QA: NA

Science and engineering

2002

Managing heat in a repository at Yucca Mountain

2001

Engineers call this process thermal loading

When radioactive elements decay, one result is heat. Because it will contain waste packages with many tons of decaying spent nuclear fuel and high-level radioactive waste, the underground repository proposed for Yucca Mountain will generate heat for thousands of years.

2000

Engineers with the Yucca Mountain Project call the amount of heat generated by this radioactive decay within a particular area a "thermal load." The number, size and contents of the waste packages placed in the repository will help determine the actual concentrations of heat within the facility. How these waste packages are arranged will determine which parts of the repository will become hottest. Many packages placed closely together will concentrate considerable heat nearby. This is similar to how heaping the coals in a grill at the center focuses more intense heat there than at the edges. Placing these same packages farther apart - a low thermal load - results in lower temperatures over a greater area.

1998

Scientists consider heat management to be an essential design element for a repository. This is because the way heat moves through a repository could affect its rock floors and walls, and therefore the facility's ability to do its job. Each possible arrangement comes with its own potential advantages and disadvantages. Scientists have conducted extensive underground and laboratory tests of the man-made materials and the rock at Yucca Mountain to determine which method of spacing will best contribute to the safe disposal of highly radioactive materials there.

High thermal load keeps waste packages dry

A high thermal load involves packing a large number of waste packages into a relatively small area. The waste packages themselves would be spaced closely together within their own tunnels. Temperatures in and near these tunnels would reach 200 C (390 F), well above the boiling point of water.

The main benefit of a high thermal load is that the concentrated heat would force any moisture in the rock walls of the repository away from the waste packages. Since corrosion is caused by the presence of moisture, drier conditions near the packages would lessen corrosion, and fewer packages would degrade over the thousands of years the repository would function. A possible drawback is the likelihood that moisture driven off by heat would seep back once temperatures cool. Scientists also anticipate permanent chemical, mechanical, and hydrological changes in the repository rock, as well as a possible decline in the ability of some zeolites within the rock at Yucca Mountain to keep radionuclides from moving outward.

Low thermal load makes for a cooler repository

A low thermal load can be achieved by a number of means. These include increasing the

In the underground laboratory at Yucca Mountain, employees set up the Drift Scale Test, which simulates the placement of waste packages in a potential repository. This test allows scientists to determine what effect heat has on the rock at Yucca Mountain.

spacing between tunnels and waste packages; combining hotter radioactive substances in waste packages with cooler ones; waiting for radioactive materials to decay further, and thus become cooler, before burying them, or by ventilating the repository for longer periods of time.

The lower thermal loads that would result could produce peak temperatures lower than 96 C (204F), below the boiling point of water. Such temperatures would result in less movement of moisture, lower stresses in the rock, and more limited changes to minerals and zeolites. If very little or no rock is heated above the boiling point of water, permanent mechanical, chemical, or hydrological changes within the repository would likely be less substantial, and in a smaller volume of rock, than for a high thermal load.

A possible disadvantage of a low thermal load is that moisture existing in, and percolating through the rock may contact more waste packages sooner than in the high thermal load scenario. Engineers believe, however, that they can use waste packages made from more corrosion-resistant metals to better resist degradation, as well as by using drip shields to divert seeping water around the waste packages. Use of multiple components in this way adds "defense in depth" to the design.

The decision on how best to manage the heat with a repository will be based on extensive studies of how heat and moisture will effect the repository rock. Scientists now believe that a high thermal load would extend the time that waste packages would remain dry, thereby extending their lifetimes. A low thermal load, on the other hand, would cause fewer changes in the rock.

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN
SITE CHARACTERIZATION
PROJECT

P.O. Box 30307
North Las Vegas, NV 89036-0307
1-800-225-6972
http://www.ymp.gov

DOE/YMP-0204
June 2000