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[redacted]

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DATE: 11/08/2006

November 7, 2006

Dr. Jane Summerson, EIS Document Manager
Regulatory Authority Office, OCRWM
U.S. Department of Energy
1551 Hillshire Drive, M/S 010
Las Vegas, NV 89134

RE: Comments Pertinent to the Public Scoping Meetings on EIS
[10-27-2006 Washington Post Announcement, p. A21]

Dear Dr. Summerson:

The following questions and the reasons prompting the inquiries are presented to you before the 11-27-2006 deadline for written comment. The topics include:

1) Testing the Radiation Mitigation Capability of Volcanic Tuff
   Attachment 1: My Correspondence with W. John Arthur III
   Attachment 2: The Climax Mine Spent Fuel Test
2) The Seismic Nature of the Yucca Mountain Site
   Attachment 3: Shifting Ground at nuclear waste site
   Attachment 4: Earthquakes and Faulting
   Attachment 5: 1995 Kobe Earthquake, Japan
3) The TAD Canister
   Attachment 6: Correspondence 8-10-2006 on TAD from Lawrence E. Kokajko to Mark H. Williams

Testing the Radiation Mitigation Capability of Volcanic Tuff

When will the radiation mitigation capability of the Yucca Mountain volcanic tuff be accurately determined via test using live spent fuel? Since Yucca Mountain itself is not licensed to receive live spent fuel, but large incised blocks of volcanic tuff representative of the natural barrier system may be shipped elsewhere to facilitate such test procedures, at which licensed facility will such testing take place?

Reasons for the inquiry: John Arthur III's 07-07-2005 reply (Attachment 1) reveals that the radiation mitigation capabilities of the volcanic tuff in Yucca Mountain were not tested with live spent fuel. Although thermal effects are currently being studied as stated, these experiments do not have the same safety related imperative as experiments that accurately assess the radiation mitigation capability of volcanic tuff. In order to produce an optimum design for the Transport, Aging and Disposal Canister (TAD), as accurate a measure as possible of the radiation protection provided by the natural barrier system is required, because the TAD (component of the engineered barrier system), when interred, must compensate for any insufficiency in radiation mitigation capability of the natural barriers to satisfy the radiation protection performance criteria encoded in the statute.

The Seismic Nature of the Yucca Mountain Site

What magnitude Richter scale event has been chosen as the "design to" parameter for the above-surface and sub-surface facilities and apparatus, respectively, at the Yucca Mountain site? If such values have been proposed, by what methodology were they produced? To what structural g-loading(s) are they equivalent (i.e., 2-g, 3-g, 4-g)? If only structural g-loadings are currently available, what magnitude Richter scale event will the structures and mechanisms so designed withstand?

Have any cost assessment comparisons been generated for design, development and construction of a facility with identical repository function on a non-seismically active site and, in addition, on a site not afflicted by creep? How may I obtain copies of the cost comparisons, if they exist?

Reasons for the inquiry: Attachment 3 indicates that rapid creep is a soil phenomenon afflicting the Yucca Mountain site. Attachment 4 briefly summarizes what is known about the seismic nature of the Yucca Mountain repository site and its surroundings---predicting the potential for a magnitude 6.5 to 7.0 event and recalling the June 1992 magnitude 5.6 event, which damaged Yucca Mountain project surface facilities. The 1995 Hanshin (magnitude 6.9) Earthquake damage demonstrates that predicting and building to withstand the greatest potential magnitude of a future earthquake in addition to anticipating its possible propagation path is not an exact science. The collapse of the Hanshin Expressway punctuates this contention dramatically. In short, an underestimate of the possible magnitude of potential earthquakes led to the design and construction of an expressway structure not robust enough to survive a magnitude 6.9 event. (See Attachment 5.) Cost played a major role in the fatal underestimate. It was deemed prohibitively expensive to over-engineer the expressway to withstand a magnitude 7.0 event, for example. What the Japanese felt they could afford proved disastrously insufficient. Since Yucca Mountain will be receiving and storing toxic carcinogenic radioactive materials, failure (of any assembly) during the occurrence of any magnitude seismic event is not an option. Hence my concern about the imperative to structurally over-engineer and its related costs at Yucca Mountain.

The TAD Canister

How many years ("the most likely time") will the development of the TAD canister take from the release of the performance specifications (scheduled for the end of this month, i.e., November 2006) until a (fully NRC-reviewed, live-spent-fuel-tested) commercial version is in assembly-line production for distribution to nuclear power facilities nationwide? Does any DOE Program Evaluation & Review Technique (PERT) chart (or equivalent) currently exist showing the anticipated schedule of milestones (events) and activities to achieve this goal? Is it available for public scrutiny? If a PERT chart for TAD development exists (however preliminary), I would like to obtain a copy. Allen

Benson has already instructed me to write directly to Christopher Kouts to obtain a copy of the TAD performance specifications forthcoming at the end of this month.

Reasons for the inquiry: In 1982 the Yucca Mountain project management could not have escaped the realization that their project would be burdened with the design and development of a disposal container specifically for exceptionally long-term safe interment of high-level spent nuclear fuel in volcanic tuff within a sub-surface repository. The obviousness of the facility's primary task by definition is demonstrated by the following, which actually took place: The terminology "nuclear waste disposal repository" was introduced to a third grade class. The children were asked to describe what they might find inside such a building, if they were allowed to peek in. One child replied, "Garbage cans?" Any professional engineer (who values his license) cannot deny that ***without*** a successfully tested "garbage can," any sub-surface nuclear waste repository development effort cannot claim to have an implementable design, since the disposal function defines the primary reason for the facility. Further, evaluating the relative importance of the "garbage can" to the other components on the public-safety-related-component priority list (the so-called "Q list"), the engineered barrier component performing the disposal function (and simultaneously tasked with the greatest radiation mitigation burden) is assigned the "number 1" position, i.e., the highest priority.

Once the performance specifications are released, the TAD faces the gauntlet of conceptual design, preliminary design, detailed design, final design, prototype fabrication and test, design update based on test results, production fabrication and test and multiple reviews under 10 CFR Parts 69, 71, 72 and perhaps Part 50. (See Attachment 6.) "Gross negligence" on the part of project management is an appropriate characterization for the delay of a quarter century from the start date of the project in 1982 until the initial development in 2006 of the performance specifications for the "lynch-pin" component (i.e., the component that empowers the implementation of the repository design). As a consequence, the licensing of the repository can expect to be additionally delayed for at least the duration of the TAD design and development effort. Even assuming that the impending TAD activity will eventually produce an acceptably functioning TAD, the Yucca Mountain project will suffer uncertainty in the interim.

Sincerely,

J.E. Holmgren

Enc.

cc: C. White, TAD Lead, Office of the Chief Engineer

Department of Energy
Office of Civilian Radioactive Waste Management
Office of Repository Development
1551 Hillshire Drive
Las Vegas, NV 89134-6321

QA: N/A

Ms. J. E. Holmgren
[redacted]

JUL 0 7 2005

Dear Ms. Holmgren:

Thank you for your letter of May 24, 2005, regarding the Climax Mine fact sheets and the Climax Spent Fuel Tests. It seems that you may have misinterpreted the highlighted text. I apologize for this confusion, and offer you this clarification.

At the writing of the fact sheet, granite, along with shale, salt, and volcanic tuff, were being studied for their isolation capabilities. What is not made clear in the fact sheet is that granite in the Climax Mine was the only rock type that underwent testing with live spent fuel. The purpose of the Climax Mine test was to demonstrate that spent fuel could be packaged, emplaced, and retrieved safely. It was not a long term test of geological disposal in granite. It was neither planned nor thought necessary to repeat this type of physical demonstration at sites involving other rock types. However, short term studies were performed at Climax Mine on the effects of heat and radiation on the environment within the underground facility on the materials introduced with the spent fuel. Those tests influenced the design of the thermal testing planned and carried out at Yucca Mountain, Nevada.

A test similar, in significant ways, to the Climax Mine test is still taking place in Alcove 5 at Yucca Mountain. This test is using electric heaters to mimic the thermal effects of the larger waste packages envisioned for a Yucca Mountain repository laid end to end (see enclosed Drift Scale Heater Test fact sheets). The Drift Scale Heater Test is currently in the cool-down phase. This study will continue in even greater detail, using drills to obtain samples of rock at several distances from the heaters later this year. The test has already, especially during its heat-up phase, produced significant data, which was applied to the current repository design.

Following construction and waste receipt, one or more of the first drifts to receive actual waste will be instrumented, much like those in the Climax Mine experiment, and the results will either corroborate the design or lead to design changes. However, this will be long term monitoring, not short term tests like those conducted at the Climax Mine site.

If there is any additional information you require, please do not hesitate to contact me at (702) 794-1300 or Allen Benson at (702) 794-1322.

Sincerely,

W. John Arthur, III
Deputy Director

Enclosure:
As stated

[redacted]

May 24, 2005

John Arthur III, Department Director
Office: DOE / OCRWM
1581 Hillshire Drive, Suite A
Las Vegas, NV 89134-6321
702-794-1300 / FAX 702-794-1428

RE: Document Request

Dear Mr. Arthur:

In my continuing quest for information on storage casks, I acquired the attached set of Climax Mine Spent Fuel Test fact sheets. I was gratified to learn that successful full-up testing in granite of 11 storage canisters, using actual nuclear waste fuel, was conducted for the depicted storage strategy, before the inception of the Yucca Mountain repository project in 1982. Quoting: "...the Climax tunnels were host to thousands of visitors from around the world who came to learn about the Climax Spent Fuel Test [1980-1983] or how a modern, high-level nuclear waste repository might look. Due to escalating operating and maintenance costs..., the Climax Spent Fuel Test Tunnels were closed in 1989."

The fact sheets claim that shale, salt and tuff were also studied by the DOE in the same time frame "to see if it might be capable of isolating high-level nuclear waste." (This text is highlighted on the enclosed copy.) In order to precisely compare the radiation mitigating capabilities of the 4 geologic media mentioned, it would have been necessary to perform the exact same storage test with the same instrumentation in each geologic medium for the same test time duration. Was this done, and if so, which sites were used for the shale, tuff and salt tests?

What is the future implementation status of the storage strategy presented in the fact sheets? Referencing the first page final paragraph: "Once the 2,268-kilogram (5,000-pound) concrete plug was in place on top of the canister hole, there was no radiation detectable above the background level of granite." Did all four geologic media equally display this high radiation mitigation capacity using the same storage strategy?

Since the final paragraph says: "...the test results have been given to research facilities both in the United States and abroad...," please have copies of the 1980-era granite, tuff, shale and salt nuclear spent fuel test reports sent to me at the above address, in addition to answering my specific questions. I look forward to hearing from you. Also, please thank Mr. Dyer for his kind reply to my previous correspondence.

Sincerely,

J. E. Holmgren

Enc.

ATTACHMENT 2

The Climax Mine Spent Fuel Test

United States
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Site Characterization Project

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Preparing for the Climax Spent Fuel Test

As part of early research into safely isolating nuclear waste, the U.S. Department of Energy (DOE) directed Lawrence Livermore National Laboratory (LLNL) to conduct the Climax Spent Fuel Test. Thirteen spent fuel assemblies from a nuclear reactor in Turkey Point, Florida, were used for the test. The fuel used for this test had been out of a reactor for only 2.5 years. The heat generated by the fuel gave it the peak canister temperature of approximately 140 degrees Celsius (284 degrees Fahrenheit) ten months after it was stored in the granite. If the fuel had cooled longer before emplacement, the peak temperature would have been lower.

Natural radiation, or "background" radiation

All people are exposed to natural radiation. Natural radiation comes from the sun and outer space and is present in the earth, in homes, and in the food people eat. The amounts of this natural "background" radiation vary from place to place. To understand descriptions of background radiation in different places, one needs to know the units of measure used in measuring radiation.

There are several different units used to describe measures of radiation. The unit most commonly used in the United States is the millirem (mrem), which is one-thousandth of a rem. The rem unit stands for "roentgen equivalent man." This unit was devised to define a level of radiation in terms of its effect on human tissue.

In Las Vegas, Nevada, the average level of background radiation in 1988 was 51 mrem per year. Therefore, the average person living in Las Vegas had that dose of radiation in 1988. If the average exposure to radon were included, it could have increased a person's average dose to about 250 millirem. That level could have been increased by choices a person made that year. For example, a coast-to-coast plane flight would increase that radiation dose by 1 mrem.

Radiation levels at the Climax Spent Fuel Test

One part of this test was designed to measure the effects high levels of radiation have on rock. Since spent fuel is highly radioactive, the radiation levels of the spent fuel were much higher than background levels of the surrounding rock. Even though the spent fuel used in this test was safely sealed in shielded canisters when it arrived at the test site, it still had to be handled by remote-controlled equipment. Although workers could be around the shielded canisters when necessary, workers' exposure to radiation was kept as low as reasonably achievable and well within safety guidelines. If a fuel assembly were ever completely unshielded, a person standing next to it could receive a lethal dose of radiation in less than one minute. That is why the handling of spent fuel is so highly regulated.

Once the canisters were lowered into their steel-lined storage holes in the granite, the readings above the storage holes were lowered to 3-4 mrem per hour. Once the 2,268-kilogram (5,000-pound) concrete floor plug was in place on top of the canister hole, there was no radiation detectable above the background level of the granite.

You may read about the Climax Spent Fuel Test in detail in the fact sheets, "Overview of the Climax Spent Fuel Test" and "Results of the Climax Spent Fuel Test."

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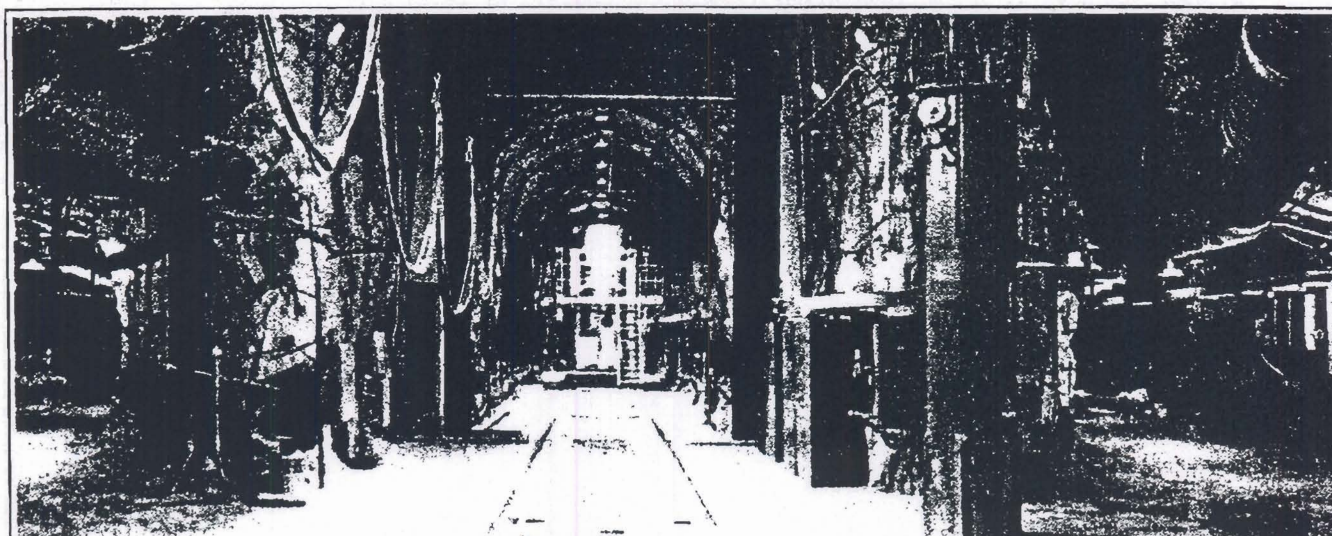
Geology and history of the Climax Mine

The Climax Spent Fuel Test was conducted in granite at Oak Spring Butte on the Nevada Test Site. That granite was formed by magma forcing its way into the existing sedimentary limestone 93 million years ago. It was not the first time the sedimentary limestone had been intruded by magma. Nearby, granite had been formed a few million years earlier. Both intrusions of magma formed masses that surged through the limestone to the surface of the mountain and made a somewhat triangular area about 1.5 miles long.

Granite is a fairly common crystalline rock. During the 1970s and '80s, it was one of several geologic media, including shale, salt, and volcanic tuff, studied by the U.S. Department of Energy to see if it might be capable of isolating high-level nuclear waste.

The mass of granite was named Climax because of the nearby Climax Mine located in the older granite. The family-owned mine was active from the 1930s through 1950, mining scheelite for tungsten, a metal used to harden alloys such as steel. Oak Spring Butte is located in the Oak Spring Mining District which primarily produced copper and tungsten. The federal government bought the Climax Mine when the Nevada Test Site was expanded.

In the 1960s the Climax granite was used to contain two nuclear weapons tests named "Hard Hat" and "Piledriver." Tunnels were mined deep into the granite to meet the requirements of the tests and to contain the explosions. In the late 1970s, scientists chose a site near where the two weapons tests had been conducted so they could use the existing access shaft and other support facilities for the Spent Fuel Test. Working from



View of the entrance to all 3 tunnels of the Climax Spent Fuel Test during construction. Photo by Lawrence Livermore National Laboratory, Nevada

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the existing tunnels, miners excavated a short access tunnel and three new parallel test tunnels.

In addition to successful scientific projects, the Climax tunnels were host to thousands of visitors from around the world who came to learn about the Climax Spent Fuel Test or how a modern, high-level nuclear waste repository might look.

Due to escalating operating and maintenance costs to keep them open, the Climax Spent Fuel Test tunnels were closed in 1989. During its 50-year use by Nevadans and the U.S. Department of Energy, the Climax granite contributed useful minerals, unique test locations, and important information which was shared with scientists throughout America and abroad.

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What is spent nuclear fuel and how was it used in the Climax Spent Fuel Test?

The nuclear fuel used to produce electricity is made of solid pellets of enriched uranium, each about the size of a pencil eraser. These small pellets produce a tremendous amount of energy when used in a nuclear power plant. The pellets are sealed in tubes, or rods, of a strong, corrosion- and heat-resistant metal alloy. The tubes containing the uranium pellets are bundled together in a square grid to form a nuclear "fuel assembly." The assemblies are placed inside a nuclear reactor and used to generate heat to make electricity. The fuel will continue to provide that heat until the fuel is "spent," or no longer efficient in generating heat.

Once a year, approximately one-third of the nuclear fuel inside a reactor is removed and replaced with fresh fuel. The spent fuel is highly radioactive and once it is removed from a reactor, it must be isolated carefully for thousands of years because its radioactivity can harm people and the environment. During that time, the spent fuel will decay to a level that could produce the same health effects as natural, uranium-ore deposits. High-level nuclear waste comes from two primary sources: nuclear power plants and waste from defense programs. Most high-level nuclear waste in the United States is spent fuel.

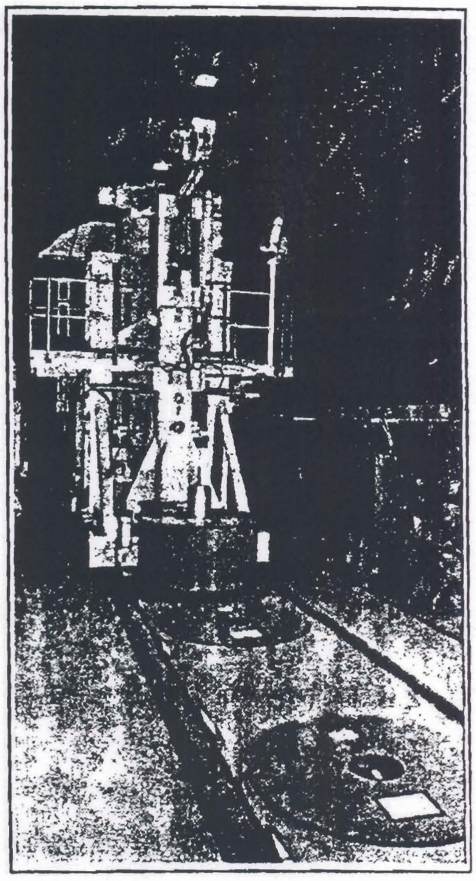
What happens to the spent fuel?

When spent fuel is removed from a reactor, usually it is put into a pool of water at the reactor site. The water is a radiation shield and coolant. Pool storage is a temporary measure until a permanent disposal facility is in place. At some nuclear plants, pool storage is nearing capacity.

As an alternative to pool storage, some spent fuel is being stored aboveground at the reactor site in concrete or steel containers. Like storage in pools, this also is temporary.

Today, using pools and dry storage, approximately 20,000 metric tons of spent fuel are stored at more than 60 nuclear power plant locations across the country. By the year 2000, an estimated 40,000 metric tons of spent fuel will have been produced. There also will be about 8,000 metric tons of solidified high-level nuclear waste from defense programs. Currently, high-level waste from defense programs is stored primarily at three U.S. Department of Energy (DOE) facilities: one each in Idaho, South Carolina, and the state of Washington.

Even if no more nuclear reactors are built or reprocessing becomes economically feasible, the United States still will need to dispose of the stored spent fuel as well as the spent fuel produced by plants operating today. That is why Congress passed the Nuclear Waste Policy Act as amended: to find a permanent and safe solution to the waste problem.



The emplacement vehicle put the 2,268 kilogram (5,000 pound) concrete plug over the top of each access hole. This kept the radiation levels below that of the natural radiation of the granite tunnels. Lawrence Livermore National Laboratory, Nevada photo.

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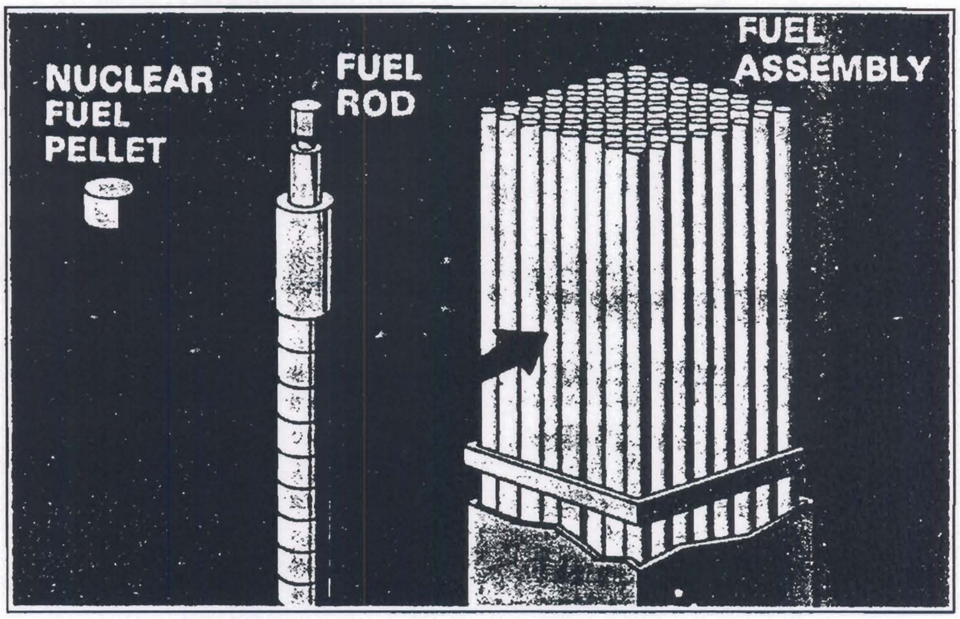
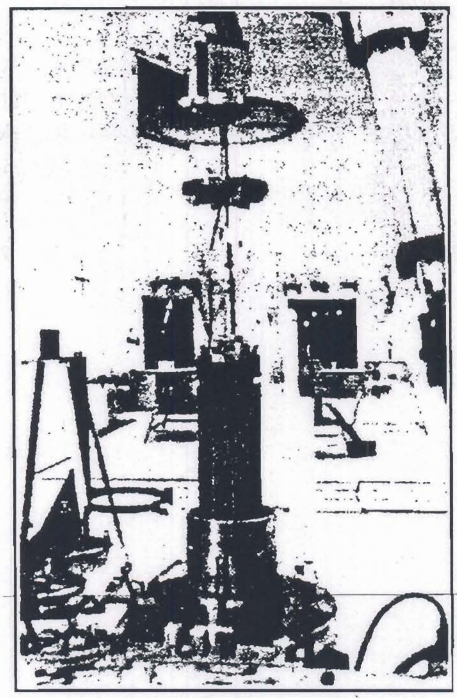
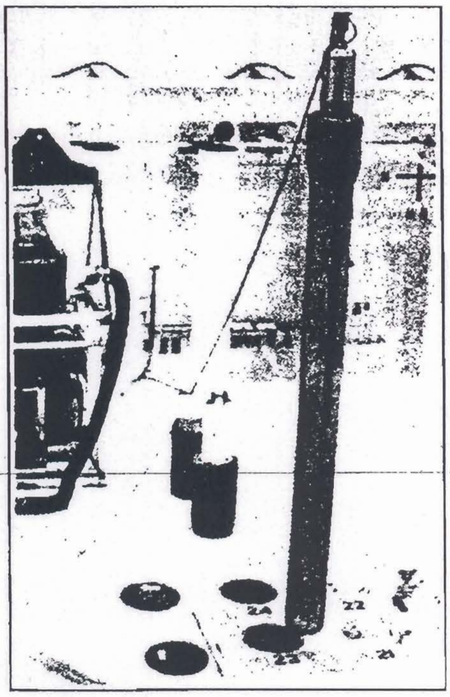


Pellets of uranium oxide are sealed inside a fuel rod. The rods are then bundled together in a square grid to form a fuel assembly.



At the Engine Maintenance, Assembly, and Disassembly (E-MAD) facility, the fuel assemblies are placed inside stainless steel canisters using remote control.



Remote control operations are used to move the canisters containing the fuel assemblies to the specially shielded storage area in the E-MAD facility.

Results of the Climax Spent Fuel tests

Earlier tests laid the groundwork for the 1980-1983 Climax Spent Fuel Test.
In 1977 the thermal conductivity and the permeability of the Climax granite were measured. After that, three tunnels were mined 467 meters (1400 feet) below the surface in the Climax granite.

Advanced computer system monitors test

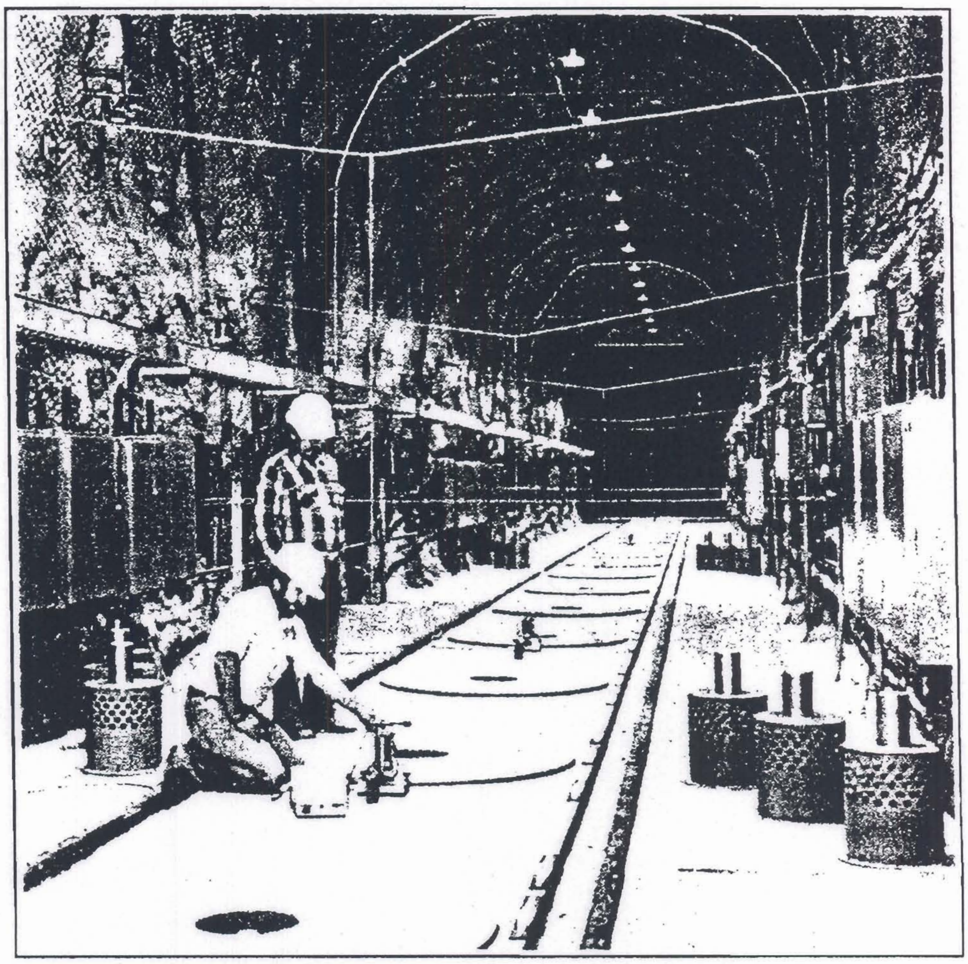
Over the three-and-a-half-year test, 900 sensors measured temperature changes, rock expansion and contraction, stress changes in the rock, and monitored radiation levels. Equipment connected to the sensors included channel scanners, precision digital voltmeters, and radiation detection electronics.

Data from the sensors fed directly into a computer system at the ground surface and directly to LLNL facilities in California. If any data were unusual, the computer was programmed to sound an alarm at the Spent Fuel Test site and in California.

How did heat affect the granite?

Heat had only minor effects on the granite: the rock expanded upward a maximum of three millimeters (about 1/10th of an inch).

Temperatures in and around the spent fuel storage holes were monitored throughout the test. More than 500 temperature sensors gave scientists a complete reading of all three tunnels.



Before construction in the tunnels was completed, sensors were installed in the rock walls and floor. An instrumentation specialist installs a thermocouple to record temperatures in the central tunnel. Photo by Lawrence Livermore National Laboratory, Nevada.

ATTACHMENT 4 (p. 1 of 3)

Earthquakes and Faulting

Yucca Mountain is located in an area that the U.S. Geological Survey classifies as very prone to earthquakes. in fact, the USGS designates the region as Class 4 earthquake zone, its highest rating. As recently as June 1992, a magnitude 5.6 quake struck an area just 12 miles southeast of Yucca Mountain itself, causing substantial damage to Yucca Mountain project surface facilities. The entire area that includes the site is rife with evidence of large numbers of earthquakes in the geologic past. There are at least 33 known earthquake faults within the study area for the repository, with at least two of the faults actually cutting through the proposed repository site.

Earthquakes pose significant problems far a high-level nuclear waste repository for a number of reasons. They increase the risks associated with the handing and above-ground storage of the waste prior to emplacement underground. Above-ground facilities at Yucca Mountain will have to be built to withstand at least a 7.0 magnitude quake. Even with adequate engineering, a moderate or large event occurring during the transfer of spent fuel from transport to storage containers could pose significant safety risks to workers.

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The maximum canister temperature recorded was 140 degrees Celsius, (284 degrees Fahrenheit) while the maximum rock temperature near the canisters was 85 degrees Celsius (185 degrees Fahrenheit). Scientists had predicted the range of temperatures within 3-4 degrees Celsius, confirming the accuracy of the computer models they used.

Radiation monitoring before and during the test

Radiation monitoring to determine the granite's natural background levels began before the 11 spent fuel canisters were stored. This was done to compare radiation levels once the spent fuel was in place. In the storage holes, the spent fuel canisters emitted 3-4 millirem per hour. Once the plugs were in place there was no radiation detectable in addition to the natural background radiation of the granite.

Thorough evaluations done when studies completed

When the studies were finished in 1983, the 11 canisters were removed, and the tunnels were thoroughly tested. The cooling of the granite was studied, rock samples were analyzed, and the effectiveness of the instrumentation was evaluated. The steel lining of the storage holes was removed for sampling. Nearly five million data points from the instrumentation were tabulated by the computer and stored for future reference. The instruments were calibrated and checked for precision and accuracy. After the test, rock samples from the canister area were removed and there were no increased amounts of radiation in the rock.

Significant benefits from the test

Analyzing the data and evaluating the computer models and equipment monitoring was important for this test and for the development of a future repository. The Climax Spent Fuel Test enabled researchers to:

- develop new types of instruments for rock mechanics;
- track the flow of gas in rock fractures;
- develop new equipment to learn more about natural fractures during tunneling experiments;
- take better measurements about the elasticity of rock;
- analyze the effect of heat and radiation on granite; and
- develop sophisticated computer models that can be used to calculate the flow of ground water, and track water movement through fractures in granite.

Additionally, the test results have been given to research facilities both in the United States and abroad to further understanding about storing nuclear waste underground.

Earth Science

Shifting ground at nuclear waste site

Yucca Mountain in Nevada—the nation's top candidate for a high-level radioactive waste repository—is on the move. This windswept ridge and its environs are shifting at least 10 times faster than geologists had expected, according to precise surveying measurements made with the Global Positioning System (GPS) satellites.

For nearly 2 decades, federal scientists have been studying Yucca Mountain to determine whether it would make a suitable underground burial site for radioactive waste from nuclear power plants and weapons facilities. Once tucked away inside the mountain, the waste must remain isolated for 10,000 years while its radioactive isotopes decay (SN: 11/1/97, p. 277).

To study ground movement around the proposed location, geologist Brian Wernicke and his colleagues took GPS readings at five sites situated along a 34-kilometer line that cuts across Yucca Mountain. Given the relatively short time frame of their study and the history of faults, the researchers expected to find no movement. Yet from 1991 to 1997, the two farthest stations moved apart roughly 1.7 millimeters per year, with smaller shifts between the middle stations, the researchers report in the March 27 SCIENCE.

"That is 10 to 100 times [the value] that you would derive from what's known about the seismic history of faults across Yucca Mountain," says Wernicke of the California Institute of Technology in Pasadena.

Researchers are puzzled about why the region is stretching so much faster now than it has over the last million years. One possibility is than the crust is undergoing temporary readjustments following a magnitude 5.4 earthquake that struck 20 km southeast of Yucca Mountain in 1992. Wernicke and his colleagues argue that this explanation is unlikely because the quake was relatively small and far away from many of the GPS sites.

Instead, they propose that magma movement deep in the crust could be driving the ground motion at Yucca Mountain. If so, the region could be passing through a geologically short period of activity, lasting roughly 100,000 years, when the rates of earthquakes and volcanic eruptions exceed the long-term average over millions of years.

Eruptions are of particular concern because a direct hit would blast radioactive material into the atmosphere. Yet past studies have concluded that the volcanic threat is minimal. Researchers have estimated a 1 in 10,000 chance that a volcanic eruption will disrupt the site of the proposed nuclear waste repository over the next 10,000 years, says Bruce M. Crowe, a geologist with Los Alamos (N.M.) National Laboratory.

Wernicke and his coworkers suggest that the true probability could be 10 times higher. Crowe says the impact of the new study remains uncertain. "I think [Wernicke] has jumped a little too quickly to the volcanism model to explain his interpretations." Both agree that a prudent plan would be to set up a network of GPS stations around Yucca Mountain to resolve how much the ground is shifting. —*R.M.*

Ancient quake sliced crusader castle

Around dawn on May 20, 1202, a powerful earthquake cut though a crusader castle overlooking the Jordan River in what is now Israel, according to a team of geologists and archaeologists. The researchers gleaned such a precise description of the damage by studying historical accounts and the disturbed sediments near the castle, called Vadum Jacob.

The walls of Vadum Jacob sit directly atop a major fault in Earth's crust, making them ideal recorders of ground movement, according to Ronnie Ellenblum of Hebrew University in Jerusalem and his colleagues. The earthquake, with an estimated magnitude of 7.6, shifted the walls by 1.6 meters, the researchers report in the April GEOLOGY. —*R.M.*

ATTACHMENT 3

January 1997

Fault and Earthquake Hazard

- Research confirms that a fault and earthquake hazard exists at the site. A repository sited in a seismically active area is vulnerable to damage and possible loss of isolation capability from seismic events and fault movement. It is the conclusion of Agency earthquake researchers that a magnitude 6.5 - 7.0 earthquake is likely in the vicinity of the site in the next 10,000 years. Of the 33 known Quaternary faults (less than two million years old) in the vicinity of the site, at least five of these faults contain observed volcanic ash, thus providing evidence of a contemporaneous (closely spaced in time) volcanic eruption at Lathrop Wells volcano south of the site with a fault rupture event at the site. Apart from the potential for direct damage to the repository and waste packages, earthquakes cause faults to move and have the potential to result in changes in water tables, to initiate volcanic or geothermal activity, and to drastically alter the hydrologic and geologic conditions at the site.

- The Agency's work has contributed to the finding that the tectonics of Yucca Mountain are complex. There is considerable scientific debate over which tectonic model (i.e., which conceptualization of site-specific conditions) appropriately represents the site's complexity. Much of this debate is based on the recognized uncertainties and gaps in knowledge about the geology and tectonics in the region. Resolution of the debate appears unlikely in the near future, and without resolution, it is not possible to predict with any certainty how waste isolation can be impacted by tectonic processes, something that will make licensing a repository at Yucca Mountain difficult, if not impossible.

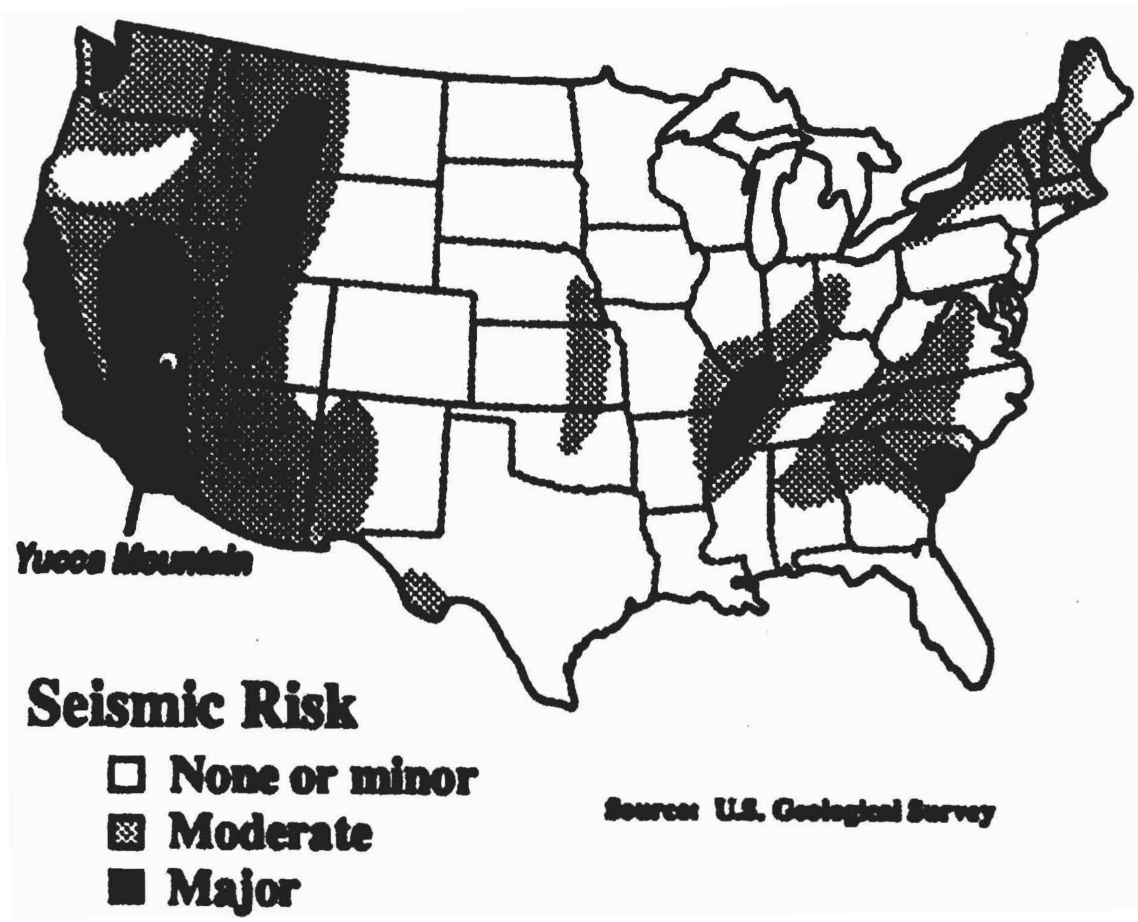
Volcanic Hazard

- Agency researchers have found that, contrary to DOE assumptions, a volcanic eruption is probable within the repository design life. Five volcanic centers are located within 10 miles of the site. Also, geophysical studies suggest that there are buried volcanic features beneath the site. Evidence developed by numerous researchers has concluded that the probability of renewed volcanic activity in the Yucca Mountain area is real, but the exact location of this future activity cannot be predicted.

ATTACHMENT 4 (p. 2 of 3)

ATTACHMENT 4 (p. 3 of 3)

Seismic Risk Map of the U.S.

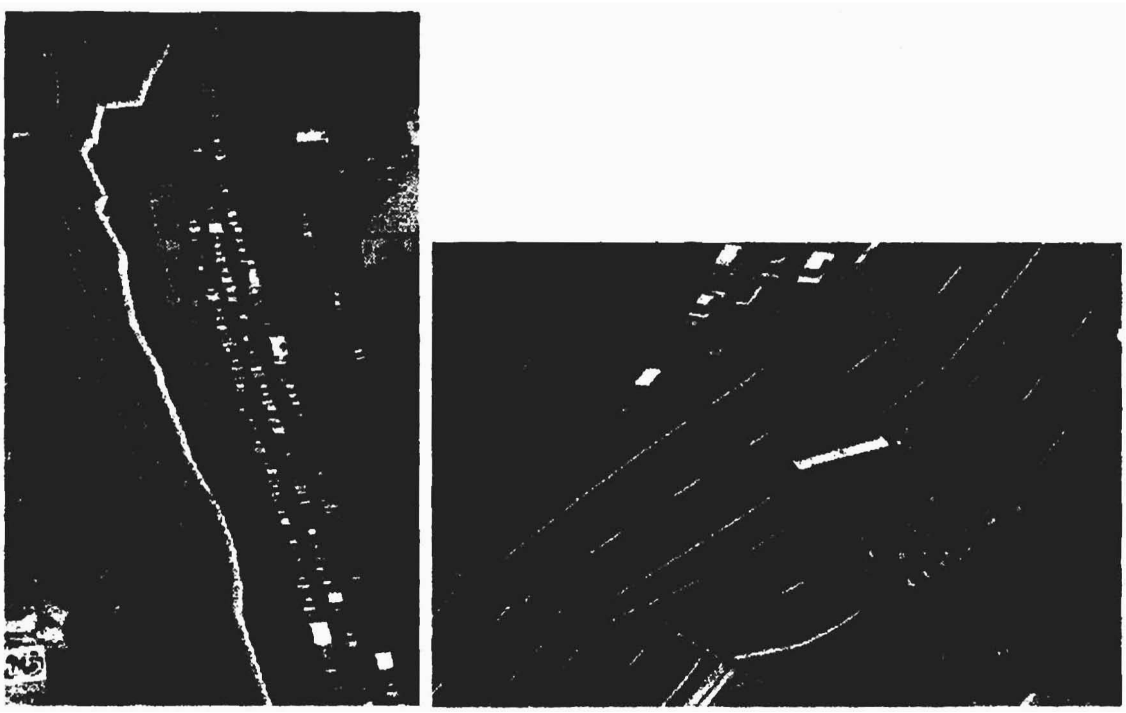


Seismic Risk Map of the United States

ATTACHMENT 5 (p. 1 of 2)

1995 Kobe earthquake, Japan

The 1995 Great Hanshin Earthquake (M=6.9), commonly referred to as the Kobe earthquake, was one of the most devastating earthquakes ever to hit Japan; more than 5,500 were killed and over 26,000 injured. The economic loss has been estimated at about $US 200 billion. The proximity of the epicenter, and the propagation of rupture directly beneath the highly populated region, help explain the great loss of life and the high level of destruction. (On line report of Kobe earthquake). The spectacular collapse of the Hanshin expressway illustrates the effects of the high (above, KG) loads that were imposed on structures in the area. The strong ground motions that led to collapse of the Hanshin Express way also caused severe liquefaction damage to port and wharf facilities as can be seen to the left and below (GH).



(from a report by J.-P. Bardet at USC and others at Gifu Univ.; used by permission; and from Japanese TV) Large sections of the main Hanshin Expressway toppled over. This was particularly likely where the road crossed areas of softer, wetter ground, where the shaking was stronger and lasted longer.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

ATTACHMENT 6

August 10, 2006

Mr. Mark H. Williams, Director
Regulatory Authority Office
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
1551 Hillshire Drive
North Las Vegas, NV 89134-6321

SUBJECT: TRANSPORT, AGING AND DISPOSAL CANISTER FOR SPENT NUCLEAR FUEL MANAGEMENT

Dear Mr. Williams:

The U.S. Department of Energy (DOE) has proposed using a Transport, Aging, and Disposal (TAD) canister as its primary container for commercial spent nuclear fuel (CSNF) at the proposed high-level waste repository at Yucca Mountain, Nevada. As has been discussed at several public meetings, DOE is currently developing performance specifications and, ultimately, designs for the proposed TAD canister and revisions to proposed surface facilities. DOE has indicated that its TAD performance specifications will be provided to commercial vendors in the near future. This letter provides comments from the U. S. Nuclear Regulatory Commission (NRC) staff on regulatory criteria and other possible areas of consideration for the development of TAD canister designs and performance specifications.

The first area concerns how the TAD canister might meet the NRC safety requirements for all its proposed functions in transportation, possible interim storage at a reactor or other NRC - licensed site, and aging and disposal in a geologic repository. As you are aware, the proposed TAD system will involve separate reviews under 10 CFR Part 71 for the approval of a transportation cask, under 10 CFR Part 72 for approval of a storage cask, and under 10 CFR Part 63 for approval of an aging cask and as part of the engineered barrier system for geologic disposal. Additionally, it may involve review of reactor licensing activities under 10 CFR Part 50, for potential loading and handling of TAD canisters at reactor facilities.

The enclosure provides a high-level summary of some of the regulations that may be relevant to the TAD canister concept. Because multiple regulatory approvals are involved, it is important to identify crosscutting issues early in the regulatory process. This is important given the projected timing of applications for approval of TAD-based storage and transportation casks relative to DOE's proposed submittal date of June 2008, for a proposed Yucca Mountain License Application.

Our current understanding is that DOE's planning is based on the assumption that a TAD canister will be certified for storage and transportation prior to completion of the NRC staff's review of the performance assessment under 10 CFR Part 63. DOE should recognize the fundamental difference in the risk-informed, performance-based criteria of Part 63 from the technical and safety requirements of 10 CFR Parts 71 and 72, which have been used many times to approve shipping and storage casks. Early identification and resolution of crosscutting issues is key to reducing possible regulatory risk to the applicant.

The second area of consideration concerns the treatment of specific technical aspects of a TAD canister within the performance assessment under 10 CFR Part 63. These aspects could be addressed in the TAD canister performance specifications currently being developed by DOE.

1. The materials used in the canister and its internals may affect the in-package chemistry, which, in turn, could affect the CSNF dissolution rate and the solubility limits of radionuclides to be considered in the performance assessment for the postclosure period. For example, corrosion of materials could affect the in-package pH, possibly increasing the CSNF dissolution rate and the solubility limits. As another example, corrosion of carbon steel could promote colloid formation, facilitating radionuclide release and transport.

2. Assessment of the continued integrity of cladding on CSNF may be less straightforward in a TAD canister than in the previous fuel-handling approach that DOE was considering. For example, in the performance assessment in DOE's "Environmental Impact Statement," the CSNF cladding plays an important role in the postclosure performance. If DOE continues with this approach, a means to determine the state of the cladding may be necessary, especially for high-burnup CSNF. Possible performance credit for cladding could also bear on the compatibility of thermal limits for Parts 71, 72, and 63, with respect to the potential for cladding embrittlement.

3. As currently understood, DOE's approach for criticality control during the postclosure period of the repository is to screen out a criticality event based on burnup credit for actinides and fission products, fixed neutron absorbers, geometry control, and limiting moderation. These may also drive the TAD canister design. For example, the proposed neutron-absorber materials (e.g., Ni-Cr-Mo-Gd alloy) may degrade by thermal aging or corrosion during the long postclosure period. Cladding degradation by embrittlement and basket degradation may alter other bases for the criticality control used in the previous fuel-handling approach.

4. DOE has acknowledged that the use of a TAD canister will significantly impact preclosure operations. The intended safety function of the TAD canister, its place in preclosure event sequences, and its possible classification as an important-to-safety system based on the potential preclosure event sequences are examples of how a TAD would be considered within the preclosure safety analysis (PCSA). As discussed recently at our PCSA Technical Exchange on May 16-17, 2006, reference reliability information for relevant structures, systems, and components is needed to categorize event sequences and to perform the PCSA.

The third area of consideration concerns Quality Assurance (QA), which is an important part of 10 CFR Parts 50, 63, 71, and 72 . For TAD canister use at a geologic repository, under the provisions of the NRC-approved DOE Part 63, Subpart G, QA program, DOE needs to implement QA requirements consistent with the safety significance of the TAD canisters and their internal materials and components (e.g., CSNF cladding). The need and methods for assurance or verification of TAD canister components and material compliance with the DOE specifications and CSNF Waste Acceptance Criteria are also important. These include the QA program processes and methods for requiring and implementing technical and QA program requirements for the entities that provide and load the TAD canisters, and the DOE QA program oversight, verification, and receipt inspection.

In summary, NRC will evaluate DOE's proposed TAD system under the applicable regulations for each function of the TAD. The staff plans to discuss these and other topics related to the TAD canister approach, in the interest of early consideration of crosscutting regulatory issues, at our upcoming Technical Exchange.

If you have any question regarding this matter, please contact Dr. Mahendra Shah at (301) 415-8537, or by e-mail, at mjs3@nrc.gov or Marissa Bailey at (301) 415-7198, or by e-mail at mgb@nrc.gov.

Sincerely,

Lawrence E. Kokajko, Deputy Director
Division of High-Level Waste Repository Safety
Office of Nuclear Material Safety
and Safeguards

Enclosure: NRC Regulatory Criteria
Applicable to a Transportation,
Aging and Disposal Canister

cc: See attached list.

Topics for Ned Larson Briefing on November 9, 2006

Purpose

- Review Schedule

- Describe content of applications

- Prepare for review and signature phase

Schedule

- Draft applications ready by 11/22
  - field verification of waypoints
  - additional map rework following field verification

- Issues needing resolution at NSE meeting on 11/27

  Plans for revisions/submittal after meeting

- Projected filing date is 12/14/2006

Describe number of wells and locations (use map)

- Temporary vs. permanent appropriations

- Types of uses (construction, industrial, maintenance)

  Place of use philosophy

Limits identified on applications

- Annual duty
  - temporary wells – 85% of total demand for each basin
  - all wells in each basin supplemental
  - total demand for 10-year construction for basin is explained

Strategy for submittal in other basins

- Mina or Caliente or both…when?