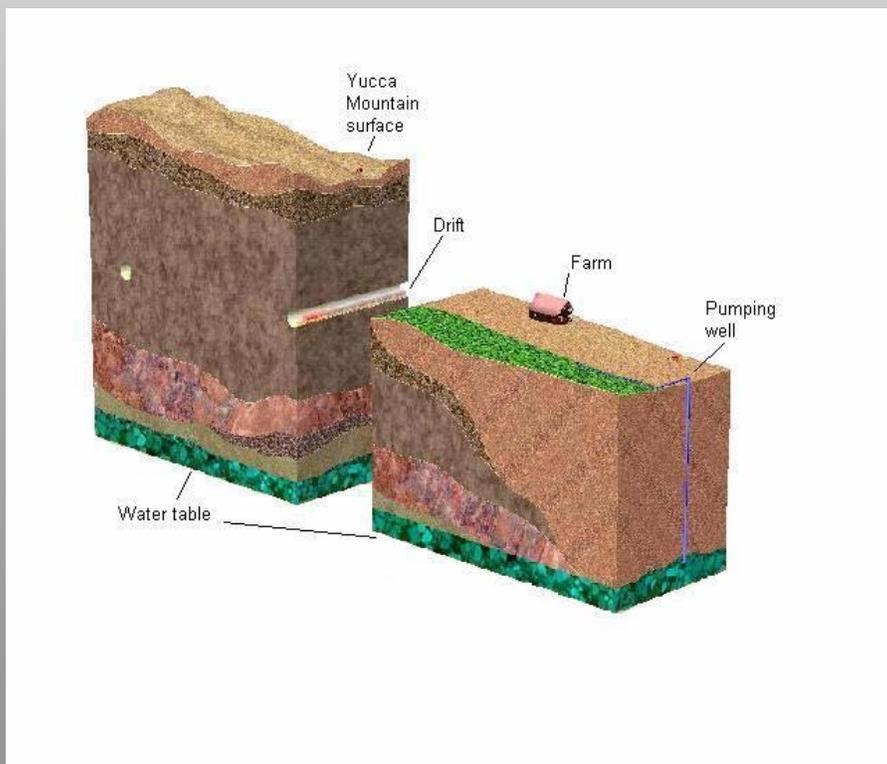
Barriers work to isolate waste in various ways. They can limit contact of water with the waste packages by blocking or slowing down water as it seeps from the surface to the depth of the repository. Barriers can prolong lifetimes of other barriers such as the waste package. Barriers, such as waste forms, can limit the amount of waste that is able to dissolve in water that comes in contact with the waste. Additionally, natural system barriers can cause dissolved waste to come out of the water by sorbing onto rock mineral surfaces, thereby restricting the waste's ability to travel away from the repository.



NRC requires DOE to demonstrate the capabilities of repository barriers for several reasons. First, such a demonstration, if performed correctly, should increase NRC's confidence that public health and safety are protected. Second, it helps NRC focus its technical review of DOE's license application on those repository attributes essential for safety. Third, showing the full capabilities of multiple barriers illustrates how the repository could respond to unanticipated failures and external challenges. By requiring a repository system of multiple barriers, NRC expects that DOE will show that its repository design provides successive levels or layers of protection. NRC believes that understanding the capability of the system's barrier components improves understanding of the overall repository system, which in turn enables NRC to determine whether there is sufficient confidence that safety and environmental standards will be met.

NRC regulations require that

- The repository must include multiple barriers, consisting of both natural barriers and an engineered barrier system
- DOE must identify those design features of the engineered barrier system and natural features of the geologic setting that DOE considers important for isolation of waste
- DOE must describe the capability of these barriers to isolate waste, considering the uncertainty in what is known about their properties and behavior over long periods of time
- DOE must design its engineered barrier system so that, working in combination with natural barriers, releases of radionuclides into the accessible environment and the resulting radiological exposures meet environmental and safety standards set by EPA
- DOE must show that these rigorous standards are met by using a comprehensive set of calculations called a performance assessment
- DOE must support its description of each barrier capability with facts. Those facts must be consistent with those DOE uses in the performance assessment.



Illustrative diagram of various underground layers of Yucca Mountain which may serve as barriers.

Will NRC just take DOE's word for it that things are being done correctly?

No, NRC has a rigorous program of inspection and enforcement for all stages of repository construction and operation. If NRC authorizes DOE to build a repository, NRC will assign resident inspectors to provide direct oversight at Yucca Mountain. These inspectors would live nearby and would oversee DOE operations on a daily basis. In addition to the onsite inspections, teams of NRC experts would perform targeted inspections of construction and operational activities. As part of its safety mission, NRC has the authority to conduct announced and unannounced inspections of all licensed facilities at any time.



Further, NRC regulations require that DOE have an acceptable “quality assurance” program in place. Quality assurance (QA), is a system of specific policies and procedures that must be followed and documented to provide confidence that construction and operation of a repository is completed correctly. QA policies apply to every aspect of the repository that might affect safety and isolation of waste. Some examples include checking the quality of materials used in construction, having proper administrative procedures, tracking and controlling documents, testing and calibrating equipment, confirming the accuracy of calculations and computer models, and verifying that materials and data are traceable. QA also means ensuring that the workers building and operating the repository are qualified and properly trained to do the job. Auditing is another important part of quality assurance. Regular review of DOE documents, field activities, and laboratory activities by both DOE staff and external parties is important to ensure that DOE follows its procedures to assure quality. DOE also must regularly review the status and adequacy of its QA program and cannot change the program without NRC approval.

Is DOE required to document and retain records of what it puts in the repository?

Yes, DOE must keep complete and comprehensive records of its repository activities and findings. These include records of site characterization, construction activities, repository design, laboratory tests, scientific studies, quality assurance, personnel training, operational procedures, inventories of waste and emplacement location, and so forth. These documents must be accessible for NRC review. DOE also has to make the repository area, documents, and facilities available for NRC inspections and reviews.

Land Ownership and Control

NRC's regulations require DOE to show that the land used for the Yucca Mountain repository and surface facilities is legally under the jurisdiction and control of DOE. The land must be free from claims such as mineral rights and right-of-way easements. DOE must also show that it has the water rights necessary to operate and close the repository safely.

After DOE closes the repository, can DOE just walk away?

No, DOE remains responsible for the safety and security of the repository after closure. By law, DOE must provide continued oversight and monitor the repository to prevent any activity at the site that could interfere with repository barriers or that could cause radiation doses to the public to exceed allowable limits. Before NRC would allow DOE to close the repository, DOE must show that it has put in place suitable land use controls, erected durable monuments, and provided for widespread dissemination of knowledge about the location and contents of the repository.

Emergency Planning

NRC requires that DOE prepare detailed plans for responding to and recovering from radiological emergencies or accidents that might occur before the repository is closed and surface facilities are cleaned up and dismantled. Before NRC would allow waste to be received at a repository, DOE must demonstrate that it will take adequate protective measures in the event of an emergency.



Can NRC say no?

Yes, NRC could deny the application, or NRC could authorize DOE to construct a repository as described in DOE's application. NRC could also allow DOE to build a repository subject to specific, enforceable conditions which NRC believes are necessary to ensure safety, security and environmental protection. NRC will only allow DOE to build a repository at Yucca Mountain if it finds that DOE can build and operate the repository safely and securely, and in a way that meets NRC's regulations. DOE must show that it can handle and dispose of spent nuclear fuel and radioactive wastes at Yucca Mountain without unreasonable risk to public health and safety and that operation of the repository will not undermine common defense, security, and environmental values. NRC will base its decision on a comprehensive safety evaluation of DOE's application and on the results of a full and fair public hearing. Interested state, local and tribal governments can choose to participate in this hearing, whether or not they elect to contest the contents of DOE's application.

If NRC were to approve construction of a repository at Yucca Mountain and if DOE were to build one, DOE would again need to ask NRC for permission to receive radioactive waste for disposal. NRC would make this second decision after reviewing DOE's demonstration that it can manage and dispose of waste safely at the repository, in compliance with NRC's licensing regulations. Similar to the decision on granting permission to build the repository, NRC would base the decision of whether to allow DOE to operate the repository on a comprehensive, updated safety evaluation and the results of a second full and fair public hearing.

Protection for Workers Who Raise Safety Concerns

NRC regulations specifically provide protection for "whistleblowers," or workers who report safety concerns or violations of NRC regulations. Workers cannot be discriminated against or lose their jobs based on providing such information.

Glossary

- *Canister*: a cylindrical metal container that facilitates handling, transportation, storage, or disposal of high-level nuclear waste. Also known as a waste package.
- *Closure*: the sealing of shafts, ramps, and boreholes, and final backfilling of the underground facility, if appropriate.
- *DOE*: Department of Energy; agency responsible for designing, constructing, and operating a repository.
- *Engineered barrier system*: the waste packages, including engineered components and systems other than the waste package (e.g., drip shields), and the underground facility.
- *Geologic repository*: a system that is intended to be used for the disposal of radioactive wastes in excavated geologic media. A geologic repository includes the engineered barrier system and the portion of the geologic setting that provides isolation of the radioactive waste.
- *High-level waste*: the highly radioactive material resulting from the reprocessing of spent nuclear fuel.
- *NRC*: Nuclear Regulatory Commission; the agency responsible for enforcing standards and granting or denying a license to DOE.
- *Performance assessment for Yucca Mountain*: an analysis that:
 - Identifies the features, events, processes that might affect the Yucca Mountain disposal system
 - Examines the effects of those features, events, processes, and sequences of events and processes upon the performance of the Yucca Mountain disposal system; and
 - Estimates the dose incurred by the reasonably maximally exposed individual as a result of releases caused by all significant features, events, processes, and sequences of events and processes
- *Preclosure safety analysis*: a systematic examination of the site; the design; and the potential hazards, initiating events, and event sequences and their consequences (e.g., radiological exposures to workers and the public). The analysis identifies structures, systems, and components important to safety.
- *Radionuclide*: a radioactive type of atom with an unstable nucleus that decays and emits ionizing radiation.
- *Reasonably maximally exposed individual*: a typical healthy adult person living, eating, drinking, and farming, similar to those in the Amargosa Valley area and in the area of highest potential concentration.
- *Spent nuclear fuel*: fuel that has been withdrawn from a nuclear reactor because it is no longer an efficient contributor to producing nuclear energy. Spent fuel is still highly radioactive.
- *Waste form*: the radioactive waste materials and any encapsulating or stabilizing matrix .
- *Waste isolation*: inhibiting the transport of radioactive material to the surrounding environment.
- *Waste package*: the waste form and any containers, shielding, packing, and other absorbent materials immediately surrounding an individual waste container.



DIVISION OF HIGH-LEVEL WASTE REPOSITORY SAFETY

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