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CONGRESSIONAL-EXECUTIVE INTERACTION AND THE NUCLEAR WASTE REPOSITORY SITE SELECTION PROCESS

James A. Thurber
Director, Center for Congressional and Presidential Studies
School of Public Affairs
The American University
4400 Massachusetts Avenue N.W.
Washington, D.C. 20016
(202) 885-6247

Timothy C. Evanson
School of Public Affairs
The American University
4400 Massachusetts Avenue N.W.
Washington, D.C. 20016
(202) 885-2713

ABSTRACT

The Nuclear Waste Policy Act of 1982 (NWPA) (P.L. 97-425) and the Nuclear Waste Policy Amendments Act of 1987 (NWPAA) (Title V of P.L. 100-203) provide the framework for the Department of Energy's (DOE) Office of Civilian Radioactive Waste Management (OCRWM) to find a permanent means for disposing of high-level nuclear waste in the United States. The focus of this study is the congressional decision-making process associated with passage of the Nuclear Waste Policy Amendments Act of 1987. The passage of NWPAA was a direct result of the failure of the policy adopted in the Nuclear Waste Policy Act of 1982. This study analyzes the nature of congressional nuclear waste policy-making through the lens of subsystems theory.[1] The data analysis is primarily based on confidential interviews with over fifty key actors in the nuclear waste policy subsystem as well as an analysis of primary source documents.

I. THEORETICAL FRAMEWORK: POLICY SUBSYSTEMS

In order to explain the strategies of the major players involved in the development and passage of NWPAA, it is necessary to place nuclear waste policy-making in a broader theoretical framework. Until recently, the predominant description of the policy process in political science has been encapsulated in two forms--iron triangles and issue networks. Iron triangles are relatively closed policy arenas distinguished by stable relations among a limited number of participants--executive bureaus and agencies, congressional committees, and interest groups or "clientele groups." The issue network is characterized as open, fragmented, and extraordinarily complex, making it unsuited to resolving conflict or reaching decisions quickly. Many participants move in and out of the issue network, and power in the network is disaggregated.[2]

Subsystem theory builds upon these metaphors by modeling the different political environments in which decisions are made. Subsystem theory identifies three decision-making systems: macropolicy systems (general decision-making with major political effects involving broad public interests, divisiveness, extensive media coverage, and many participants); policy subsystems (ranging in turn from dominant to competitive to disintegrated); and micropolicy systems (narrowly focused, often closed decision-making involving a very small group of decision makers). Several variables are used to distinguish these systems from one another: the visibility of conflict, the level of conflict, the scope of conflict, and the number of participants in the subsystem.[1]

Policy subsystems are dynamic and highly variable (see Table 1). Within the policy subsystem category, there exist three subsystems. The dominant subsystem exhibits stable relations among a small group of decision-makers, and uncertainty and information costs are low. Competitive subsystems exhibit coalitions that are short-lived due to competition for resources and information, while in disintegrated subsystems the level of conflict and visibility are higher, and large numbers of participants engage the interested public. Subsystem theory does not consider political conflict to be undesirable.[*] In the policy subsystem model, environmental factors have a direct impact on the dynamics of decision-making.

II. HISTORY OF NUCLEAR WASTE DISPOSAL POLICY-MAKING

Congressional-executive relations associated with nuclear waste policy have evolved through three policy-making stages. In the first stage, a closed and dominant policy-making system typified by congressional-executive cooperation in the research and development of waste management isolation technologies operated with a high level of secrecy and discretion from 1954 until 1979. A second, more competitive stage existed from 1979 to 1986. In this stage, the decision-making system became more open to participation by other actors. Congressional-executive conflict increased but Congress,

[*] More commonly, policy conflict is seen as disruptive and even dysfunctional.

Table 1 - Typology of Policy Subsystems.

Subsystem Type	Coalition	Visibility of Decision	Specificity of Jurisdiction	Scope of Conflict	Level of Conflict	Number of Participants	Access to Decision Process
Dominant	Stable	Low	Well Defined	Narrow	Low	Small	Closed
Competitive	Not Stable for Short Periods	Low	Overlapping and Challenged	Moderate	Moderate	Moderate	Open Only to Those Competing
Disintegrated	Not Stable	High	Fragmented	Wide	High	Large	Open

SOURCE: J. A. THURBER, "Dynamics of Policy Subsystems in American Politics," in <u>Interest Group Politics</u>, eds. A. J. CIGLER and B. A. LOOMIS, Washington, D.C., Congressional Quarterly Press (1991).

DOE, and interest groups worked closely in the passage and implementation of NWPA.

As DOE focused on potential sites for characterization, conflict over the direction of nuclear waste policy expanded, and became more visible and electorally volatile. The increasing level and widening scope of conflict pushed the subsystem into a third, micro-policy-making stage lasting from the latter half of 1986 until the passage of the NWPA Amendments in early 1987. The post-1987 NWPAA stage, a fourth period, is again primarily a dominant policy subsystem. This stage is generally characterized by cooperation and co-management between Congress and DOE in decisions about the funding and implementation of nuclear waste policy.

The development of long-term repositories for nuclear waste has always been the responsibility of the federal government. In 1954, Congress created the Atomic Energy Commission (AEC) to regulate and promote civilian nuclear power. The stated goal of the AEC was to develop a long-term nuclear waste storage option that would literally last thousands of years. On-site storage was accepted as the short-term solution to the waste storage problem, but the AEC publicly argued that long-term storage solutions could be in operation by the early 1970s.[3]

The geologic repository concept became the most commonly accepted repository option after the National Academy of Sciences endorsed it in September, 1955.[4] Beginning in the mid 1960s, the Oak Ridge National Laboratory began to look at salt domes as the most promising media for a repository.[3] In the spring of 1968, the AEC declared that all waste should be reprocessed into an AEC-approved form and deposited in a permanent waste repository not more than 10 years after its reprocessing.[b] In 1972 AEC Chair James Schlesinger pressed for the development of a surface repository.[3]

The JCAE held very few hearings concerning nuclear waste storage during this period, the earliest and most important set occurring in early 1959.[5] Scientists appearing as witnesses at the hearings approved of the AEC's tank storage and long-term repository programs. The hearings were well reported and caused a large public stir, but they wound down without directly examining the AEC's high-level waste disposal program.

During the 1960s and 1970s, both long-term and short-term political changes occurred which led to the breakup of the dominant policy subsystem. One of the most important long-term trends was the growing environmental movement. This helped to create a positive political climate for the passage of the National Environmental Protection Act (NEPA) and the Occupational Safety and Health Act, and new legal mechanisms in these laws provided citizens with opportunities to affect governmental decision-making.[6]

Short-term trends, however, were more important. In 1974, in the wake of the first OPEC oil embargo, the AEC was divided into two new agencies, with regulatory duties given to the Nuclear Regulatory Commission (NRC) and responsibility to promote nuclear energy transferred to the Energy Research and Development Administration (ERDA). Following a reform recommendation in the Senate, the JCAE was abolished in 1976 and its oversight duties distributed among several House and Senate committees.[7] The energy crisis of 1973-74 and the oil price increase of 1979 and 1980 also indirectly affected the old nuclear waste policy subsystem. As nuclear energy came to be seen as one major solution to the energy crisis, more people became aware of the industry's problems.[6] Finally, as the public and their representatives in Congress became less trustful of pro-nuclear expert opinion, the number of nuclear waste policy decision-makers expanded.[c]

The 1979 Three Mile Island accident mobilized a large, aggressive, and vocal national anti-nuclear power lobby which challenged the weak but still dominant subsystem. The public's awareness of nuclear waste issues also increased dramatically at this time. In 1980-1981, an average of about six articles per quarter were published in national newsmagazines or newspapers compared with an average of about ten articles per quarter in the 1982-1983 period, a forty percent increase. Passage of the 1987 NWPAA legislation and additional concern about nuclear power generated by the Chernobyl accident led to another jump in the average number of articles per quarter during 1987-1988.

Reacting to this public pressure, DOE issued several environmental studies regarding repositories in the early 1980s and even characterized several sites. However, a growing number of constituents, having lost faith in the scientific expertise and public-interest orientation of DOE, pressured Congress to "do something" about nuclear waste policy.

In 1982 Congress passed NWPA, which states that "geologic conditions" of potential sites are to be the "primary criteria" for selection of an appropriate nuclear waste site. The Secretary of DOE was directed by NWPA to administer the site selection process in several stages. DOE was to screen potential sites and recommend three sites for characterization to the President from a list of five potential candidate sites. Upon completion of the site characterization process, the President was to recommend to Congress one of the three characterized sites as "qualified" for the first repository. NWPA provided for extensive public hearings and consultation with state governments, and gave the state

[b] The regulations published at that time can be found at 10 CFR 50, appendix F, November 1970.

[c] The AEC's authority on issues of safety and health began to be disputed in part because the agency had failed to raise questions of safety and economics in a timely fasion during the 1950s and 1960s.

selected as the site of the repository a veto (the veto could be overridden by majority vote of both houses of Congress). DOE was also to locate a second repository in the East or Midwest to achieve regional balance.[4]

Citizens living close to potential nuclear waste sites quickly expressed attitudes consonant with the NIMBY syndrome.[6] But Congress was determined to work around the NIMBY problem: "We have been around this block many times before. We have heard from the states that they do not want nuclear waste in their backyard. We have heard from the Department of Energy that it must go somewhere. We have heard from the utilities that it is already in storage on-site at nuclear reactors all around the country. The simple fact is that nuclear waste is already in temporary storage in 33 states around the country."[8]

Congress attempted to structure NWPA to avoid NIMBY pressures.[9] In an attempt to avoid long delays, Congress created a multi-site selection process. The act's strict schedule also required DOE to begin disposing of waste at a repository no later than January 31, 1998, a clear attempt to avoid a drawn-out site selection process that would be electorally damaging. Anticipating NIMBY pressure, Congress decided to "spread the pain" by authorizing two regional repositories.

It also appears that Congress deliberately shifted responsibility for educating the public about the repository program to DOE. Congressional respondents have noted that some Members of Congress worried that if Congress itself tried to educate the public about the repository program, voters who opposed the policy would retaliate against incumbents at election time. Therefore, DOE was forced to play the role of educator.

NWPA also made DOE subject to regulations issued by other federal agencies. Congress felt that this could break the utilities' hold on DOE. Therefore, DOE was forced to comply with regulations published by the Environmental Protection Agency (EPA) in 40 CFR 191 and by the Nuclear Regulatory Commission (NRC) in 10 CFR 60.

Congress also authorized DOE to site, construct, and operate a monitored retrievable storage (MRS) facility for the short-term storage of high-level radioactive waste. Although Congress chose permanent disposal over monitored and retrievably stored waste isolation in NWPA, the act still directed DOE to study the need for and feasibility of constructing an MRS facility. DOE submitted the requisite report and proposal in March 1987, proposing to site an MRS facility at Oak Ridge, Tennessee.

Congress also created the Office of Civilian Radioactive Waste Management (OCRWM) within DOE to manage the nuclear waste program. OCRWM has guided the repository site selection process through regulations published at 10 CFR 960.

III. CHRONOLOGY, PLAYERS, AND STRATEGY IN PASSAGE OF THE NUCLEAR WASTE POLICY ACT AMENDMENTS OF 1987

The passage of NWPA failed to resolve many of the issues which concerned the public, and each element of NWPA raised new issues of significant concern to Congress, state and local governments, and constituents. Congressional hearings on the repository site selection process were frequent and regular during the 1980-1983 period as the competitive subsystem built a coalition to pass NWPA. But in the 1984-1987 period, hearings became even more frequent, occurring at an average of 4.5 hearings per quarter. And as Members of Congress and many witnesses noted at hearings held during the 1984-87 period, the hearings were being conducted at least in part because of the growing public dissatisfaction that existed with the implementation of NWPA. More importantly, the number of expert and executive branch witnesses appearing at each congressional hearing increased dramatically after the passage of NWPA. This indicates that hearings became much more substantive during NWPA's implementation than before its passage or after the NWPA Amendments in 1987. These data also indicate that the scope of conflict over the nuclear waste issue expanded as NIMBY sentiment spread like a contagion. The wider the conflict, the less influence the congressional nuclear power advocacy committees and DOE had over the outcome of nuclear waste policy.

DOE's handling of the public hearings process worsened the political situation.[10] DOE personnel believed in a scientific-technical culture that reduced the importance of politics, and they were criticized for discussing issues only in the technical jargon of the engineering profession. Respondents agree that these cultural norms made it difficult for DOE to respond to public and congressional pressure.

Soon, Members of Congress, their constituents, and state government officials began to doubt DOE's ability to successfully implement nuclear waste disposal policy. Public distrust of DOE scientific credibility increased and DOE lost a high degree of institutional legitimacy.[10] Other political pressures also encouraged DOE to avoid a faithful implementation of NWPA. The Reagan administration had taken office in 1981 asking Congress to abolish DOE. With many critics and few strong supporters, officials at DOE reasoned that the agency could not survive if it became the public's scapegoat over the nuclear waste repository siting issue. Strong criticism regarding the eastern and midwestern

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[4] Many commentators have asserted that NWPA mandates that one repository be built in the East or Midwest and another repository in the West. However, the east-west arrangement was not explicitly written into law.

[6] "NIMBY refers to intense, sometimes emotional, and often adamant local opposition to siting proposals that residents believe will result in adverse impacts." M. E. KRAFT and B. B. CLARY, "Citizen Participation and the NIMBY Syndrome: Public Response to Radioactive Waste Disposal," Western Political Quarterly 44 (June 1991).

sites led DOE to insulate itself from this pressure. In May 1986 DOE "indefinitely postponed" the search for a second repository in the Midwest and East. In retaliation, Western senators cut nearly all FY87 funds for site-specific work. An interviewee observed that the May, 1986 decision affected DOE's relations with Congress:

> DOE then tried to [argue] there was not going to be as much waste as originally expected because there are not as many new nuclear power plants as originally planned. DOE took a bashing for 'suspending' the work on the second site, but then Congress followed DOE's lead and selected Yucca Mountain. [But there] was always a back channel between DOE and the Hill. Senator Johnston still had warm relationships with many at DOE.

In May 1986, DOE formally selected the Nevada, Texas, and Washington sites for site characterization. Narrowing the list of potential sites ignited citizen and congressional opposition to building a nuclear waste repository. Congress tried to save the 1982 NWPA policy by holding hearings, but quickly found that people with NIMBY attitudes were not responsive to attempts at persuasion. As NIMBY pressures mounted, Members of Congress (especially those in the Senate) responded by pushing for the enactment of new legislation.

The political pressure was particularly acute in Louisiana. Senator J. Bennett Johnston (D-LA) and his constituents were convinced that Louisiana (which had at one time been a prime candidate for a repository in salt domes) would become home to the new nuclear repository. Johnston's position as chair of the Environment and Public Works Committee and the Appropriations Subcommittee on Energy and Water Development, both with jurisdiction over the nuclear waste program, helped him become a major force in nuclear waste policy-making.

Political pressures built throughout 1987 and opened a window of opportunity for Members of Congress who wished to amend or discard NWPA. In January, 1987 DOE announced that it was postponing the opening of the first repository to 2008, and that it was moving forward to build an MRS facility at Oak Ridge. Then in February, 1987 Secretary of Energy John Herrington threatened to reopen the search for a second repository site if Congress did not amend NWPA and eliminate the second repository requirement.

Although bills had been introduced in the Senate to terminate the second repository program, it was clear that such measures would not clear the House.[11] In late March, 1987 Johnston and Senator James McClure (R-ID) introduced legislation designed to find a willing host for the repositories. By August, Johnston had drafted more new amendments which in their final form would become NWPAA. On August 29, 1987 the Senate Committee on Energy and Natural Resources voted to include these amendments as part of the budget reconciliation bill (S. 1688). As one conference committee participant noted:

> The House conferees did not want any action on nuclear waste until the Senate forced their hand by Senator Johnston putting the NWPAA in the reconciliation bill. Senator Johnston thought up the strategy to put the NWPAA in the reconciliation bill as a way to move the issue. He came up with the idea in mid-July [1987]. Senator Johnston, by force of personality and strategy, forced the committee to make decisions about amending the nuclear waste act.

Johnston then adopted a "two-track" approach. On September 9, 1987 Senator Johnston announced that he would include language concerning nuclear waste policy identical to that found in the reconciliation bill to the energy appropriations bill (H.R. 2700). By voice vote the full committee approved of the amendments.

The appropriations bill went to the Senate floor, where it encountered severe opposition. Johnston overcame the opposition of Senator Sasser by adding language that established a commission to review the need for an MRS facility. But Senators Adams (D-WA) and Reid (D-NV) were also bitterly opposed to the bill and tried to stop it through a filibuster. One conference committee participant described the maneuvering which overcame this opposition:

> Senators Evans [R-WA] and Hatfield [R-OR] included language that steered the DOE toward Nevada. ...The Evans and Hatfield language was written up and returned to the Senate for approval [which was given]. They [Senators Evans and Hatfield] felt they were directing DOE to characterize Yucca Mountain only. Senator Johnston and most committee members [on the Senate Committee on Energy and Natural Resources] and DOE realized what was going on. This was the first policy action toward the one site solution.

The clarifying language--and the fact that Johnston was close to obtaining cloture--ended the filibuster.

Nevada was chosen as the sole site to be characterized because, as a respondent from the Executive Office of the President observed, "Nevada was weaker politically. It had a smaller congressional delegation. The government already owned the land. It is a desert, dry, far away from water and people." Another executive branch respondent noted that the Yucca Mountain site also seemed to be the best political solution:

> DOE was asked several times by the Senate about the suitability of the Nevada site: give us your opinion about which site is best. [Ben] Rusche [at

> DOE] thought a'l three sites would be okay. In DOE, they always thought it would be Nevada for political reasons. Nevada only had two votes in the House, and Washington [had eight], Oregon [had five], and Texas [had twenty-seven]. Plus Texas had Speaker Wright and Washington [had] Majority Leader Foley. Generally the people at DOE who knew thought that Johnston wanted Nevada to be chosen. However, Johnston tried to work things out with [Senator] Reid [of Nevada]. Reid hurt himself by not being more cooperative. Eventually Johnston got mad and gave up on Reid and Nevada.

Finally, with the Reagan administration supporting the bill, the Senate approved the Johnston energy appropriations bill. By this time, however, the reconciliation bill had already gone to its own conference committee.

The House and Senate started the conference with differences that looked irreconcilable. The House position was a bill (H.R. 2976) sponsored by Rep. Udall (D-AZ), the chair of the Interior and Insular Affairs committee. Johnston chose a three-pronged strategy to insure that the NWPA amendments were included in the conference committee's bill. First, Johnston personally lobbied other Members of Congress. Second, Johnston emphasized that if Nevada was not chosen as the only site to be characterized then any state could end up housing nuclear waste. Lastly, Johnston demanded that the amending language remain in the reconciliation bill.

The conference committee first met on December 14, 1987. The first signs of movement came at a December 14 meeting of the sub-conference committee on nuclear waste, when Texans from the House Energy and Commerce Committee led by Representative Jack Fields (R-TX) pushed the House closer to the Johnston plan. The House conferees made the Senate an offer on the afternoon of December 14, suggesting that Nevada be the only site to be characterized. But their offer did not contain an authorization for the MRS facility which Senator Johnston wanted, and the Senate conferees made a counteroffer on December 15 that included an MRS. One conferee noted that the House leadership played an important role in the negotiations on this point:

> Butler Derrick [Representative from South Carolina] from the Rules Committee (and the Steering and Policy Committee, so we thought he was linked to the leadership) was not appointed to the conference committee but he showed up at both conferences. ...It seemed that the [House] leadership had appointed Derrick to help (and watch) the House conferees. The House conferees were told by Wright and Foley to deal with the Senate on the issue [and not] to stop the Senate effort to put it on reconciliation. But Wright and Foley did not explicitly tell the conferees to drop Texas and Washington for Yucca Mountain. The Senate conferees were unsure about what the House leadership position was at this time.

On December 16 the House and Senate conferees again met. For a time, the two sides seemed at loggerheads, but each side had the means to break the impasse. Under a procedural agreement, Johnston could have moved the whole issue to a friendlier forum, the conference on the omnibus spending resolution (H.J.Res. 395). Udall, House Energy and Commerce chair John Dingell (D-MI), Derrick, and several other House conferees won Wright's assurance that if necessary they would be allowed a floor vote to substitute their own language for any Johnston provision they disagreed with. Udall and Dingell were confident they could beat Johnston in a House floor vote. According to several respondents, the results of that meeting were made known to Senator Johnston and his staff.

Johnston readily compromised on the MRS facility. The House recommended that an independent commission should review the need for an MRS and that only one MRS site should be characterized at a time should the review commission support the need for an MRS facility. Johnston agreed, setting the stage for an agreement on the NWPA amendments.

In the final draft of the amendments, the conferees eventually agreed to add language establishing two new organizational entities: the Office of the Nuclear Waste Negotiator, and an MRS Review Commission. An executive branch respondent revealed why these proposals were added to the NWPA amendments:

> Udall was enamored with the negotiator idea. It was clear that Udall did not like [DOE's 1986 decision to suspend the search for the eastern/midwestern repository], he did not like [Energy Secretary Herrington] and did not trust him, but he was not really trying to undermine DOE. The MRS Commission idea was set up to avoid the bloodbath of a yes-no vote in Congress on the location of the MRS. That way both opponents and proponents of MRS could claim victory.

However, DOE's close relationship with the Senate conferees in drafting language produced tension between the House and Senate during the conference. One Senate conferee noted:

> The House had poor relations with DOE and did not run anything by them. In fact Tom Isaacs [of DOE] sat in on the conference, which irritated the House conferees and their staff.

Another executive branch respondent detailed DOE's involvement:

> DOE was involved in the drafting of the amendments. The process began with a phone call from Ben Cooper [on Senator Johnston's staff] to Ben Rusche [at DOE]. Senator Johnston wanted DOE to draft the amendments (with a list of items to be included from Ben Cooper and Mary Louise Wagner [another Johnston staff member] for Senator Johnston). Cooper, Wagner and [the] DOE staff worked closely together through 1987 until the final amendments were passed. The drafting was done at DOE with the content defined by Ben and ML [Mary Louise Wagner]. DOE was not supposed to talk with outsiders about this. The House, ANEC [the American Nuclear Energy Council], and other interest groups were not involved. DOE came forward with its own views for the amendments, such as payments to the state with a site.

The amendments to NWPA agreed to in the conference committee were never discussed in committee or on the floor of either chamber. Respondents say that most Members of Congress were barely aware of the changes that Johnston's bill made in the NWPA act. Most knew their states would not house the MRS and would not undergo site characterization, and that was enough to satisfy them.

The Yucca Mountain siting decision was a major turning point in relations between Congress and DOE. NWPAA narrowed the discretion of DOE managers, and gave DOE a much stronger political mandate to proceed. NWPAA also changed the way oversight of DOE was conducted by embedding the agency in an oversight "spider-web." No longer would Congress have the sole responsibility to oversee DOE. The MRS Review Commission, Nuclear Waste Technical Review Board, and Nuclear Waste Negotiator all gave Congress more oversight resources regarding nuclear waste policy.

Additionally, Congress tried to smooth site selection in two ways in NWPAA. First, Congress authorized payment to Nevada of $10 million per year during siting and construction of the Yucca Mountain repository, and $20 million per year during operation, but in order to receive the funds the state had to give up its right to veto the site. Second, Congress created the Office of the Nuclear Waste Negotiator. The Negotiator was charged with seeking a State or Indian Tribe willing to host a repository or MRS facility at a qualified site on reasonable terms. If the Negotiator found a willing site, Congress would be expected to approve it. The Negotiator was, however, to be responsible to Congress, not the executive branch.[f]

[f] The President refused to have the Negotiator in the Executive Office of the President (EOP), so it is now free standing. It is directly responsible to the President and Congress, but not part of EOP or DOE (see P.L. 100-507).

IV. CONCLUSIONS ABOUT POST-NWPAA CONGRESSIONAL-EXECUTIVE RELATIONS

Relations between DOE and Congress (especially in the Senate) since the passage of NWPAA have been cooperative and informal. The policy-making subsystem is dominant again. There are relatively few actors involved in decision-making concerning Yucca Mountain, and although conflict with the state of Nevada is relatively high the scope of the conflict has not moved into other states. Discussion among the subsystem actors at the federal level is extensive, free-flowing, generally supportive, and largely informal.

Despite concerns that Yucca Mountain is scientifically unsuited for a repository, Senator Johnston and other congressional players have refused to back away from the NWPAA legislation. Congress seems to show disapproval of DOE's progress on site characterization by consistently reducing funding requests for Yucca Mountain. DOE's requests for Fiscal Years 1987 and 1988 were roughly halved, and outlays have consistently outpaced appropriations since 1987. In FY91 and FY92 funding requests were more limited, and congressionally-mandated cuts were less severe. However, Senator Johnston and his staff have proceeded to work closely with DOE in administering the program and checking the efforts of Nevada to slow site characterization. This cooperation, or co-management, has been made possible by the weakening of the anti-nuclear power movement and the direction of the electorate's attention to other problems.

Most nuclear waste policy subsystem actors interviewed for this study feel that there are currently no serious problems with micro-management (unreasonable intervention in DOE programmatic details) by Congress. Congress is again passive, waiting for information to come in about the nuclear waste program, and there is a preference for informal contacts among DOE administrators and Members of Congress and their staff. There has also been only limited use of formal oversight mechanisms like hearings.

Currently, the perception on Capitol Hill is that Yucca Mountain will be the nuclear waste repository, so few Members of Congress have focused on the program. The state of Nevada is considered the outsider, a non-player inside the subsystem. Thus, Nevada is using the courts to pursue its policy objective of stopping site characterization at Yucca Mountain. Generally, the post-NWPAA decision-making system structured around nuclear waste policy has again evolved into a dominant policy subsystem which is relatively closed, cooperative, and dominated by experts and functional representation.

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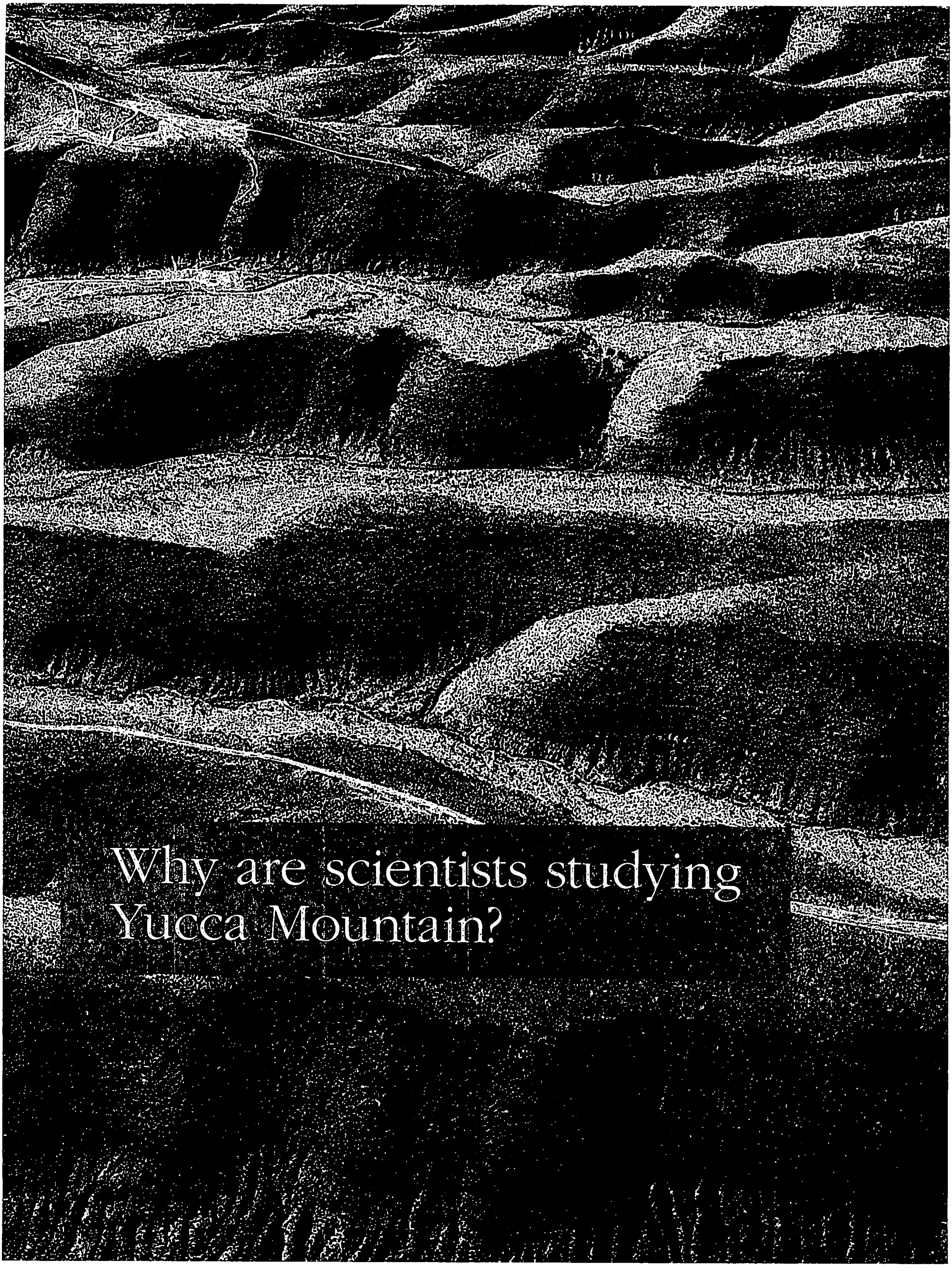
Why are scientists studying Yucca Mountain?



An environmental problem must be solved.

In the United States, used nuclear fuel is being stored temporarily at the power plants where it helped make electricity. Now, some plants' storage facilities are almost full. The federal government is responsible for finding a way to safely dispose of this used fuel. It is aggressively pursuing a solution to the environmental problem of accumulated, highly radioactive waste in the form of used nuclear fuel.

Scientists have determined that the safest place for used, or spent, fuel is to put it deep underground in a facility called a repository. This approach is the result of more than 30 years of scientific research. At least 10 years of additional studies will be needed to decide if the potential site at Yucca Mountain, Nevada, could safely isolate this waste.

This same approach—a deep underground repository—has been chosen by many other nations which benefit from nuclear power.

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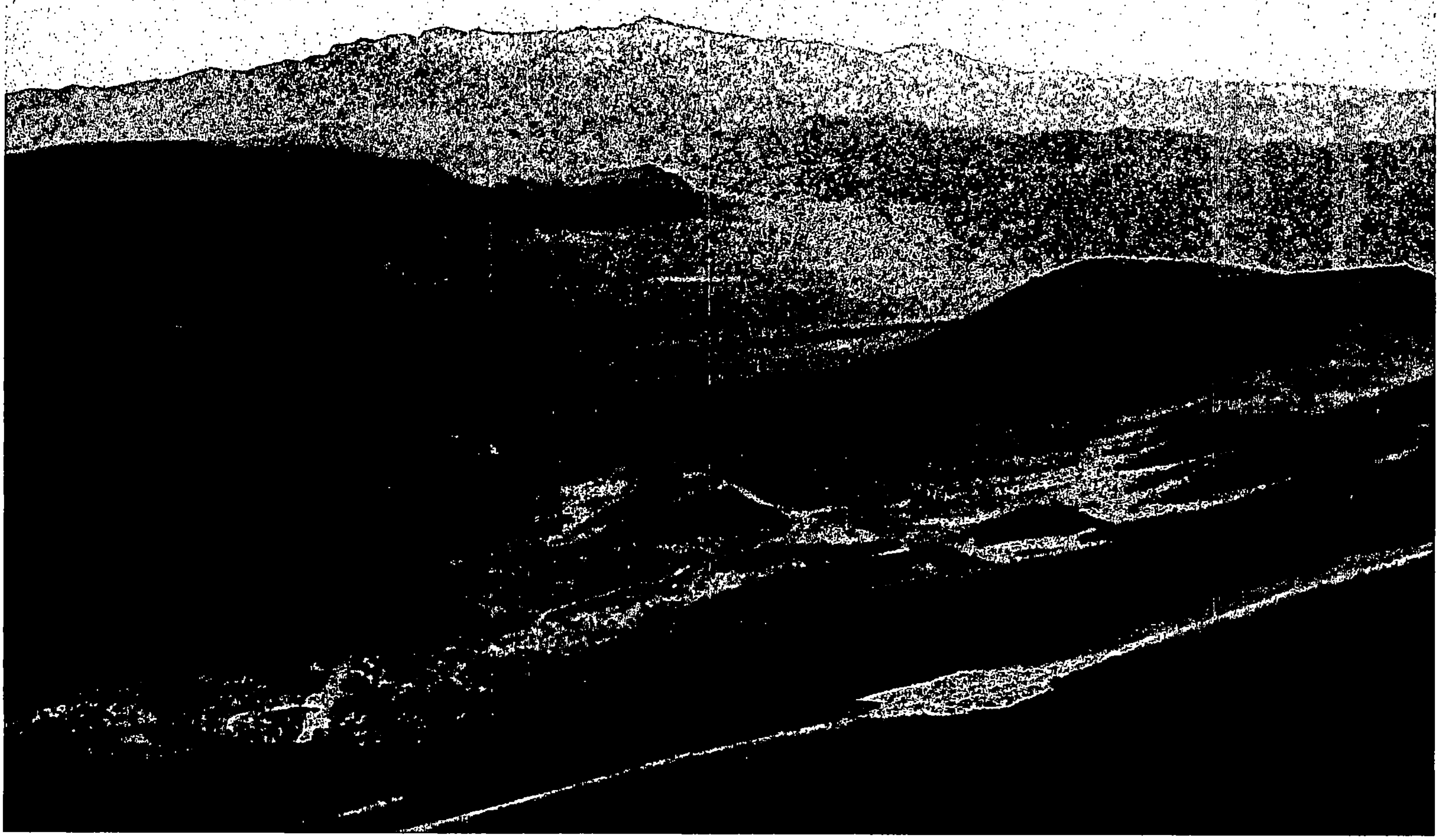
Scientific studies will determine whe
Yucca Mountain is a safe site for dis

Yucca Mountain has special qualities which might allow it to isolate nuclear waste for thousands of years.

Hundreds of the nation's best scientists will do several billion dollars in studies at Yucca Mountain to understand how the site's geophysical processes work.

If, at any time, the studies show that Yucca Mountain would not be a safe place for disposal of waste, DOE will stop the studies and seek new direction from Congress.

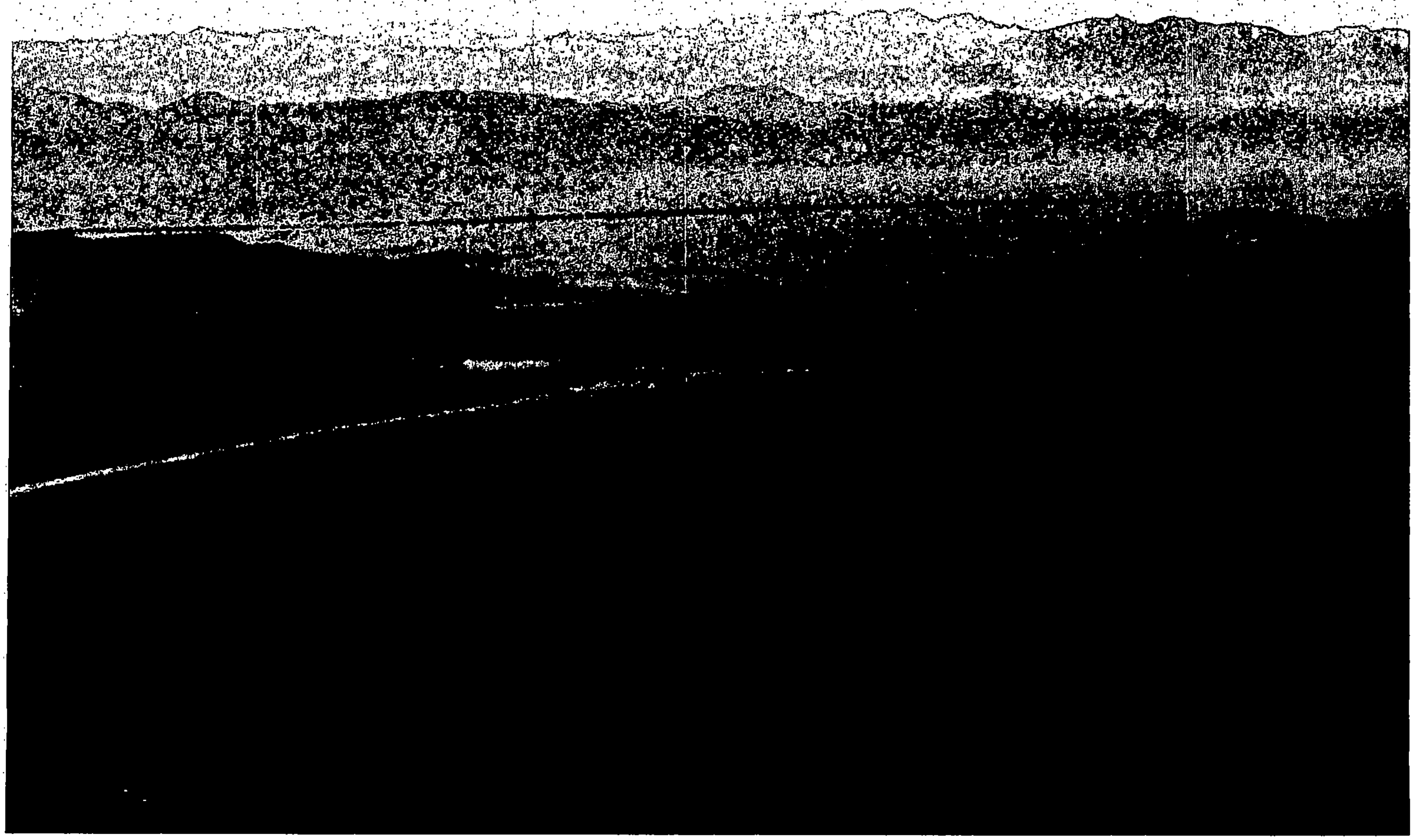


ther posal of nuclear waste.

DOE's studies are checked by independent scientists, including those working for the state of Nevada, the presidentially appointed Nuclear Waste Technical Review Board, and others.

If the studies indicate that Yucca Mountain could safely store waste, the scientific evidence would be sent to an independent federal agency, the Nuclear Regulatory Commission (NRC). In public proceedings, the NRC would make the final scientific decision about the suitability of a repository at Yucca Mountain.

If the NRC approves the site, the state of Nevada has the right to exercise a veto. That veto may be overturned only by a majority vote of Congress.



U.S. DEPARTMENT OF ENERGY
YUCCA MOUNTAIN
SITE CHARACTERIZATION PROJECT

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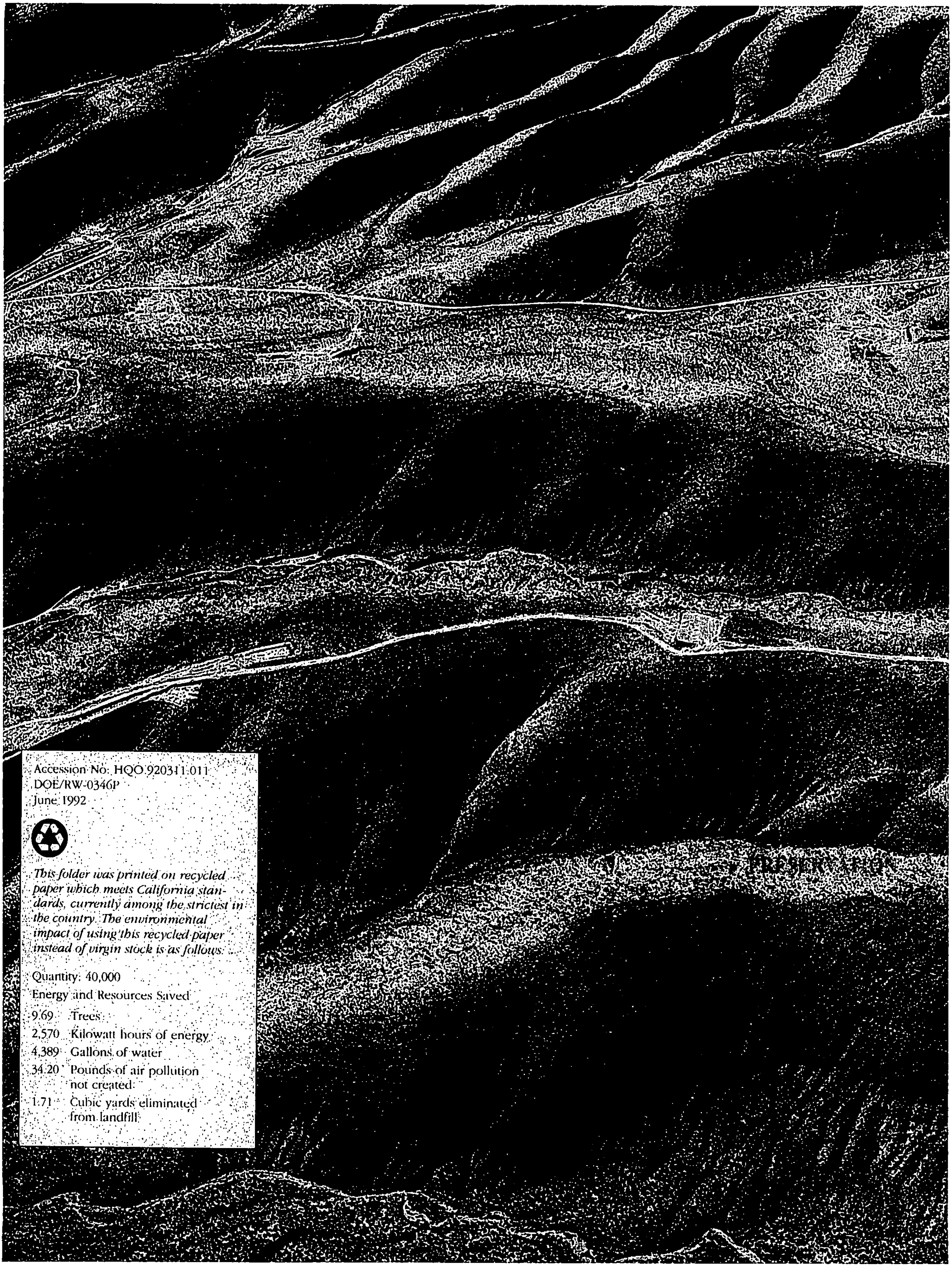
Las Vegas, Nevada 89193-8608
(702) 794-7900



Accession No: HQO.920311.011
DOE/RW-0346P
June 1992

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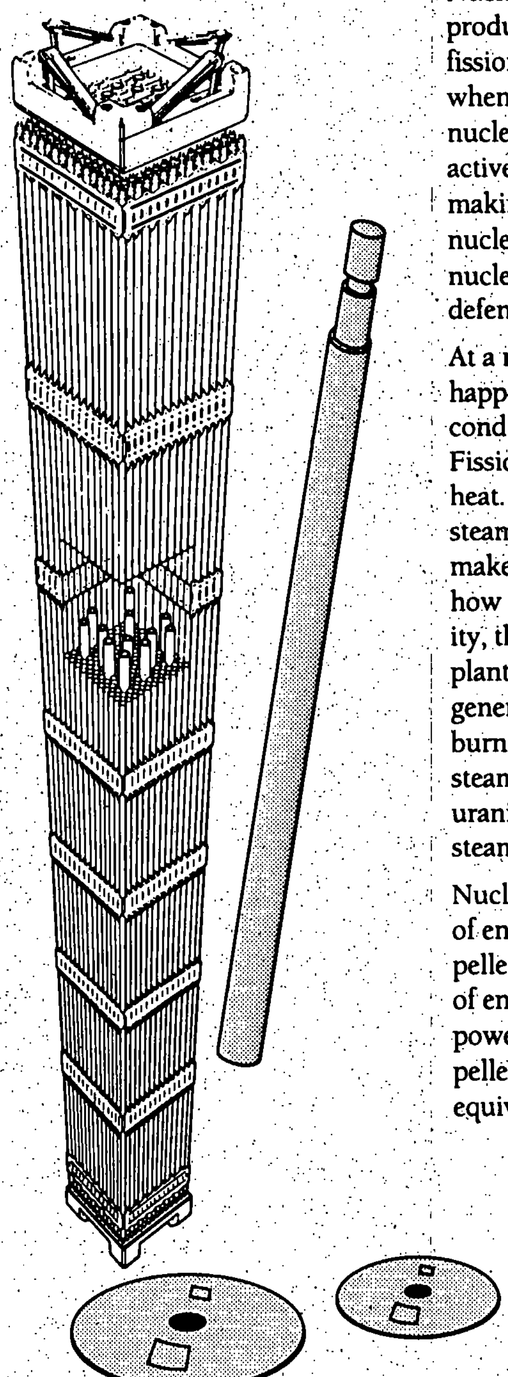
General Information

What is nuclear fuel and waste?



Nuclear, or radioactive, waste is produced whenever we put nuclear fission to work. Fission occurs when atoms split and cause a nuclear reaction. High-level radioactive waste is the by-product of making electricity at commercial nuclear power plants and from nuclear materials production at defense facilities.

At a nuclear power plant, fission happens under carefully controlled conditions inside a nuclear reactor. Fission generates energy, including heat. This heat is used to make steam, which turns turbines to make electricity. To understand how nuclear fuel generates electricity, think about how other power plants work. When electricity is generated at coal-fired plants, coal is burned to produce heat to make steam. At nuclear power plants, uranium is the fuel used to make steam to turn turbines.

Nuclear fuel is made of solid pellets of enriched uranium. These small pellets create a tremendous amount of energy when used in a nuclear power plant. For example, one pellet has an amount of energy equivalent to almost one ton of coal. The pellets are sealed in tubes of a strong corrosion- and heat-resistant metal alloy. The tubes containing the uranium pellets are bundled together to form a nuclear fuel assembly. The assemblies are put inside a nuclear reactor and used to generate heat to make electricity. The fuel will be used until it is spent, or no longer efficient in generating heat.

What happens to the spent fuel?

Once a year, approximately one-third of the nuclear fuel inside a reactor is removed and replaced with fresh fuel. The used fuel is called spent fuel. It is highly radioactive and is the primary form of high-level nuclear waste. It must be isolated carefully in a repository for thousands of years because, if not properly isolated, its radioactivity can harm people and the environment.

When spent fuel is removed from a reactor, it is put into a pool of water at the reactor site. The water is a radiation shield and coolant. Storing the spent fuel in pools is intended only as a temporary measure until a permanent disposal place is found.

As an alternative to storing in pools, some spent fuel is being stored aboveground at reactor sites in concrete or steel containers called dry casks. Like storage under water in pools, this approach also is intended as temporary.

While pool storage is effective for short-term storage, the need to find safe, permanent disposal is becoming more and more critical because at some nuclear power plants, the storage pools are almost full.

Repository must isolate it for thousands of years

A key element of permanent disposal is that it must be able to isolate high-level radioactive waste for thousands of years because its radioactivity can harm people and the environment. According to U.S. Environmental Protection Agency (EPA) standards, a repository may pose no greater risk than unmined uranium from which the high-level waste was produced. The DOE must prove that a repository will be safe for 10,000 years. After 10,000 years of radioactive decay, according to EPA standards, the spent fuel and high-level waste no longer pose a threat to public health and safety.

In pools and dry casks today, more than 20,000 metric tons of spent fuel is stored at more than 60 nuclear power plants across the country. By the year 2000, an estimated 40,000 metric tons of spent fuel will have been produced. By then, there also will be about 8,000 metric tons of solidified waste from defense programs. Currently, high-level defense waste is stored at Department of Energy facilities in the states of Idaho, South Carolina, and Washington.

What about reprocessing the fuel?

The chemical process by which uranium and plutonium are recovered from spent fuel is called reprocessing. Several countries with nuclear power reprocess their spent fuel. Although the United States reprocesses defense nuclear fuel, private industry in the United States is not reprocessing fuel now because it costs more than mining and making new fuel.

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(702) 794-7900
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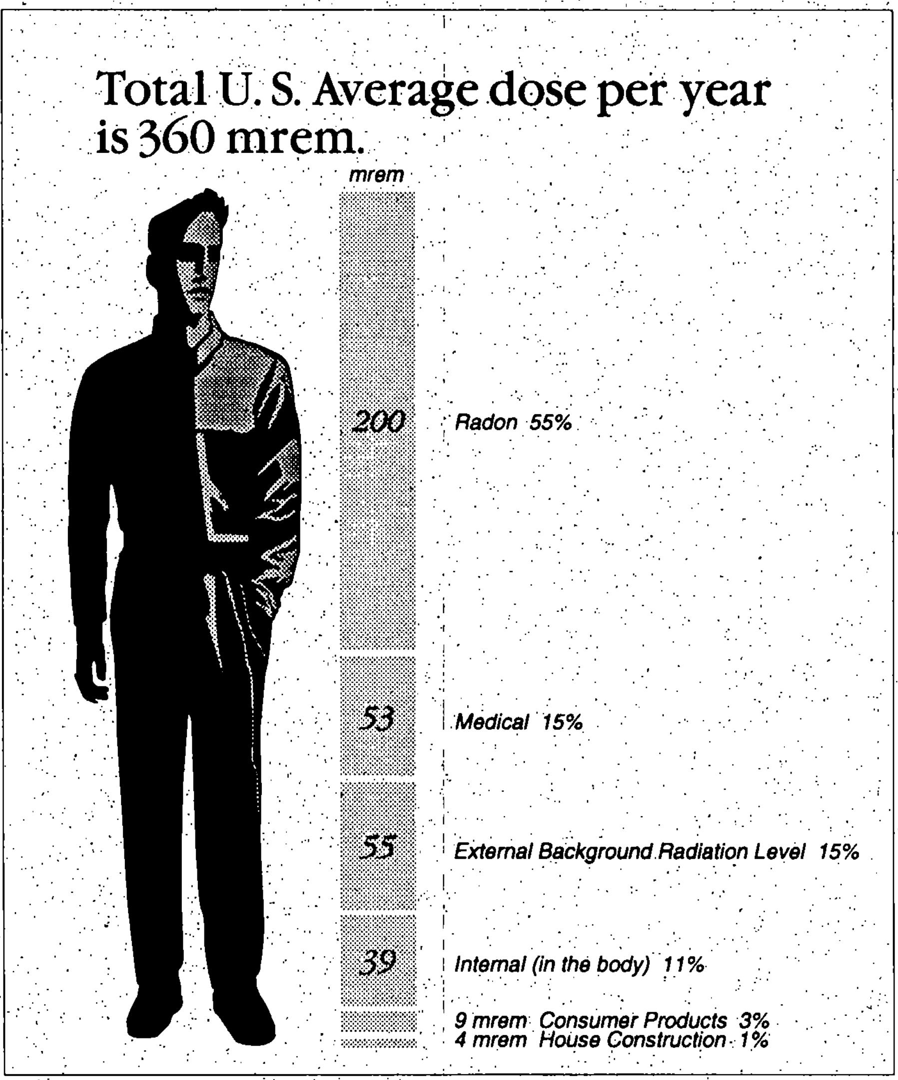
Radiation Safety

Nevadans' average radiation exposure

We live with radiation every day. We receive radiation doses from cosmic rays from outer space and from radon gas and other naturally radioactive elements in the earth. This is called natural background radiation. It includes the radiation we get from plants, animals and from our own bodies.

We also are exposed to man-made sources of radiation, including medical and dental treatments, smoke detectors, television sets and emissions from coal-fired power plants.

Each year in the United States, the average dose to people from natural and man-made radiation sources is about 360 millirem. A millirem is one-thousandth of a rem, which is a measure of the effect of a radiation dose on human tissue. A millirem is an extremely tiny amount.



Where you live contributes to your dose

One factor contributing to radiation exposure is where you live. Background radiation in Las Vegas, Nevada, is about 59 millirem per year. Background radiation in Colorado is slightly higher due to that state's higher altitude. The atmosphere is thinner at higher altitudes and allows more radiation exposure from space. Several coastal areas of Brazil have exposures of about 500 millirem per year because of the local soil and rock. And Kerala, India, has the highest known levels of background radiation of any inhabited area on Earth. Kerala has areas that exceed 1,300 millirem per year of background radiation due to monazite sands there composed of about nine percent of the radioactive element thorium.

It is common for people to receive far more than the average of 360 millirem in a year due to a variety of other factors.

Would people near a repository be exposed to more radiation?

Preliminary estimates are that if a repository was located at Yucca Mountain, and if a person lived about five kilometers (three miles) from that repository, he or she would get less than 1 additional millirem per year of total background radiation exposure. This is because the waste would be placed deep underground, and the surrounding rocks would stop any harmful radiation from reaching the environment. Unless extensive scientific testing proves that waste can be isolated safely at Yucca Mountain, a repository would not be built there.

What would be the radiation exposure from spent fuel or high-level radioctive waste shipments? Evaluations show that exposure to people 30 meters (100 feet) from the route of a vehicle carrying spent fuel or high-level waste moving 24 kilometers (15 miles) per hour is one-thousandth to one-millionth of a millirem per shipment. This is an extremely tiny dose of radiation. For example, the average Nevadan gets approximately 59 millirem of radiation every year from natural sources, such as rocks and sunshine.

If a repository is constructed, the health and safety of repository workers and the public would be monitored continually throughout the repository's construction, operation and closing. Details of this monitoring program would be reviewed by an independent federal agency, the Nuclear Regulatory Commission (NRC), as part of the licensing process for a repository. By law, the state of Nevada and affected local governments will have the right to review this radiological monitoring process and its results.

Examples of possible doses from common sources of radiation*

Where you live

Location: Las Vegas, Nevada** (Natural background)......................59 mrem

Radon: (U.S. average)..200 mrem

House Construction: For stone, concrete, or masonry building..........7 mrem

What you eat, drink, breathe

Food, Water, Air (U.S. average)..24 mrem

World-wide weapons test fallout..4 mrem

Medical

One chest X-ray...10 mrem

(A lower gastrointestinal tract X-ray is 500 mrem.
A radiopharmaceutical exam is 300 mrem)

How you live

Jet plane travel: For each 2,500 miles add 1 mrem...............................2 mrem

TV viewing: For each hour per day, .15; so 4 hours x .15......................0.6 mrem

Sleeping: With partner, add 0.1 mrem..0.1 mrem

Cooking: With natural gas add 6 mrem..6 mrem

Total annual mrem dose for this example.................................311.7 mrem

U.S. annual average dose is 360 mrem

Most scientists agree on the internationally recognized guidelines for regulating radiation doses to protect the public and the environment. By using a philosophy that limits exposure to radiation to doses as low as reasonably achievable, doses are kept to levels less than the limits stipulated by the regulations.

This approach is used by the Department of Energy and its contractors when evaluating potential exposures that might be received by members of the general public and people who work around radioactive materials.

**NOTE Doses are estimates only and vary at any given time. Information from the BEIR Report IV National Academy of Sciences, Committee on Biological Effects of Ionizing Radiation.*

***Based on the Off-Site Environmental Monitoring Report: Radiation Monitoring Around United States Nuclear Testing Areas, calendar year 1988 - U.S. Environmental Protection Agency/Environmental Monitoring Systems Laboratory, Las Vegas, Nevada 1989.*

U.S. Department of Energy

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SITE CHARACTERIZATION
PROJECT

P.O. Box 98608
Las Vegas, NV 89193-8608
(702) 794-7900

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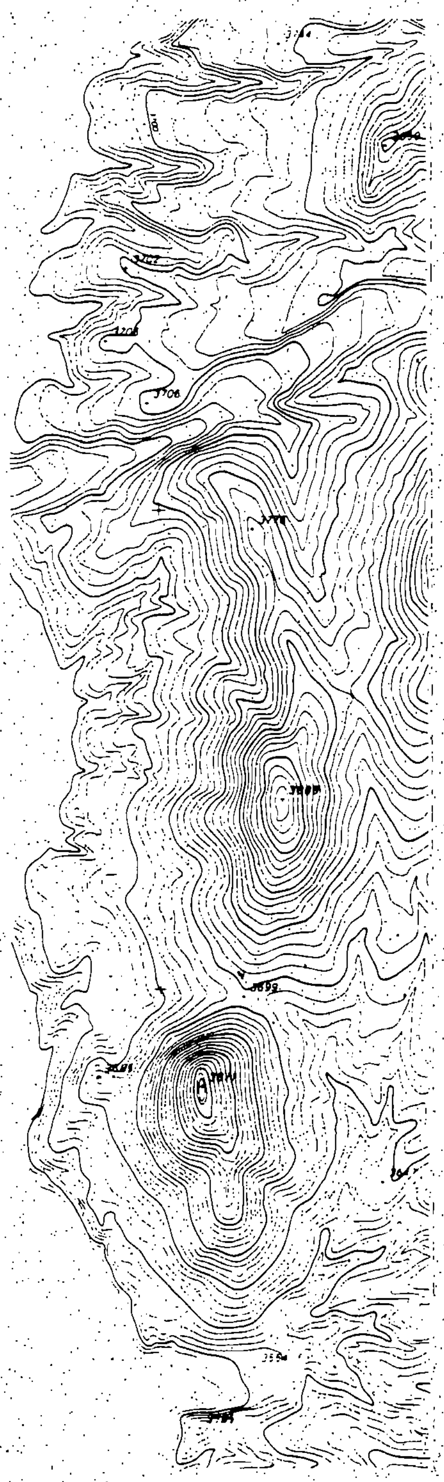
September 1992

Earth Sciences

Volcanoes and Yucca Mountain



Yucca Mountain was formed millions of years ago by a series of explosive volcanic eruptions that deposited ash and material that compressed together to create layers of rock called tuff. The explosive type of volcano that formed Yucca Mountain is extinct. There are, however, seven small and dormant volcanoes scientists are studying in the Yucca Mountain area to determine if one might erupt in the next 10,000 years and if an eruption might affect an underground nuclear waste repository. By studying the layers of soil and rock to learn about past volcanic activities, scientists can make predictions about the future.

Scientists called volcanologists have been studying volcanoes at Yucca Mountain for more than a decade. Scientists believe that the probability of a volcano erupting in the Yucca Mountain region over the next 10,000 years is very remote and does not make the site unsuitable for a repository. The chance of a volcano directly affecting a repository in the Yucca Mountain area has been calculated as about 1 in 500 million per year.

The seven volcanoes located near Yucca Mountain are among the most common type of volcano on Earth. Two cones are located about 19 to 43 kilometers (12-27 miles) away, and may have been active within the last 10,000 years. The other five, located 13 to 43 kilometers (8-27 miles) away, had their last eruptions from 300,000 years to 1.2 million years ago. All seven cones consist of less than 0.1 cubic kilometers (0.06 cubic miles) of material.

Three types of volcanoes

There are three main types of volcanoes: composite, shield and cinder cones. **Composite** volcanoes have explosive eruptions, such as Mount St. Helens in Washington. **Shield** volcanoes have less explosive eruptions, and people can walk fairly close to some slow-moving lava from these volcanoes. The Hawaiian islands are examples of shield volcanoes. Out of the three main types of volcanoes, **cinder cones** generally are the smallest volcanoes with the simplest and weakest eruptions. The seven dormant volcanoes near Yucca Mountain are cinder cones.

Different types of volcanic eruptions

When discussing volcanoes, it helps to know about different types of eruptions. The eruption type depends mainly on the amounts of water and the element called silica present in the magma beneath a volcano. Magma is a mixture of gas bubbles, crystals, molten rock and fragments of rock that forms deep inside the Earth. The amount of silica determines how fluid the magma is, as well as the final chemical composition of the rock formed from the magma. The amount of water, which is in a gaseous state within the magma, determines the force or explosiveness of the eruption.

If the magma has a high silica content, it is silicic (explosive) and erupts explosively, similar to a gushing soda pop bottle. The magma is thrown high into the atmosphere where it cools in the air and falls to earth as a blanket of ash. Over time, the ash consolidates and forms a highly porous rock called **ash-fall tuff**.

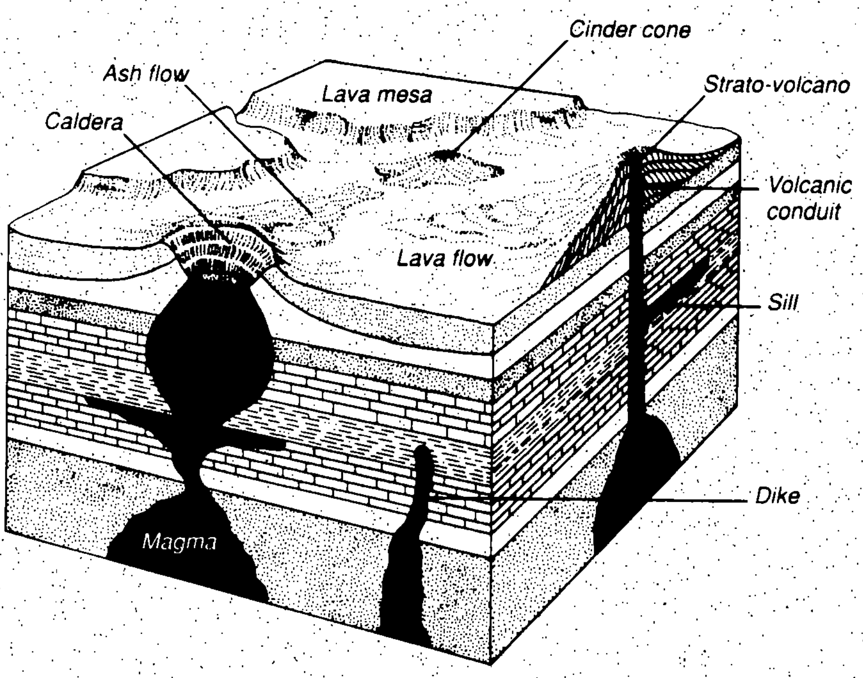
A smaller amount of silica and water, where less magma mixes with air, causes a somewhat less explosive eruption. More magma flows out at ground level and the temperature remains high over a longer period of time. Much of the magma and ash welds into dense, nonporous rock called **ash-flow tuff**.

When the magma has a low silica content, it's called **basaltic**. Basaltic volcanoes have relatively nonexplosive eruptions that throw little magma or material into the atmosphere. Instead, the magma usually flows quietly out of the volcano and outward on the ground. When this magma cools, it forms lava or cinders, depending on how it was erupted. The cinder cones near Yucca Mountain are basaltic.

How was Yucca Mountain formed?

Yucca Mountain itself was formed from multiple eruptions of a special type of composite volcano called a **caldera**. Calderas form when large volumes of magma erupt rapidly. The underground support for the volcano is removed, the surface then collapses and forms a circular depression, or caldera. Calderas can range in size from a few miles to tens of miles across.

Four major layers of ash-flow tuff were deposited at Yucca Mountain 12 million to 15 million years ago interspersed with minor ash-fall layers. The events that formed these layers produced more than 1,000 cubic kilometers (600 cubic miles) of silicic magma. The layers alternate from relatively nonporous rock to highly porous, depending on the extent of welding, and how fast the layers cooled. The volcanic tuff at Yucca Mountain is at least 1.8 kilometers (6,000 feet) thick.



Typical volcanic features of the Yucca Mountain area

About 1,000 feet below the surface of Yucca Mountain is a densely welded rock formation known as the Topopah Spring welded tuff. This ancient layer is being studied as a possible site in which to build a repository.

Will a volcano erupt in the next 10,000 years?

The last eruption from an explosive composite volcano occurred eleven million years ago. Timber Mountain, the explosive volcano that formed Yucca Mountain, is extinct.

Volcanologists believe the potential for a nonexplosive cinder cone volcano to erupt during the next 10,000 years is very small. When studying the past, volcanologists see that nonexplosive eruptions, or what scientists call basaltic eruptions, have occurred at Yucca Mountain only every 200,000 years to 300,000 years. Scientists estimate that it is very unlikely that any of the seven cinder cones will erupt in the next 10,000 years.

Scientists will spend more than a decade at Yucca Mountain studying whether volcanoes or other geologic events might affect a repository. They will use samples from laboratory studies, drilled holes, trenches, and other geophysical methods to get the data they need.

U.S. Department of Energy

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Las Vegas, NV 89193-8608
(702) 794-7900

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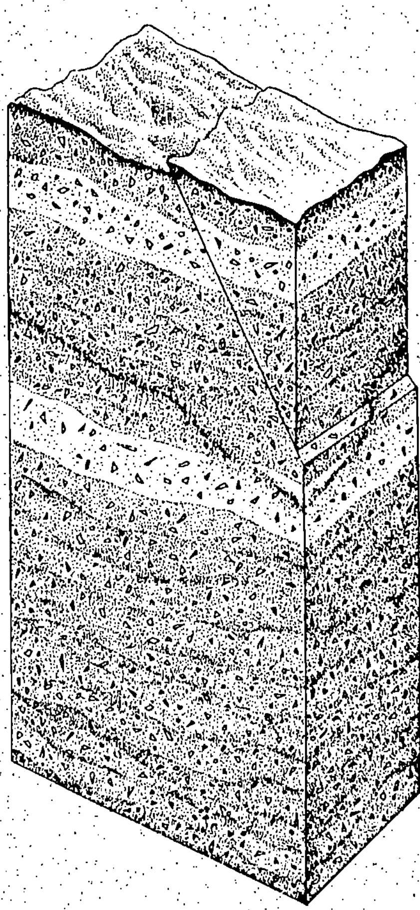
September 1992

Earth Sciences

Studying the movement of rock and earthquakes

Scientists are studying carefully the geology of Yucca Mountain, Nevada, and its surrounding region to determine whether or not spent nuclear fuel and high-level nuclear waste could be isolated safely deep below the mountain's surface. These studies began more than 15 years ago and will continue during site characterization. They will provide information about the potential for earthquakes and whether earthquakes could disrupt surface or underground waste repository facilities.



Earthquakes occur when cracks or fissures in the Earth's surface, called faults, move. Major trenching programs near Yucca Mountain will study fault movement during the past two million years. Geologic study of the deposits exposed in these trenches and minerals found in fault zones will provide evidence of how frequently and how much faults have moved in the past.

At this time, it appears that risk of damage to surface and underground facilities from faults is small because the amount of movement on local faults has been small, with possibly many thousands of years between movements.

It also appears that the potential for earthquake damage to an underground repository is very slight. Experience with earthquakes throughout the world has shown that underground structures can withstand the ground motion generated by earthquakes. And in actual tests at the Nevada Test Site, mine tunnels or drifts have withstood ground motion from underground nuclear explosions that are greater than any anticipated at or near Yucca Mountain. Repository facilities at the surface also can be designed to safely withstand earthquake effects.

Geologic dating of surface material around Yucca Mountain indicates that the mountain itself and the terrain around it have remained largely unchanged over the last one million years. Current information strongly indicates that Yucca Mountain would remain stable over the period of time required by the regulations and that faulting would not break open the mountain to expose radioactive waste.

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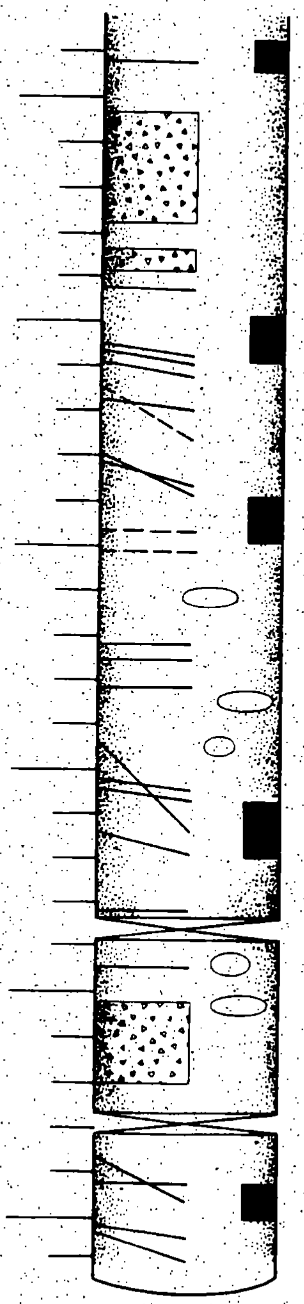
Earth Sciences

How the Sample Management Facility works



The Sample Management Facility (SMF) stores rock and other geotechnical samples for the Yucca Mountain Site Characterization Project. Most of these samples are rock cores and cuttings taken from holes drilled into Yucca Mountain. Eventually, samples from exploratory work deep underground may be stored here, too.

This facility makes certain that the collection and handling of rock samples is documented. It makes certain that rock samples can be traced to their origins and that each person who has access to the samples is documented. In this way, a complete record can be kept of each sample, who handled it, and the tests performed on it. The Department of Energy has implemented this "chain of custody" to keep permanent records about each rock sample.

Recording this chain of custody begins at the drill site. When rock core is removed from a borehole, it is pulled out of the ground in about 3-meter (10-foot) increments. It is shaped like a cylinder and is about 6 centimeters (2.4 inches) in diameter. Blue and red orientation stripes are marked on the core to ensure the pieces aren't mixed up or reversed, since the core sections can be in several pieces. The core is then packaged and bar coded. Core documentation begins in the field and continues at the SMF, creating a complete record for all core coming from each borehole.

As you walk through the Sample Management Facility, you will see a number of processes used to record the origin of the samples kept here. We have listed the various tour stops below in the order in which samples generally pass through them. For practical reasons, you may not walk through in the same order, but the stops are numbered for easy reference to this guide.

Field Core Logging Trailer (Station 1)

Field processing is the first step in documenting the core and cuttings. This trailer will be set up at a drill site for handling and processing core and cuttings in the field. Lithologic (describing the rock) and structural logs are begun as soon as samples are taken from the ground. Logging includes marking core with depth and orientation marks and describing the character of the rock. Structural features such as fractures also are described. The computer here is used to generate preliminary lithologic and structural logs and begin data entry in the field.

Sample Receiving Area (Station 2)

Boxes of core arriving from the field are processed in the shipping and receiving area. Computer terminals are used to enter data into a sample-tracking data base, creating a numbering system for the rock samples. By entering the number into the computer, or scanning a bar code number, information can be obtained about the rock, including what hole it came from and what processes it has undergone.

Borehole water samples and cores from the unsaturated zone, that is, the rock at Yucca Mountain above the saturated zone (commonly called the water table), are kept in cold storage areas. The temperature, which is about 4 degrees centigrade (40 degrees Fahrenheit), minimizes changes in the samples from biological and chemical activity. As much as 29,000 meters (96,000 linear feet) of rock core can be stored here. As with other areas, whenever a box is moved in or out of the cold storage area, the bar code is scanned so that the computer tracks sample locations at all times.

Specimen Processing Room (Station 5)

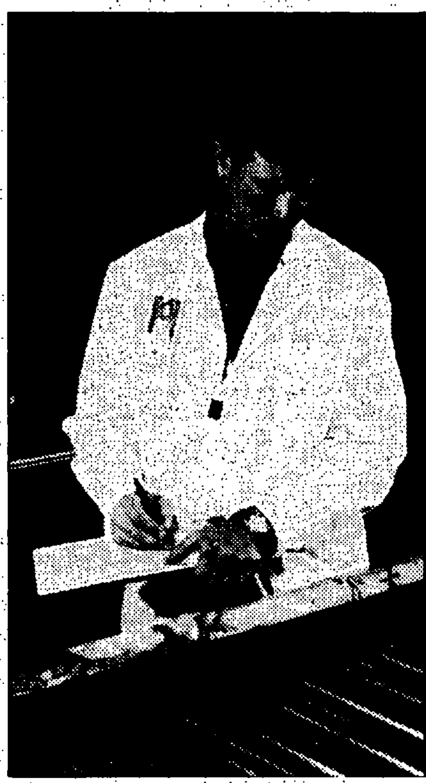
Ground-up rock chips from the drilling process are called cuttings. They can be as small as dust or as big as pebbles, depending on the size of the drill bit used. Cuttings are studied in a variety of ways, including visual exams and experiments, and geochemical tests. These samples are processed here. This includes washing off drill-hole fluids and packaging the samples.

Core Saw Room (Station 4)

Sections of core are sawed here, so that scientists can look for minerals in the rocks, evidence of possible faulting, or a specific rock feature. The saws can cut up to about 29 meters (96 feet) of core an hour, wet or dry, and a dust collection system protects the staff's health. Other pieces of rock-processing equipment here include a large slab saw and a core plugger.

Core Examination Room (Station 6)

Authorized visitors, such as Project geologists or hydrologists, examine samples in this room. The sliding work tables have lighting systems, and are outfitted with binocular microscopes and petrographic microscopes which specialists use to examine sections of rock ground so thin that light shines through them. Here, scientists also study the history of the core and determine what's happened to the rock during its long history. This data will provide clues to what the Yucca Mountain region might be like thousands of years from now.



SMF geologist logging core to describe the rocks.

Sample Storage (Station 3)

Here is the primary core storage area with a capacity of 51,000 meters (168,000 linear feet) of 6 centimeter (2.4 inch) core. This area also stores cuttings, bulk samples and specimen remnants returned to the SMF by researchers. As always, the location and origin of all core is tracked by the computerized bar code system.

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Las Vegas, NV 89193-8608
(702) 794-7900

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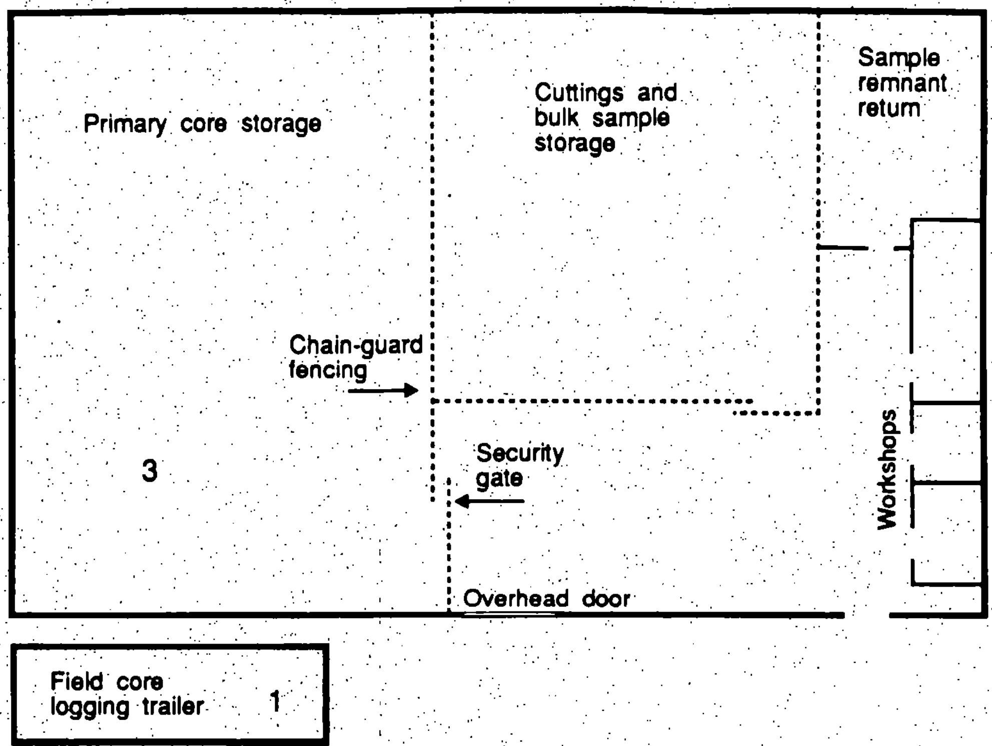
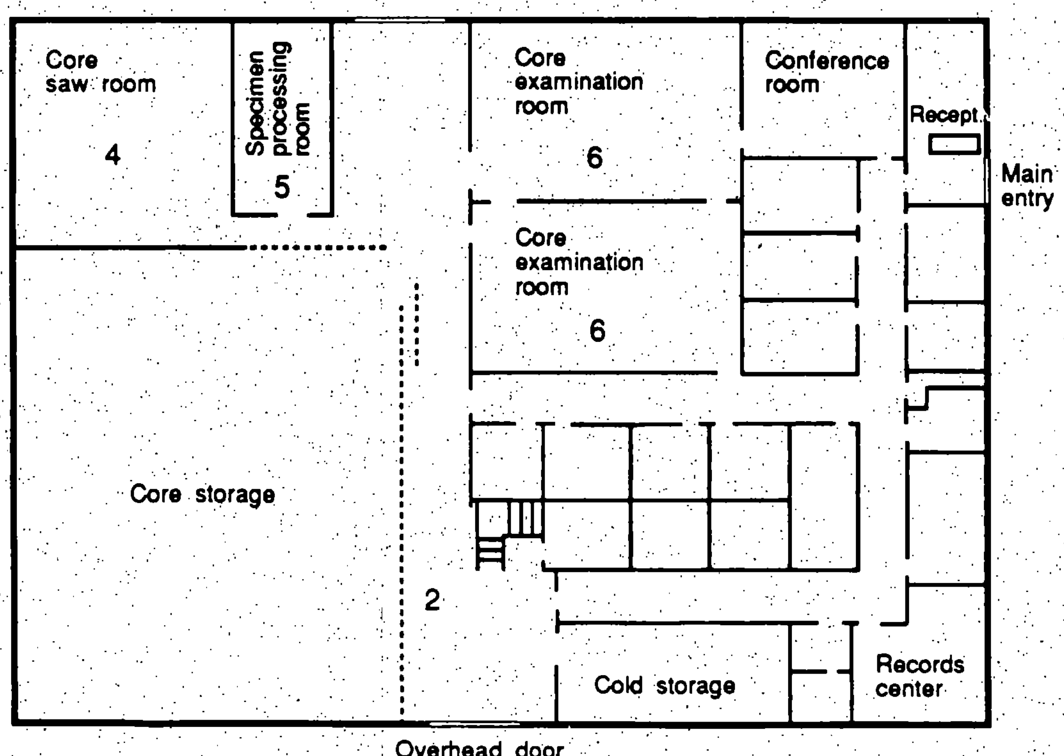
October 1992

Sample Management Facility





RECENT SITE CHARACTERIZATION ACTIVITIES AT YUCCA MOUNTAIN

JULY 1, 1993

DOE/RW-0376P
OCRWM Fact Sheet

Safety: The Key to the Civilian Radioactive Waste Management Program

Disposing of spent nuclear fuel from commercial nuclear power plants is one of the most challenging environmental issues facing Americans today. While nuclear power provides a valuable source of energy and allows utility companies to keep up with ever increasing energy demands, its byproduct - spent fuel or "used" fuel - needs to be disposed of in a safe way.

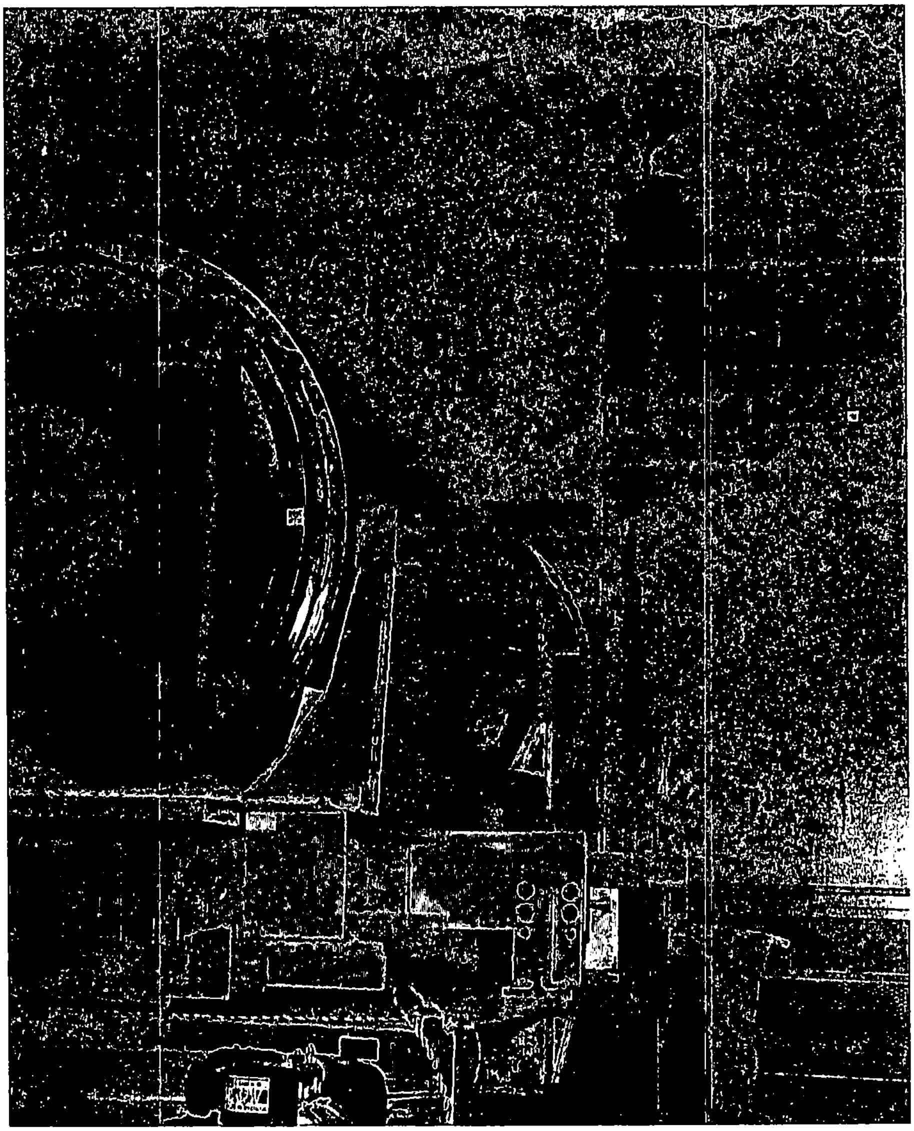
The Civilian Radioactive Waste Management System is the National system to store and dispose of used fuel. The system has three major parts: the monitored retrievable storage (MRS) facility for temporary used fuel storage, an underground repository for permanent disposal and a transportation system. The key to the success of this program is containing the radioactivity in the used fuel until it reaches a safe level.

The MRS - Using Proven Storage Technologies

Utility companies have been storing used fuel safely since the 1950s. The MRS will take advantage of the years of study and experience by utility companies' scientists, engineers, and other radiation specialists.

The MRS will be a temporary holding facility for used fuel on the way to the repository. The DOE will ship a limited quantity of the fuel to the MRS where it will be stored until the repository is ready to receive it.

The MRS will store the fuel in steel or concrete containers. These containers have thick walls to control the radiation. The containers will be stored outside on special pads or in a vault. These methods have been used with great success by several utility companies, and by other countries.

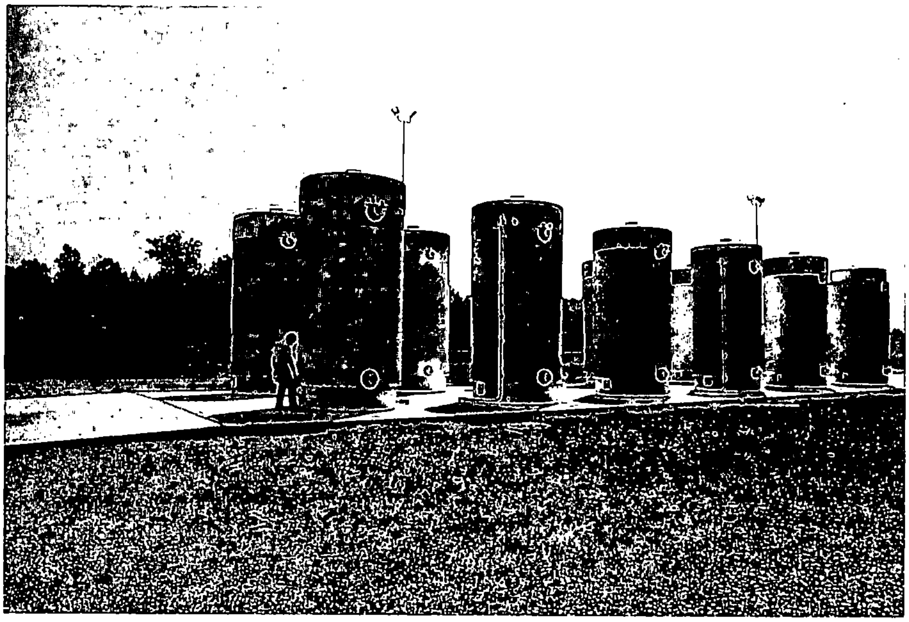


Dry storage operations at Duke Power's dry storage facility.

The MRS will be licensed and regulated by the Nuclear Regulatory Commission (NRC), the independent Federal agency responsible for overseeing nuclear activities. The MRS will have to meet strict NRC requirements before it can open. The NRC will continue to monitor the MRS when it is operating.

Multiple Barriers Will Contain Radiation at the Repository

Used fuel will be permanently disposed of in an underground repository. The repository will be built deep beneath the earth's surface in a stable area, and will be designed to contain the radioactivity for up to 10,000 years, until the radiation becomes harmless. A combination of natural carefully managed. The MRS, the repository and the transportation system will be developed using the years of experience of the experts in the field. Keeping the radiation away from people and the environment is the primary goal of the Civilian Radioactive Waste Management System.



Storing spent fuel at Virginia Power's dry storage facility.

and man-made barriers will protect people and the environment from the radiation in the used fuel.

The fuel assemblies will be sealed inside containers with multiple layers of thick steel. It will be buried 1,000 feet or more underground where nature will add its own protections. In addition, highly trained engineers and scientists with sophisticated instruments will monitor the repository to make sure the radiation stays contained.

Transporting Used Fuel - Decades of Success

The United States has an excellent safety record in shipping radioactive used fuel assemblies. Right now used fuel is shipped in heavy metal containers that weigh 20-to-100 tons. A typical shipping container is 16-17 feet long and 4-8 feet in diameter. The steel walls are 9-10 inches thick and the ends are 11-12 inches thick. All this steel has a purpose: it protects people and the environment from radioactive material and radiation. Different containers are used for trucks and trains, but all must be designed to withstand severe accidents. These containers can survive even a direct hit from a speeding locomotive. Even if the containers were punctured, burned or submerged in water, the used fuel could not be released. It is also physically impossible for the fuel to explode.

Over the last 25 years, more than 2,500 shipments of used nuclear fuel have been transported safely over America's highways and railroads. During this time, an exemplary safety record has been established with no fatalities, injuries or environmental damage caused by the radioactive nature of the cargo.

People and the Environment: The Primary Concern

Scientists worldwide have been studying radiation for decades and its effects are well understood. Radiation can be dangerous. It is essential that radioactive material, like used fuel, be

Strict Controls Governing the Storage and Disposal of Spent Fuel

The U.S. Nuclear Regulatory Commission regulates the use of nuclear energy and radioactive materials, including the licensing and regulating of storage facilities, and shippers and carriers.

The U.S. Environmental Protection Agency sets standards for protecting the environment, including radiation standards.

The U.S. Department of Transportation regulates the interstate transport of all hazardous materials including radioactive materials. These regulations include packaging, labeling, shipping papers, personnel training, loading and unloading, handling and storage.

For more information, please write:
OCRWM Information Center
Post Office Box 44375
Washington, D.C. 20026
or call: 1-800-225-NWPA
(or call 488-5513 in Washington, D.C.)

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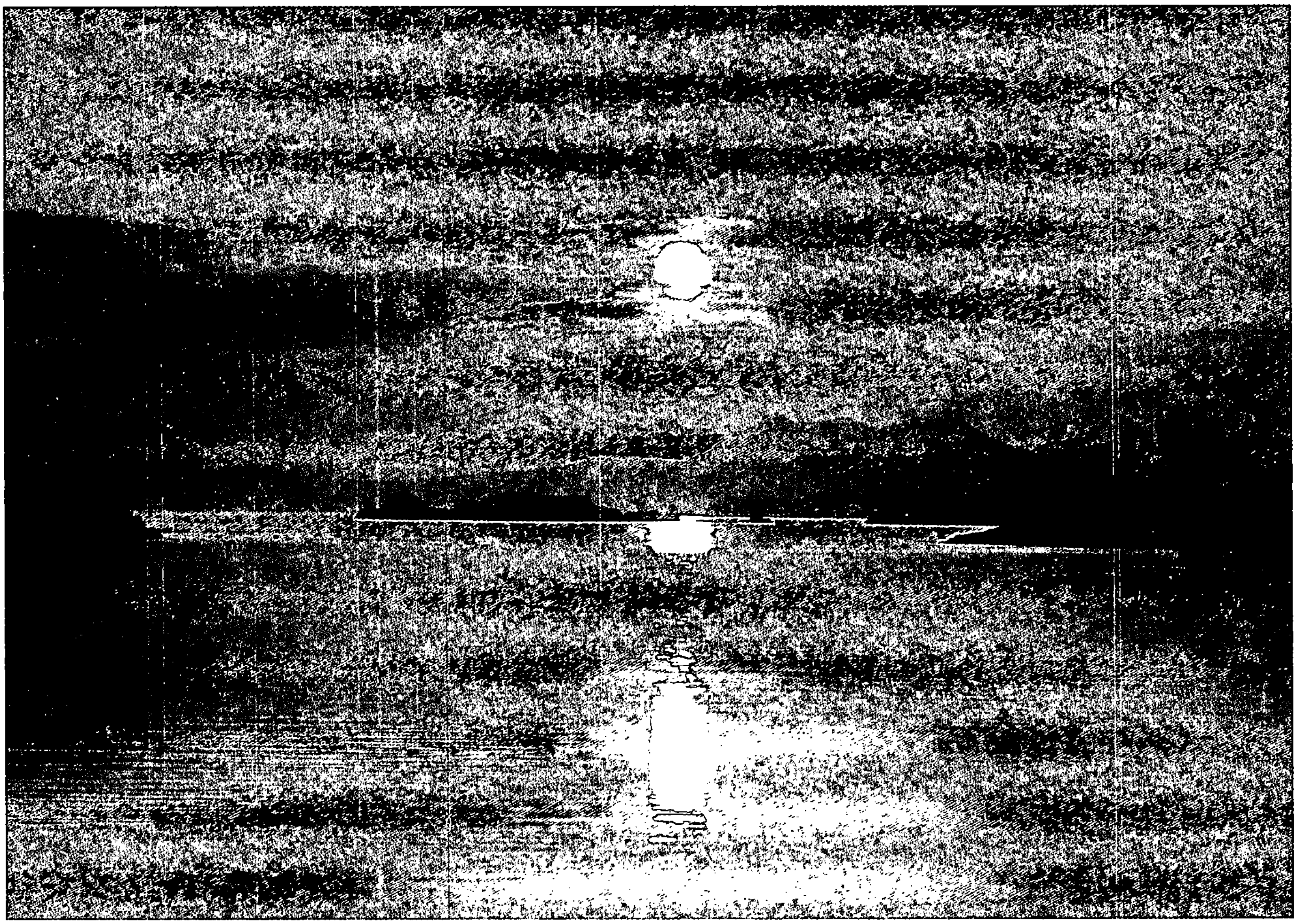
(OCRWM). December 1992

Radiation



Radiation has been on the planet longer than man.

We live safely with radiation every day. It comes from the food we eat, the water we drink, from the earth and from the sun. In fact, radiation in some form or another has been on the planet longer than man.

More than three-fourths of the radiation we receive comes from natural sources like sunlight, soil and certain types of rocks. This is called *background radiation.*

Medical procedures like x rays and common household items like color televisions and smoke detectors are all sources of what is called *man-made radiation*, which accounts for the remaining fourth of our radiation exposure. There is no difference between natural radiation and man-made radiation. Last year approximately 10 million nuclear medical procedures were performed in the United States. Diagnostic x rays and/or radiation therapy helped millions of people get well.

The study of radiation begins with the atom. Atoms are the building blocks of the universe. Natural forces hold them together, and they make our world look the way it does.

Tremendous amounts of energy are stored in the centers – called the nuclei – of atoms. When atoms are split, two things are produced: one is heat, the other is radiation.

Radiation is measured in units called millirems. A millirem measures the effect of radiation on our bodies just as degrees measure temperature and pounds measure weight.

An average American's exposure to radiation is about 360 millirems per year. About 300 millirems of that 360 come from natural sources of radiation; 60 millirems come from man-made sources, primarily medical procedures; and less than one millirem comes from the use of nuclear fuel.

Location also plays a part in how much radiation a person receives. A person living in Egypt receives 300 to 400 millirems per year. A person living in Brazil receives 500 millirems per year. A person living in certain parts of India receives 1,300 millirems per year, more than three and one-half times as much as a person living in the U.S. receives.

Examples of Different Amounts of Radiation

Standards for protection of the public from the effects of radiation have been in existence for more than forty years. Maximum exposure for the general public from the operation of a nuclear facility licensed by the Nuclear Regulatory Commission, including a Monitored Retrievable Storage (MRS) facility, a Federal central storage facility for spent nuclear fuel, is 25 millirems per year. This limit is in accord with exposure standards set by the U.S. National Council on Radiation Protection and Measurement, the International Commission on Radiation Protection, and the International Atomic Energy Agency. Exposures far below this limit will be realized by employing conservative design features and adhering to strict written and approved operating procedures for all fuel handling operations. Moreover, a management philosophy will be applied to facility operations to ensure that actual doses to the public will not only be below the allowable limit, but also as low as is reasonably achievable.

Actual exposure for any individual is expected to be far below the limit, even if that individual were to stand at the MRS site boundary 24 hours a day for 365 days a year. A realistic estimate for exposure for an individual living nearest to the MRS facility is expected to be on the order of one or so millirems. This is the same amount of exposure that the average individual in the United States gets in one day due to natural background radiation. Compare this to the additional 5 millirems one would get from a one-week ski vacation in Denver, including the flight. The maximum exposure for a worker in a licensed nuclear facility is 5,000 millirems per year. The purpose of these, and the following comparisons, is not to trivialize the subject of radiation exposure, but simply to place such exposures in perspective.

- A person living directly outside a nuclear power facility would add approximately 1 millirem per year.
- A person working in a nuclear power plant would add 300 or more millirems per year.
- From cosmic rays alone, a person living in Washington, DC, a city with a low elevation, would receive approximately 26 millirems per year. A person living in Denver, Colorado, a city with a high elevation, would receive approximately 50 millirems a year.
- A person flying in an airplane across the country would add about 5 millirems per flight because of the increased elevation during the trip. Airline pilots and flight attendants are exposed to higher levels of radiation routinely due to their occupations.
- A person receiving a full set of dental x rays would add about 40 millirems per year.
- A person working in a store on a street that a truck transporting nuclear waste passes by every week would add about one-half a millirem per year.
- A person stuck in traffic for an hour next to a truck carrying nuclear waste would add less than 10 millirems.
- A person sitting on a park bench as a truck carrying nuclear waste passes by would add less than one-tenth of a millirem.

For more information, please write:
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Washington, D.C. 20026
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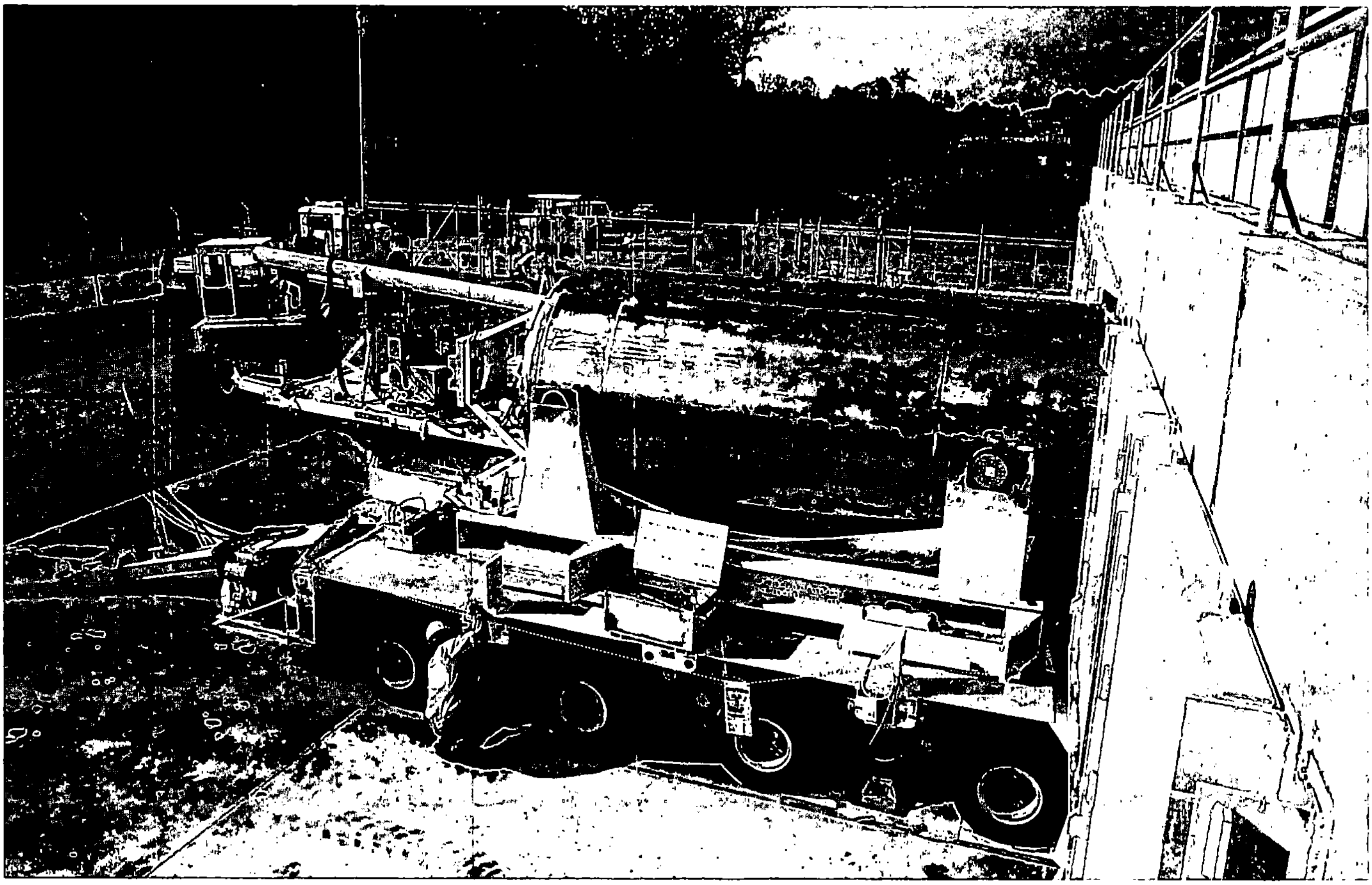
DOE/RW-0355P
OCRWM Fact Sheet

Storage of Spent Nuclear Fuel

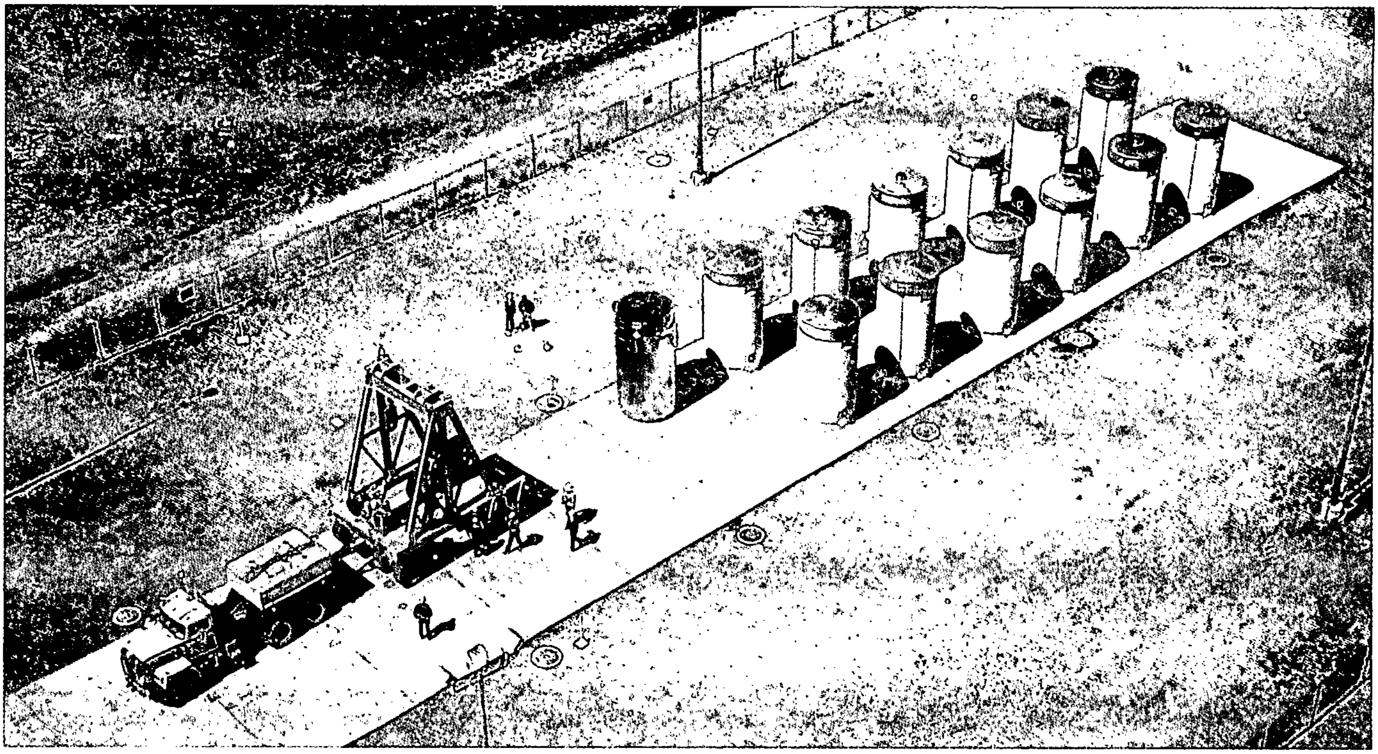


Loading of spent nuclear fuel into a concrete storage module from shielded transfer cask at Duke Power's dry storage facility.

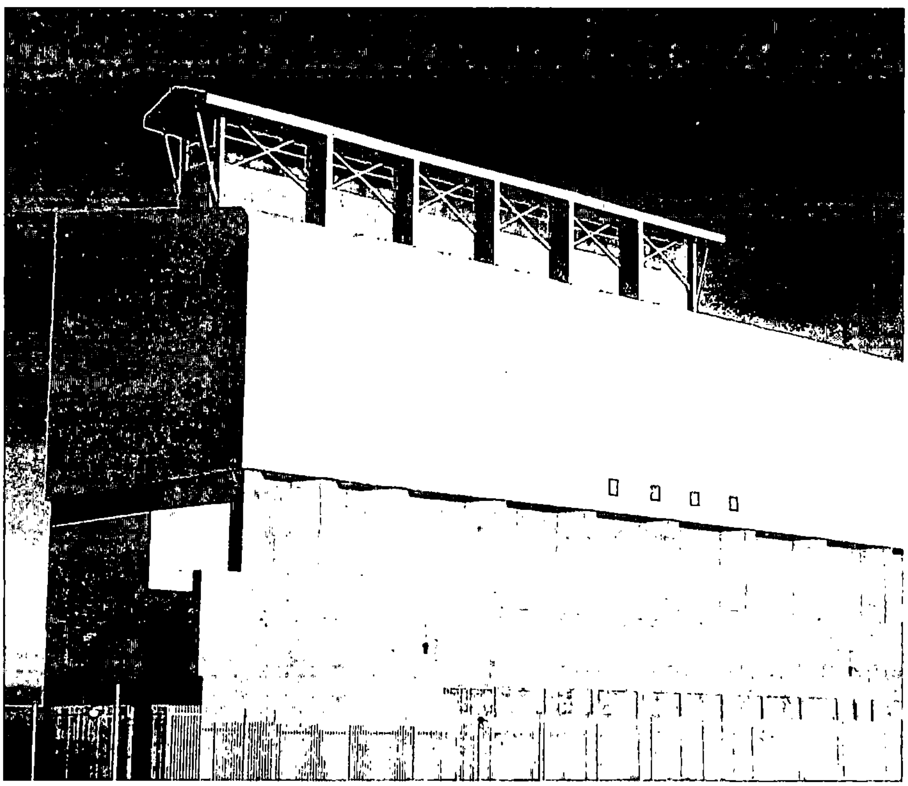
Nuclear waste is material that either contains a radioactive substance or has been contaminated by radioactive elements and is no longer useful. It includes waste products from nuclear processes, such as mining uranium ore, fissioning of uranium in commercial nuclear power plants, processing defense materials, and preparing nuclear isotopes for use in medical applications. It also includes used protective clothing and containers that once held nuclear material.

In 1982 Congress enacted the Nuclear Waste Policy Act (NWPA), which outlines a comprehensive plan for the safe disposal of spent nuclear fuel and other forms of high-level nuclear waste. It also includes development of a mined, geologic repository for long-term disposal of all forms of high-level radioactive wastes. An amendment enacted in 1987 authorizes the development of a temporary, above-ground storage facility called a Monitored Retrievable Storage (MRS) facility. The MRS will store a limited amount of "spent" or "used" nuclear fuel from commercial nuclear power plants, a solid form of radioactive waste.

To produce electricity, nuclear power plants use solid, ceramic fuel pellets made of uranium. Tremendous amounts of energy are stored in the centers of uranium atoms. When these atoms split, highly radioactive fission products are generated along with the large amounts of heat that make steam to turn turbine generators. The rock-hard fuel pellets are encased in strong metal rods. After three or four years in an operating nuclear reactor, the energy remaining inside the pellets is no longer efficient enough to produce usable heat and the pellets have become highly radioactive. These pellets and the surrounding rods must be isolated from the human environment for long periods of time, on the order of thousands of years. Until a permanent repository is in operation, spent fuel will continue to be stored in above-ground facilities such as the ones shown. The MRS will build upon



Storage of spent nuclear fuel in metal storage containers at Virginia Power's dry storage facility.



A modular vault dry storage facility operated by the Public Service Company of Colorado built to hold spent nuclear fuel.

storage technologies already in operation and demonstrated to be safe.

The U.S. Department of Energy (DOE) is responsible for the Nation's Civilian Radioactive Waste Management System. Within DOE, the Office of Civilian Radioactive Waste Management (OCRWM) is charged with executing policy and managing the program to safely dispose of used nuclear fuel and other forms of high-level radioactive waste.

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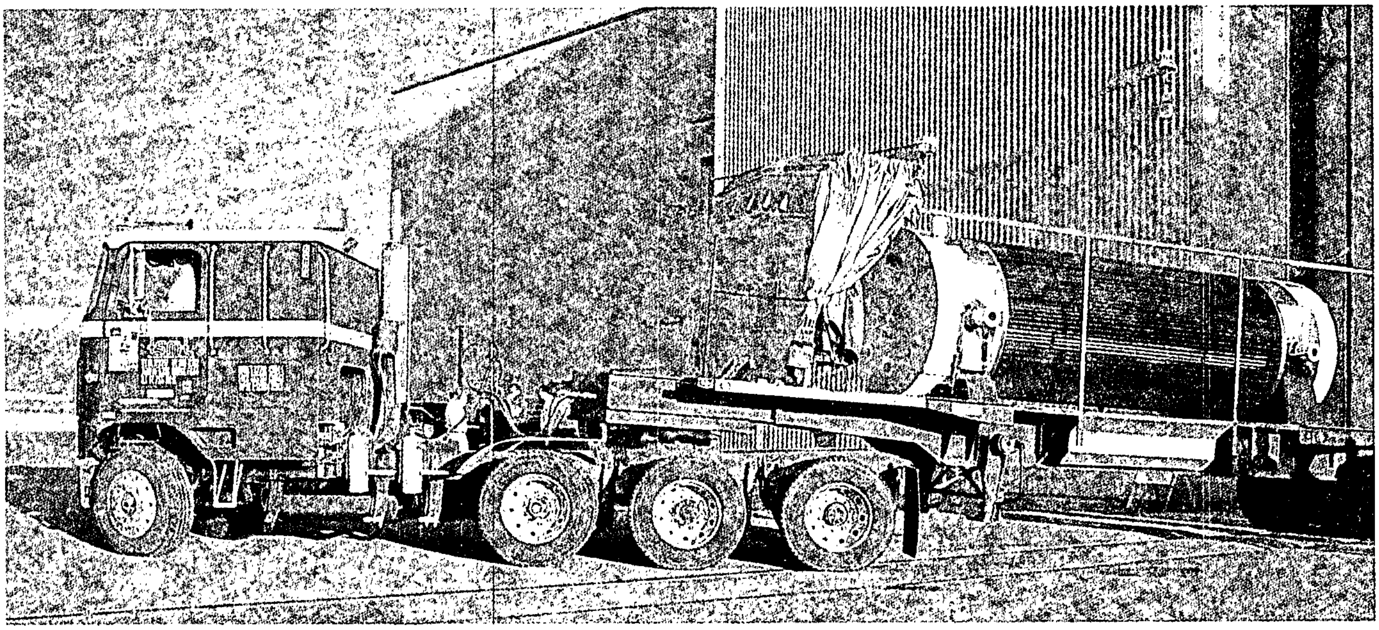
OCRWM Fact Sheet

Transportation of Used Fuel



Over the last 25 years, more than 2,500 shipments of used nuclear fuel have been transported safely over America's highways and railroads.

A safe, dependable transportation system is the crucial link in both the proposed operation of a temporary Monitored Retrievable Storage facility and a permanent geologic repository for the disposal of spent (used) nuclear fuel. The amended Nuclear Waste Policy Act requires the Department of Energy (DOE) to accept, transport, and dispose of used nuclear fuel.

Over the last 25 years, more than 2,500 shipments of used nuclear fuel have been transported safely over America's highways and railroads. During this time, an exemplary safety record has been established with no fatalities, injuries, or environmental damage caused by the radioactive nature of the cargo.

Several factors have contributed to this success story. The used fuel is a solid, rock-hard material enclosed in metal tubes and shipped dry in rugged containers. These containers are heavy, sealed, thick-walled, metal structures that safely confine the used nuclear fuel. These specially engineered containers are designed to keep their radioactive cargo from being released into the environment.

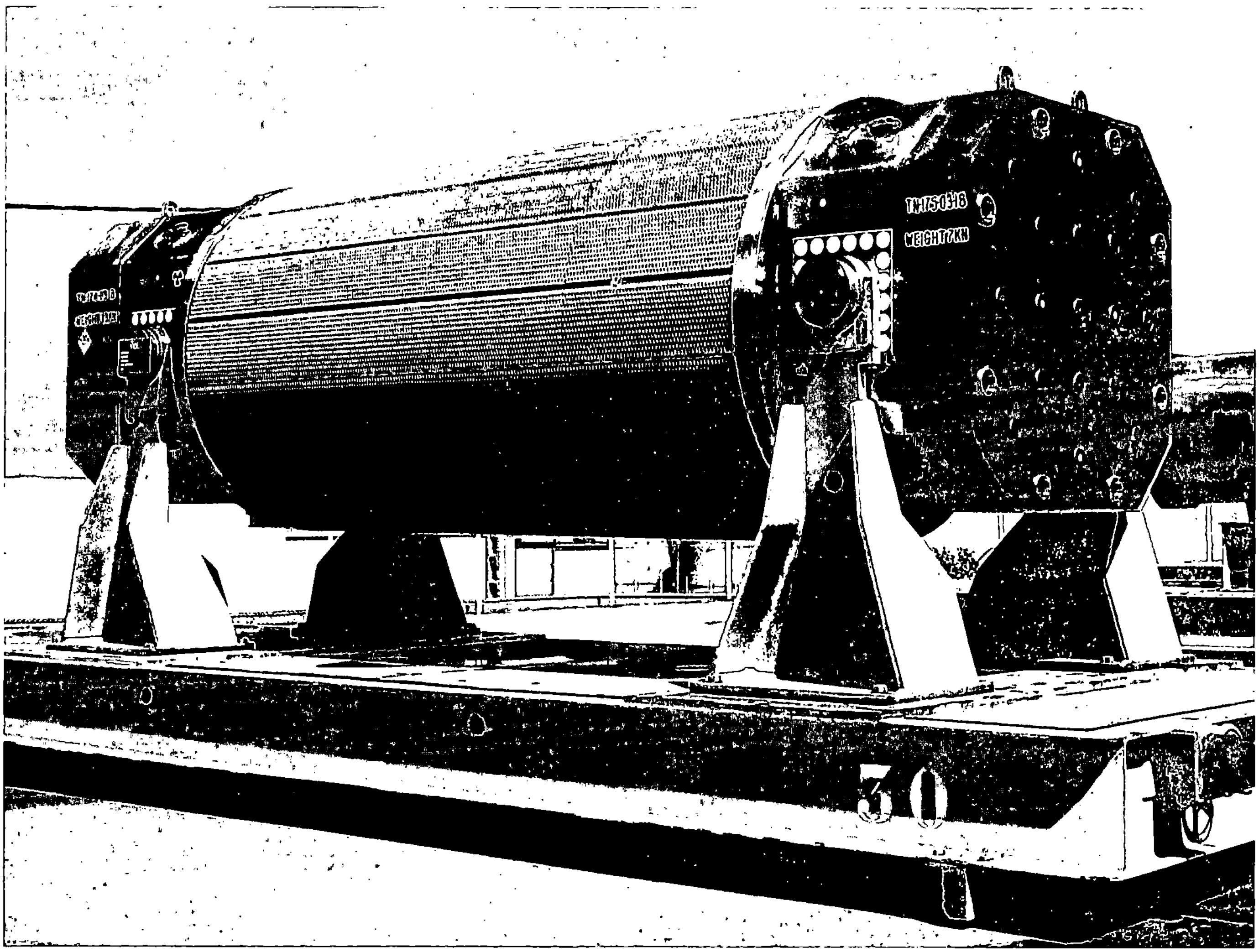
Each shipping container is designed to maintain its integrity under routine transportation conditions and during severe accidents. The containers must ensure radiological safety even after being subjected to the Nuclear Regulatory Commission's (NRC) hypothetical accident conditions, which include:

- A 30-foot free fall onto an unyielding surface
- A puncture test allowing the container to free-fall 40 inches onto a steel rod
- A 30-minute, all-engulfing fire
- An 8-hour immersion in 50 feet of water.

While the NRC is responsible for approving container design, the U.S. Department of Transportation (DOT) has established regulations for loading, unloading, and handling shipping containers; labeling containers and placarding transport vehicles for purposes of identification; driver training and certification; and highway routing.

Transportation routes will be planned and shipping containers designed with the safety of the public and the environment as the number one consideration. Containers are built with materials that provide structural strength and protect the public from radiation exposures.

Because there is a chance that an accident involving a radioactive shipment could occur, emergency response plans are in place to handle any situation that could arise. The key to effective emergency response is quality training and preparation.



Containers that transport used fuel are heavy, sealed, thick-walled, metal structures which safely confine the used fuel.

Therefore, the DOE will provide assistance for training of State, Tribal, and local governments in the development of emergency response and preparedness plans because States, local governments and Indian tribes have primary responsibility at the accident scene to protect life, property, and the environment.

All shipments will travel along DOT-authorized preferred interstate routes or rail routes. A state-of-the-art tracking device will link the truck or train with the communications center to allow instantaneous feedback in case of an accident or hazardous weather conditions that could affect safety.

As the number of shipments increases, spent fuel will continue to be moved safely across our nation's highways and railroads. To maintain the program's exemplary safety record, DOE will improve container design and emergency response capabilities and will strengthen the lines of communications among all parties.

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The Monitored Retrievable Storage Facility

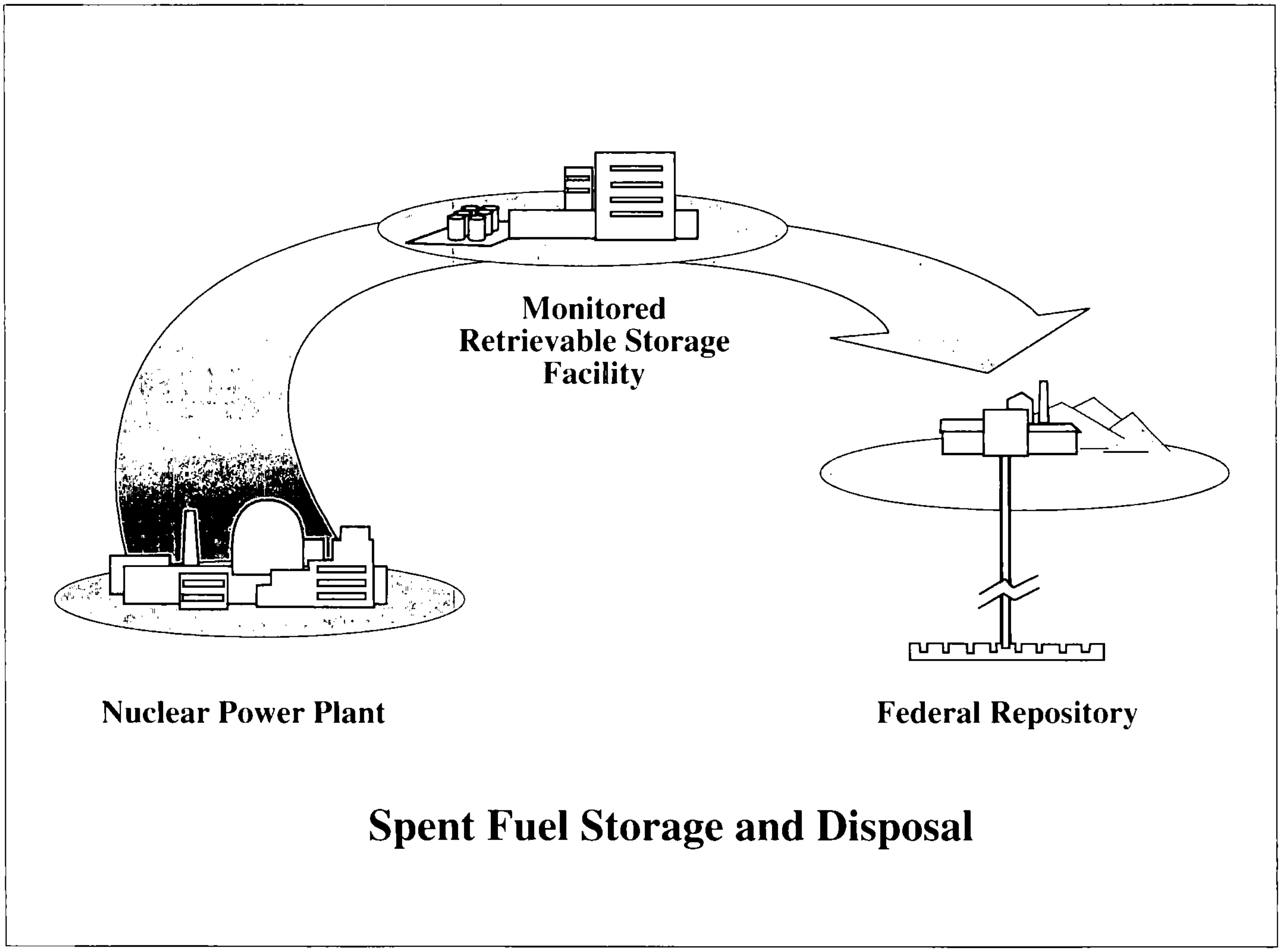
More than 110 nuclear power plants are operating safely in the United States. Nuclear power, while generating 20 percent of the nation's electricity, also produces a solid radioactive waste called "spent" or "used" nuclear fuel. This fuel is currently being stored in protected areas at the plants, but these storage facilities are rapidly reaching capacity.

To remedy this situation, Congress passed the Nuclear Waste Policy Act. This 1982 Act provides for the creation of a comprehensive Civilian Radioactive Waste Management System that is based on what most scientists agree is the best way to dispose of used fuel and other kinds of high-level radioactive waste.

A key component of this system is a Monitored Retrievable Storage (MRS) facility. The MRS will temporarily store a limited amount of the used fuel until it is shipped to a mined, underground permanent disposal facility.

Choosing the MRS Site

To find a site for the MRS, President George Bush appointed a Nuclear Waste Negotiator. The Negotiator is seeking a State or Indian tribe to volunteer to host the MRS in its jurisdiction. In return for hosting the MRS, the Federal Government has agreed to make contributions to the State or tribe and affected units of local government for public programs, projects, and other uses. It is the Negotiator's job to work out the terms of the



An example of the route nuclear waste will take from a nuclear power plant, to the MRS and finally to the Federal Repository.

agreement with the MRS host. The proposed agreement, along with the results of an environmental assessment, will be presented to Congress for final approval.

While the Negotiator is working on the agreement, an environmental assessment will be conducted to determine whether the proposed site is suited to host an MRS. Public meetings will be held to solicit citizen input on the scope of the study and to present information on potential impacts of facility construction and operations. If the site is found acceptable for further consideration and Congress approves the host's specified terms, the site will be evaluated further for development as an MRS in its environmental impact statement and safety analysis report, which will be submitted to the Nuclear Regulatory Commission for review and approval.

Design and Construction of an MRS

The MRS facility will be relatively simple to design, construct, operate, and later dismantle. Engineers and scientists will base the design on safe and proven technologies and on the experience of others with similar facilities either in operation or under construction. The MRS will not perform any atomic, chemical, or high-energy operations that would have the potential to explode and spread radioactive materials off site. Nor will any of the fuel-handling operations change the chemical or physical characteristics of the spent fuel.

Preliminary MRS designs call for several low-rise buildings to support facility operations. The facilities would be located above ground on 400 to 600 acres of land. Design plans for the MRS will be finalized after a site is demonstrated suitable. The MRS will receive used fuel in heavy, thick-walled, metal shipping containers from commercial nuclear power plants, transfer the used fuel to MRS specially designed storage structures (as necessary), and store the used fuel until it is loaded into shipping containers and shipped to a repository for permanent disposal. These operations will be carried out in accordance with written procedures approved by the Nuclear Regulatory Commission.

Any necessary transfers of used fuel between the shipping containers and the MRS storage containers will be performed inside a specially designed fuel handling building. Protective steel and concrete walls will be included in the building to minimize radiation exposure to workers and the public. The fuel will be handled using remotely operated equipment.

The MRS will be required to meet strict safety standards established and enforced by the Nuclear Regulatory Commission. Facility operations will be closely monitored to ensure the health and safety of the workers and the public. After its mission is completed, the MRS will be decommissioned and dismantled, and all radioactive materials will be removed so that the site can be released for unrestricted use.

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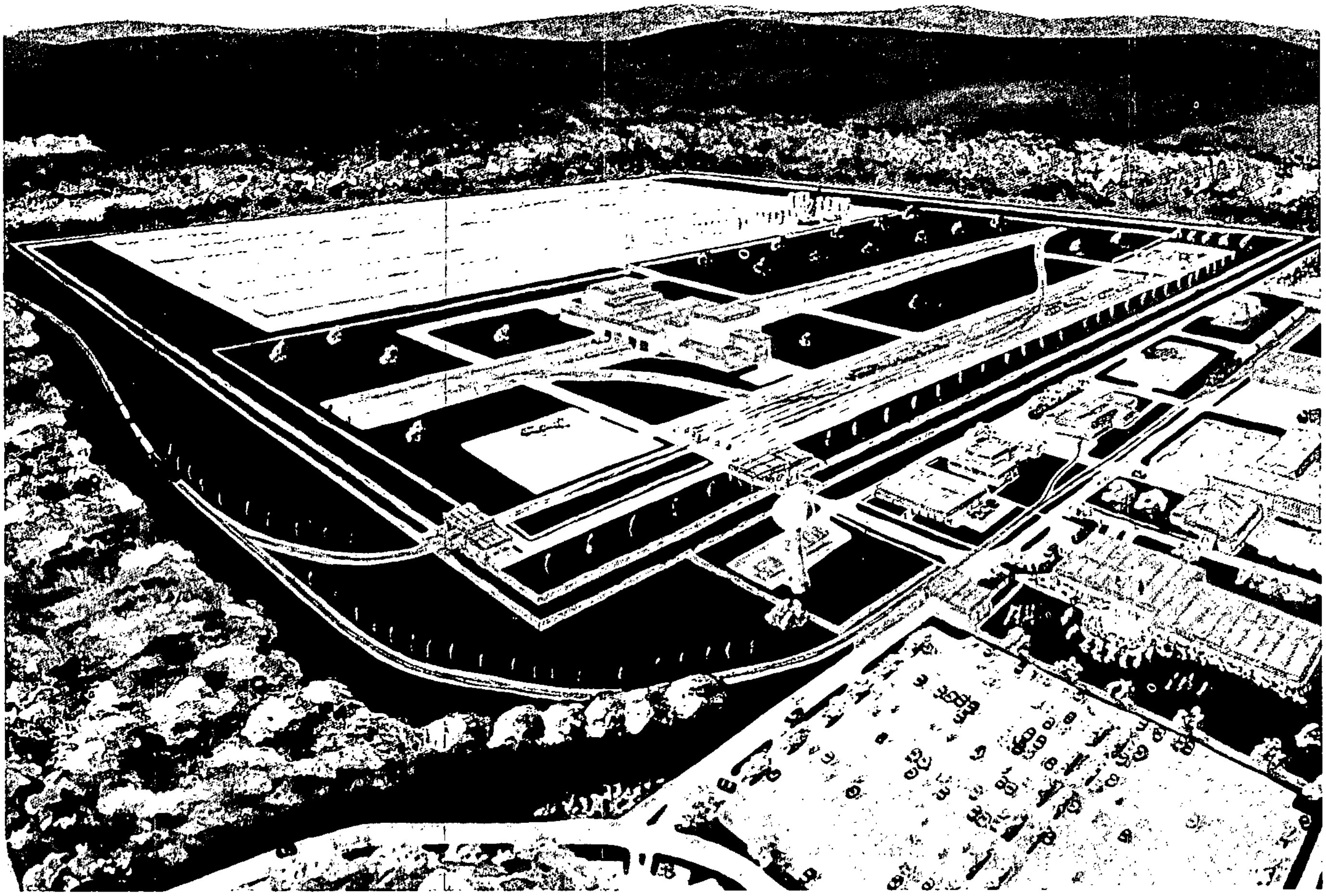
MRS Site Requirements and Considerations



A possible design of a Monitored Retrievable Storage Facility.

The Monitored Retrievable Storage (MRS) facility is a vital part of America's Civilian Radioactive Waste Management System. "Spent" or "used" fuel from commercial nuclear power plants currently is being stored safely in protected areas at the plants, but those storage spaces are rapidly reaching capacity. The MRS will temporarily store a limited amount of this used fuel in thick-walled, above-ground engineered structures until it is shipped to a mined geologic repository for permanent disposal. The facility will provide additional, temporary storage space until the repository is operational.

When Congress authorized the Department of Energy to site and build an MRS, it included several restrictions for its use and operation. The restrictions are based on Federal laws, regulations, and executive orders that were in place before the MRS was proposed and some additional measures that were added to help ensure the safety of people and the environment.

Site Requirements

Specifically, six requirements must be met:

- It should occupy between 400 and 600 acres of land
- It should be located in a state other than Nevada, the state currently being studied for a permanent disposal site
- It cannot be within 200 feet of a geologic fault that has moved or shifted in the last 10,000 years, not near a 100-year floodplain, and not within or adjacent to wetlands
- It cannot be located in the habitat of any endangered species
- It cannot be located on land that is protected from development, like national parks and wilderness areas

- It cannot be located within the Coastal Barriers Resource System, which consists of undeveloped land along the Atlantic and Gulf coasts and adjacent wetlands and inlets.

Site Considerations

Site considerations that may make one site preferable over another include:

- Land costs and how long it will take to develop the land for an MRS
- Proximity to transportation facilities like roads, railroads, and seaports
- Impact on wetlands and coastal areas
- Geologic characteristics such as earthquake activity and floodplains
- Impact on historical, cultural, and archaeological areas such as burial grounds, battlefields, and religious sites
- Proximity to human and animal activity
- Severe weather conditions that may affect operations
- Blasts or other major ground movement caused by humans
- Potential ground movement like landslides
- Volcanic activity
- Socioeconomic impact on potential host community
- Impacts on air quality
- Preservation of ground water quality
- Land ownership and land use restrictions.

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The MRS - Bringing Benefits to the Host Community

The MRS could mean up to 1,500 construction jobs for the host community.

The monitored retrievable storage (MRS) facility will be an integral part of the Civilian Radioactive Waste Management System, the National system to dispose of high-level radioactive waste. The MRS will accept a limited quantity of "spent" or used fuel from commercial nuclear power plants and temporarily store it, employing proven technology used in the United States and abroad. The facility also will act as a staging area for spent fuel shipments to the geologic repository, where the fuel will be disposed of permanently.

In addition to providing a valuable service to the waste management system, the MRS also will bring benefits to the volunteer host community.

The Nuclear Waste Negotiator, appointed by the President of the United States to find a site for the MRS, is authorized to discuss with the Governor of a State, Tribal Leader or local Government Official the terms and conditions under which the State or Tribe would be willing to host an MRS. The prospective host has the unique opportunity to have benefits tailored to specific community needs — needs that are currently not being met.

When a prospective volunteer host and the Negotiator reach an agreement, the benefits package will be submitted to Congress and the President for approval.

The Negotiator and the prospective host can discuss benefits in areas such as:

- Local employment or products purchasing agreements
- Public recreation improvement projects

- Tax subsidy or property value protection programs
- General economic development programs
- Health care programs
- Higher education programs
- Public school assistance programs
- Environmental improvements to address existing air, water or waste problems
- Infrastructure improvements, including highways, railways, airports, and other public systems
- Direct financial assistance
- Any other type of assurance, equity or assistance desired by the State, Indian Tribe or local government.

In addition to the negotiated benefits, the MRS also could mean up to 1,500 construction jobs for the community. Operation of the facility could provide up to 500 permanent jobs in security, administration, science, and engineering.

In return for specific benefits, the host would provide about 500 acres of land to the Federal Government for the MRS site. The facility will be licensed to operate for 40 years, then the site will be restored and returned to the community.

It is important to remember that any negotiation will involve only willing participants. Discussion can be terminated by the prospective host at any time without penalty.

The MRS is an important first step toward the permanent disposal of used nuclear fuel. It shows that our Nation is serious about its responsibility to leave the environment safe and clean for the next generation.

Job training could be part of the negotiated benefits agreement.

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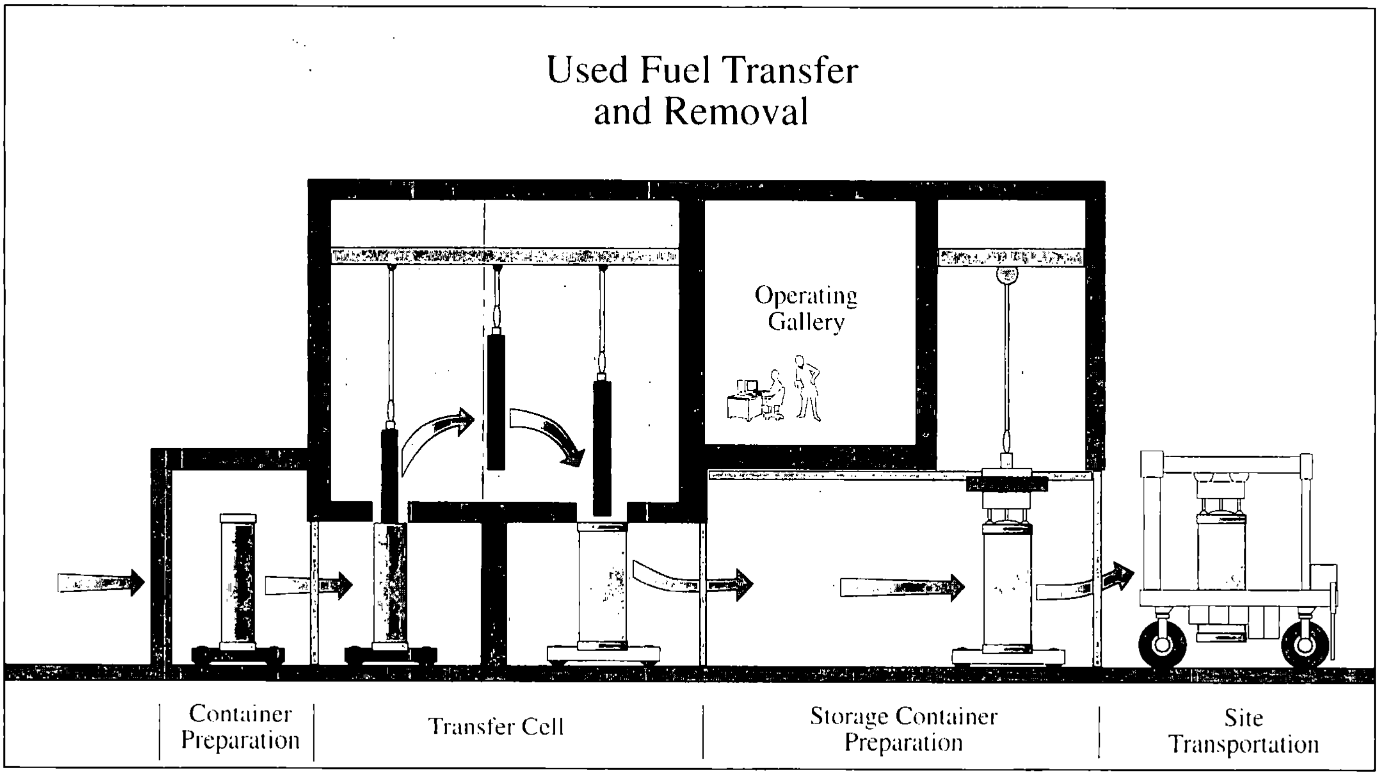
MRS Dry Handling Operations

The U.S. Department of Energy's (DOE) program to manage the Nation's spent nuclear fuel and high-level radioactive waste consists of a temporary storage facility, a permanent repository, and a transportation system. The monitored retrievable storage (MRS) facility will provide temporary storage for a limited amount of spent or "used" fuel from the country's nuclear power plants. The DOE is scheduled to begin accepting used fuel at an MRS facility in 1998.

The MRS will be capable of receiving and handling incoming used fuel shipments for temporary storage on site. When a permanent repository begins operation, used fuel will be retrieved from temporary storage on site and transferred to shipping containers for transport to the repository for permanent disposal. Some incoming shipments may be repackaged and sent directly to the repository without interim storage at the MRS.

For more than 30 years, used fuel has been handled and stored safely in the United States using both "dry" and "wet" technologies which have been approved for use by the Nuclear Regulatory Commission (NRC). The dry methods employ physical barriers such as metal, concrete, and lead to provide radiation shielding and prevent releases to the environment. The wet technique uses pools of water to provide radiation shielding during used fuel handling and storage operations.

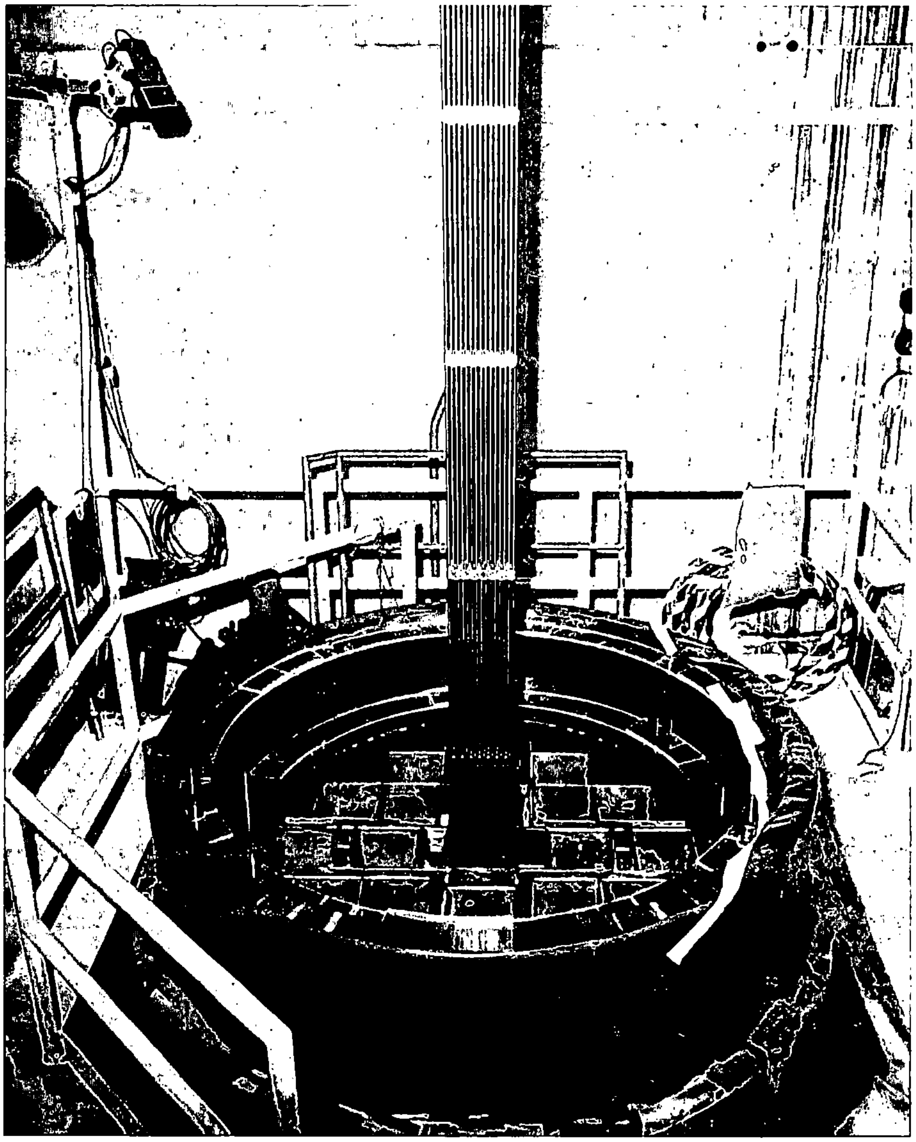
Used fuel handling operations at the MRS will be similar for the various dry storage technologies. Used fuel shipments will arrive at the MRS by truck or rail in special shipping containers designed and constructed according to regulations established by the NRC. All deliveries will enter the grounds at a receiving gatehouse, where security guards authorize used fuel shipments to proceed to the protected area for inspection. When the shipping container has passed inspection, it will be connected to an on-site transporter that will move it into the transfer facility.



Inside the transfer facility, used fuel handling operations are efficient and safe. A shipping container is prepared for the transfer operation, then moved to a transfer cell where the used fuel assemblies are individually removed from the shipping container and placed in a storage container. The storage container is sealed and then placed on the site transporter that delivers it to the storage yard.

The transfer facility is the focal point for handling all incoming and outgoing used fuel shipments. Multiple tasks will be performed in preparation for on-site storage or transport to a repository. Inside the shipping and receiving bay, the impact limiters (which function like a car's bumpers) will be removed from the shipping container and the container will be inspected. It is moved to the preparation area where the protective lid and plug will be loosened, then moved to a transfer cell.

The transfer cells are the major part of the transfer facility. All functions that involve handling and retrieving used fuel will occur in the transfer cells. A bridge crane will be used to remove the used fuel assemblies from the shipping container and individually place them into a storage container. This task will be performed from a separate area by an operator using remote controls to manipulate the transfer operation. Concrete radiation shielding and a stainless-steel liner surround the transfer cell. These physical barriers separate the workers from the transfer cell and reduce radiation exposure to very safe levels. Operators can view the activities in the transfer cell with video cameras or through lead-shielded windows.



In the transfer cell, a used fuel assembly is loaded into a storage container.

After the storage container is loaded, it will be sealed and tested in the storage preparation area, then placed on a site transporter that will move it to the storage yard. The storage yard will contain the type of storage technology, or combination of technologies, selected for use.

When retrieving used fuel from the MRS on-site storage, the same dry transfer process will occur except the tasks will be reversed. In the transfer cells, the used fuel assemblies will be removed from the storage container and placed in a shipping container. The shipping container will then be prepared for transport to the repository.

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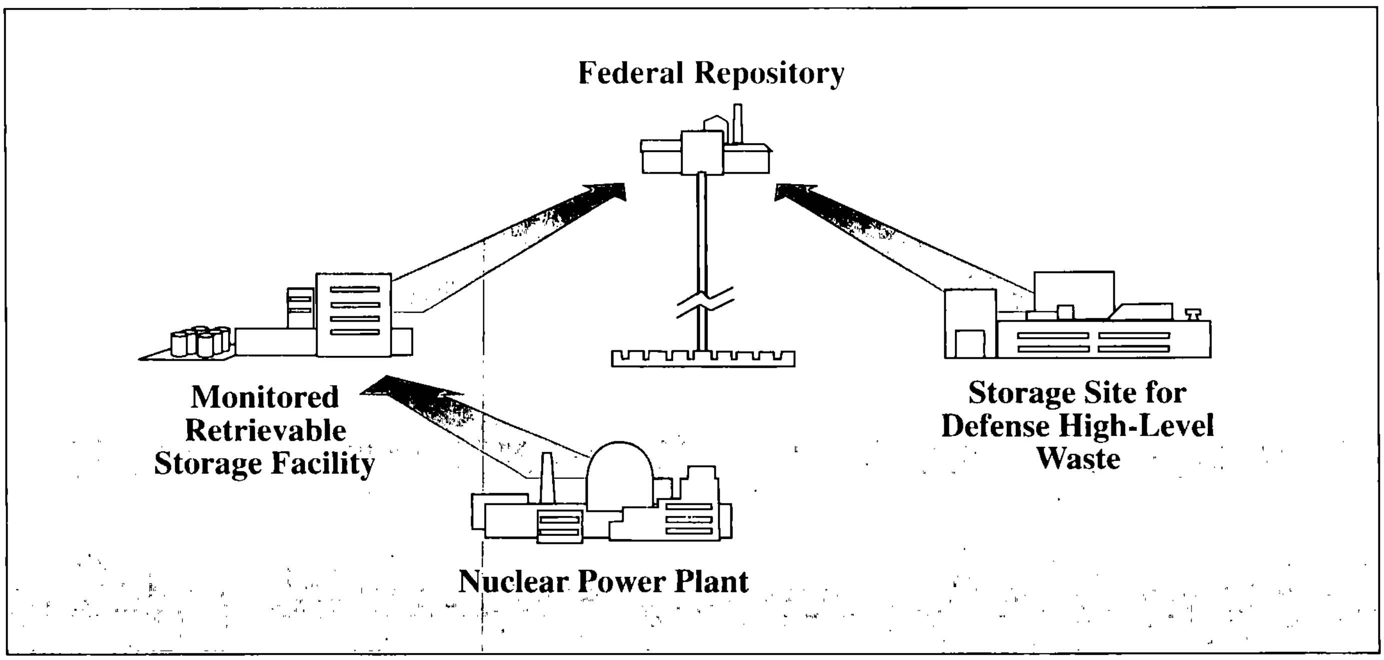
The Civilian Radioactive Waste Management System

Since the late 1950s, the American people have relied more and more on energy from nuclear reactors. Nuclear reactors now supply a little more than one-fifth of the electricity we use to run our homes, schools, factories, and farms. When the nuclear fuel that generates the electricity in these reactors is "spent" or "used," it is removed from the reactors and stored in specially designed storage pools or, in the case of some older used fuel, placed into heavy, thick-walled metal or concrete structures for storage above ground at the reactor sites. Such storage is proven safe, but is only a temporary solution. Permanent disposal of the used fuel will require isolation from the accessible environment for thousands of years.

Our government is developing a Civilian Radioactive Waste Management System that will provide for the safe disposal of the used fuel and other kinds of high-level radioactive waste. Those who use electricity produced by nuclear reactors are funding the system for used fuel storage and disposal, not the general taxpayers. These consumers pay a monthly fee, included in their utility bills, which is deposited in the Nuclear Waste Fund established by Congress to fund the program.

The waste management system includes three elements: a mined geologic repository for permanent disposal, a Monitored Retrievable Storage (MRS) facility for temporary above-ground storage, and a transportation system connecting all elements of the Civilian Radioactive Waste Management System. The geologic repository will be developed in an excavated area deep beneath the surface of the earth in a suitable rock formation. Facilities on the surface will accept the used fuel from the MRS and prepare it for disposal in underground mines. To make sure that the repository is safe, scientists will spend many years studying the rocks in and around a proposed site. Both the underground repository and the used-fuel containers will be designed to suit the unique conditions of the site.

In addition, before the repository is built and operated, it will have to be approved and licensed by the Nuclear Regulatory Commission. The scientific studies that will be performed to ensure the safety of the system, including its design and construction, will take many years. In fact, the repository is not expected to be completed until early in the next century. When completed, the repository will provide permanent disposal for used fuel from electricity-producing nuclear reactors and high-level waste from national defense activities.
The MRS facility, which is to begin operations in 1998, will receive only a limited amount of the solid, used fuel shipped from reactor sites and store it



Spent nuclear fuel will be shipped from nuclear power plants to the MRS, and from the MRS to the Federal repository.

temporarily in specially designed, above-ground structures. When the repository begins operating, the MRS facility will continue to receive used fuel before it is sent to the repository for permanent disposal. The MRS, too, must be licensed by the Nuclear Regulatory Commission. The Nuclear Regulatory Commission establishes requirements and regulations designed to ensure safe operation of licensed nuclear facilities. After its mission is completed, the MRS will be decommissioned and dismantled, and all radioactive materials will be removed so that the site can be released for unrestricted use.

The transportation element of the program will include a system for shipping the used fuel, a fleet of vehicles and railroad cars, metal shipping containers, and support facilities for maintaining the containers. These rugged, heavy, thick-walled containers are designed to completely protect public health and the environment, even in accident situations. The containers must be certified by the Nuclear Regulatory Commission, which requires that such containers be capable of passing a series of rigorous safety tests.

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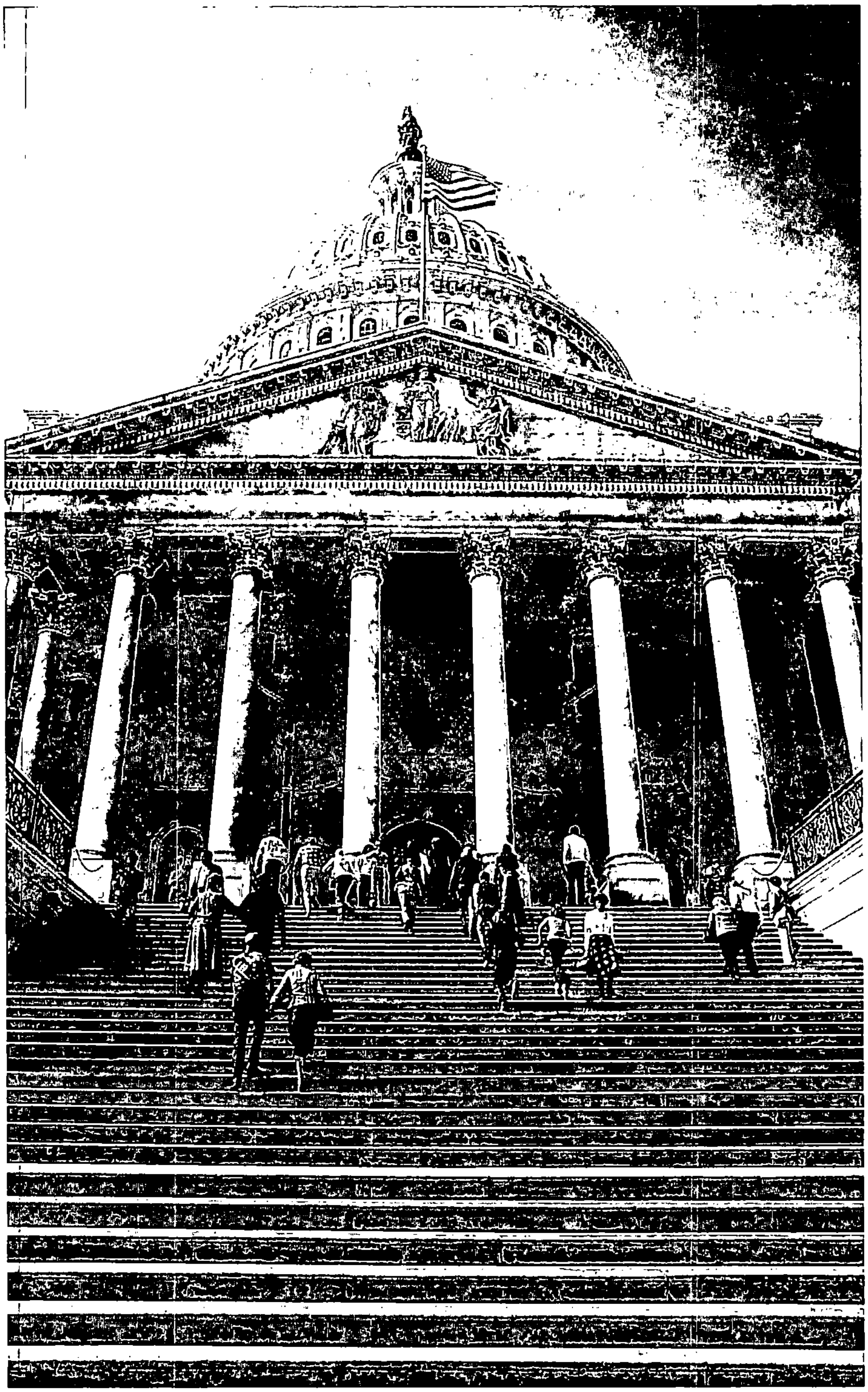
Nuclear Waste Policy Act and Amendments

In 1976, a Federal program was established to study ways to safely dispose of nuclear waste. The program was based on ideas suggested by the National Academy of Sciences, the U.S. Geological Survey, and other professional scientific organizations in the late 1950s. In 1982, Congress enacted the Nuclear Waste Policy Act, the first comprehensive legislation regarding high-level radioactive waste disposal.

The Nuclear Waste Policy Act made the U.S. Department of Energy (DOE) responsible for locating, building, and operating an underground geologic repository to permanently dispose of spent nuclear fuel and other kinds of high-level radioactive wastes. To fund the program, Congress established the Nuclear Waste Fund. People who use electricity produced by nuclear power plants pay for spent-fuel storage and disposal through their utility bills.

In 1983, DOE selected nine locations in six states for consideration as potential sites for the repository. These sites were studied and the results were presented to Congress in 1985. Based on these reports, then-President Ronald Reagan approved three sites for detailed study, called site characterization. The three sites were: Hanford, Washington; Deaf Smith County, Texas; and Yucca Mountain, Nevada.

In December 1987, Congress amended the Nuclear Waste Policy Act and directed DOE to study only one site, Yucca Mountain, to determine whether or not Yucca Mountain is a suitable site for development of a repository. It stressed that if at any time Yucca Mountain is found unsuitable, studies will be stopped immediately. If that happens, the site will be restored and DOE will seek new direction from Congress.



In 1982, Congress enacted the Nuclear Waste Policy Act, the first comprehensive legislation regarding high-level radioactive waste disposal.

The amendment also authorized the Secretary to site, construct, and operate one Monitored Retrievable Storage (MRS) facility, in order to enhance reliability and flexibility and to provide other benefits to the waste-management system. The MRS differs from the repository in that it is an above-ground facility that will store only a limited amount of used fuel and only for a limited time.

In response to the amended legislation, the Nuclear Regulatory Commission established regulations governing the siting, construction, operation, and decommissioning of an MRS.

To facilitate MRS siting, Congress established the independent Office of the Nuclear Waste Negotiator. The Negotiator is responsible for developing an agreement between a willing State or Indian tribe and the Federal Government concerning the terms and conditions for locating the MRS or repository within the state or tribal lands.

The Negotiator may develop a package of benefits with the potential host in recognition of the host's willingness to help solve this issue of national importance. Negotiations may include reasonable incentives and financial arrangements, as well as various types of public programs, projects, and problem-solving assistance.

The amendment directs the Negotiator to work out terms of an agreement. The proposed agreement and the results of an environmental assessment must be approved by Congress before it becomes effective. The Nuclear Waste Fund will be the funding source of the benefits associated with voluntarily hosting such a facility and, in the case of the MRS, for decommissioning and dismantling the facility and removing all radioactive materials so the site can be released for unrestricted use.

For more information, please write:
OCRWM Information Center
Post Office Box 44375
Washington, D.C. 20026
or call: 1-800-225-NWPA
(or call 488-5513 in Washington, D.C.)

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THIS PUBLICATION IS PRINTED ON RECYCLED PAPER CONTAINING A MINIMUM OF FIFTY PERCENT WASTEPAPER.

Used Nuclear Fuel

In December 1957, history was made when Pennsylvania's Shippingsport nuclear station became the first commercial power plant to generate electricity by harnessing energy released in nuclear fission. Since then more than 100 nuclear reactors have been built in the United States and now over 20 percent of our electricity comes from nuclear power.

Nuclear power allows utility companies to keep up with the ever increasing demands for energy. Like other industrial plants, nuclear power stations produce waste. For nuclear power stations the primary waste byproduct is spent or "used" nuclear fuel.

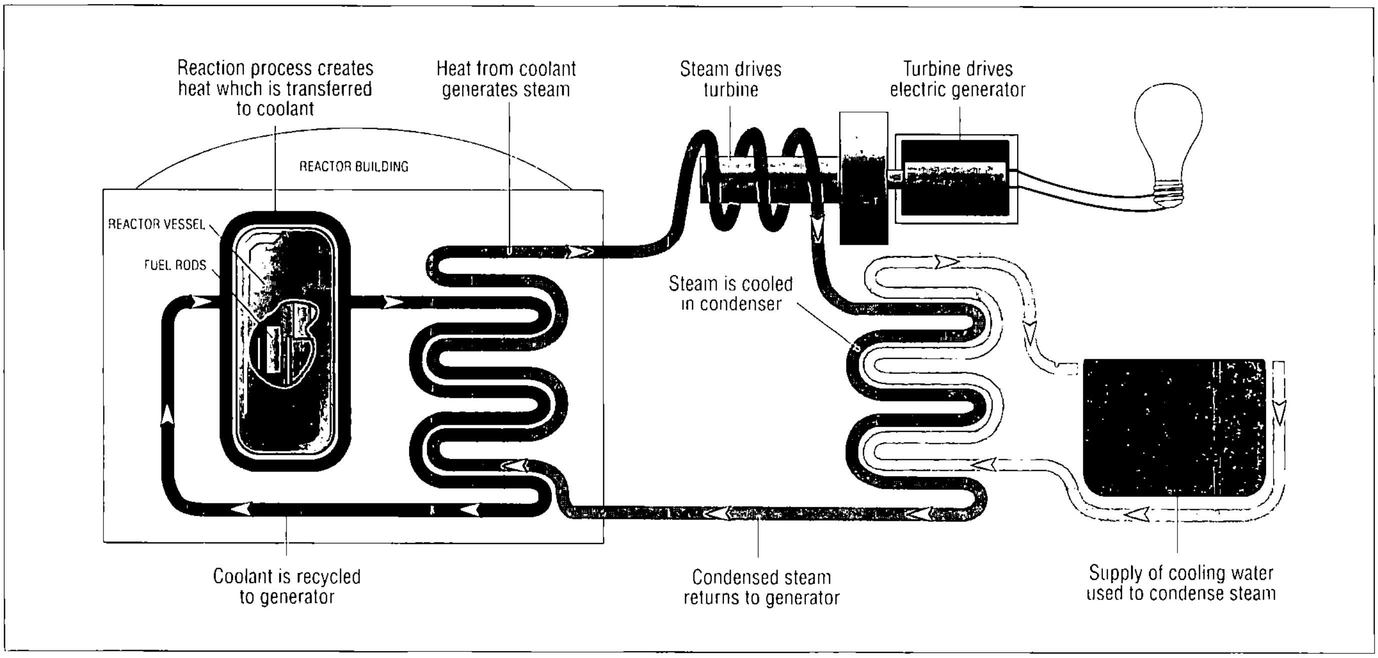
Nuclear fuel comes in the form of small pellets of enriched uranium, about the size of a pencil eraser. The pellets are stacked end-to-end in strong metal tubes, which are bundled together to form fuel assemblies. These fuel assemblies are placed inside a nuclear reactor where the nuclear fission process takes place.

Nuclear fission is the process of splitting atoms. Tremendous amounts of energy are stored in the center of atoms called the nuclei of atoms. When atoms are split two things are produced: one is heat and the other is radiation. The heat from the fission process is used to make steam needed to turn the turbine-generator to make electricity. The radioactive material (that produces radiation) remains in the metal tubes.

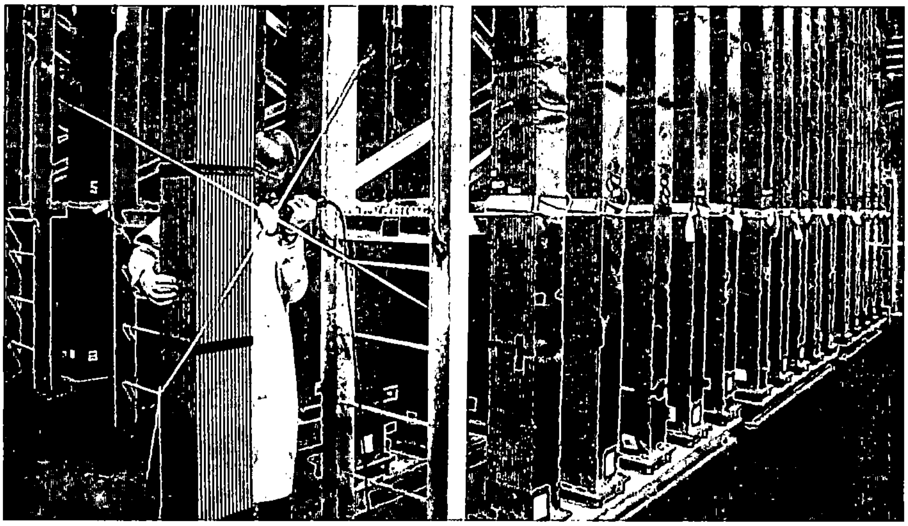
Approximately every 18 months, about a third of the used fuel is taken out of the reactor and replaced with new fuel. Radioactive materials remain inside the sealed tubes. Since the fuel bundles discharge radiation, they need to be isolated from people and the environment for thousands of years; or until the radiation decreases to the level already found in nature - a process that happens naturally with time.

After the assemblies are removed from the reactor, they are placed inside concrete pools lined with steel and filled with water. The water cools the used fuel and shields workers from radiation. All the nuclear power plants in the United States store their used fuel this way, but this method is not intended to be permanent and some pools are almost full.

In a few cases, utilities have placed some of their used fuel in dry storage. With this method, fuel assemblies are removed from the pool and sealed in heavy concrete or steel containers, and



Schematic of nuclear power generation cycle.



New nuclear fuel assemblies receive a final check.

stored on a concrete pad or in a vault at the plant site. But like pool storage, dry storage is temporary and is not designed to be permanent.

During the 1980s Congress enacted legislation that set the framework for the Civilian Radioactive Waste Management System (CRWMS) — the Federal program to dispose of used nuclear fuel. CRWMS is made up of three parts: a monitored retrievable storage (MRS) facility, a Federal repository and a transportation system to transport the fuel from the utilities to the MRS and the repository. The legislation also requires owners of civilian reactors to finance the program through contributions to a Nuclear Waste Fund. All three parts of the program must follow the guidelines imposed by the Nuclear Regulatory Commission, the independent Federal agency responsible for overseeing nuclear-related activities.

The MRS facility will temporarily store used fuel until it is shipped to a repository for permanent disposal. The MRS will be built above ground on a site of about 500 acres. It will accommodate different types of shipping containers and will be monitored continuously. The MRS will be licensed to operate for 40 years. After that, it will be decommissioned and the site restored for unrestricted use.

Used fuel and high-level defense waste will be disposed of in an underground repository. The repository will be built deep beneath the surface and will be designed to contain high-level radioactive material for up to 10,000 years. The repository will include above-ground facilities to handle and monitor the wastes and "engineered barriers" below ground. Congress has ordered the Department of Energy to study — a process called site characterization — only Yucca Mountain, Nevada to see if it is suitable for a repository.

The site characterization studies at Yucca Mountain are expected to take several years. These studies consist of geologic, hydrologic, seismologic, and other scientific tests to see whether Yucca Mountain would be a suitable site for a repository. If at any time the site is found unsuitable, the Office of Civilian Radioactive Waste Management (OCRWM) will stop the tests and seek new direction from Congress.

OCRWM's transportation system will determine how nuclear fuel is shipped from nuclear power plants to the MRS and repository. The system must comply with Department of Transportation and other federal and state laws that regulate used-fuel shipments. The system will include criteria for shipping routes and schedules. It will also specify design requirements for the shipping containers.

By 1990, civilian nuclear reactors had produced nearly 20,000 metric tons of spent fuel. The Nation's inventory of spent fuel will reach 40,000 metric tons by the year 2000. This is not a large amount compared with the millions of tons of hazardous waste produced each year in the United States. But because used fuel is highly radioactive, it requires a special program to protect people and the environment.

For more information, please write:
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THE NUCLEAR WASTE POLICY ACT OF 1982[1]

DOE/RW-0335P

Annual Report to Congress

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

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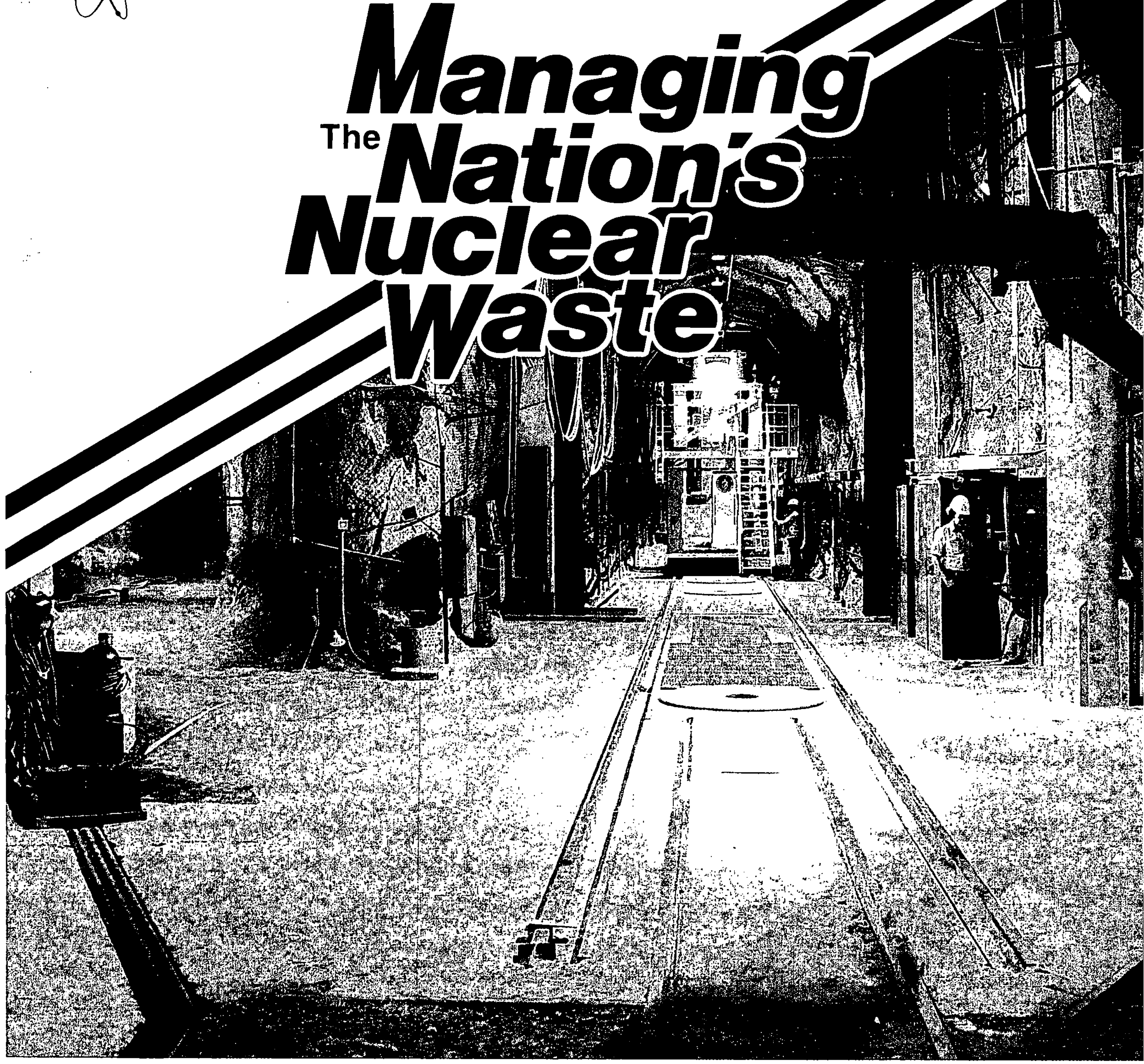
The Managing Nation's Nuclear Waste



United States of America

DOE/RW-0414

Of Mountains & Science

YUCCA MOUNTAIN PROJECT

Studies

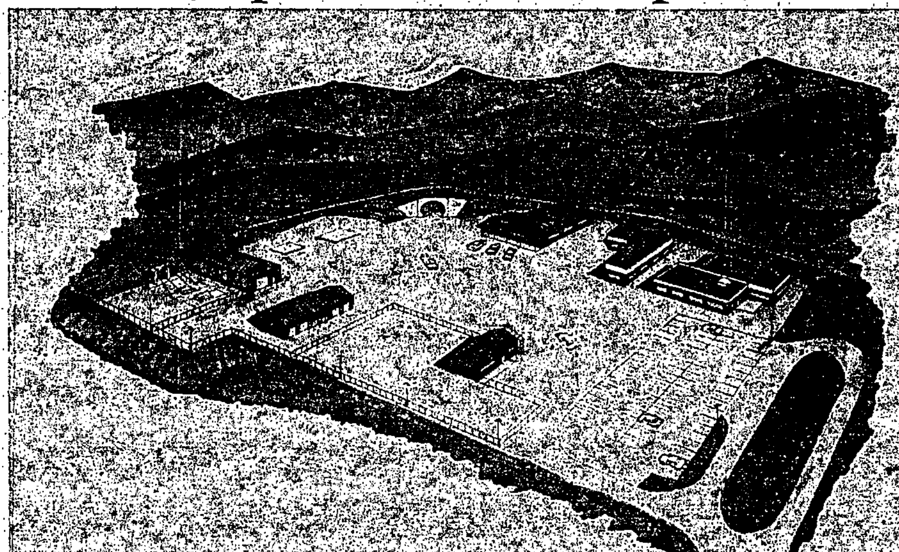
Spring 1993

Exploratory Studies Facility: pad nears completion

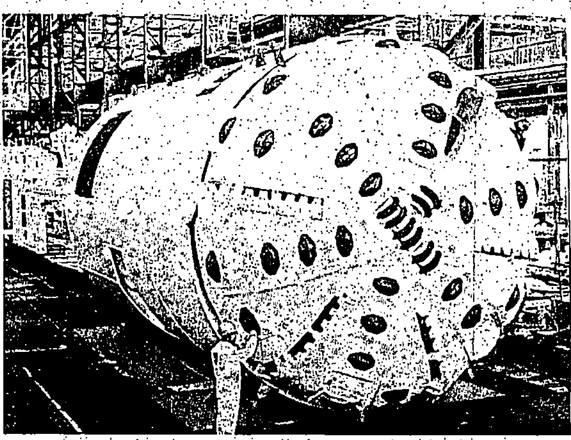
"Champing at the bit."

That's how Engineer Edgar "Ted" Petrie describes the mood of scientists and engineers now awaiting the completion of preliminary ground-work at the 12-acre North Portal entrance pad at Yucca Mountain.

"We're about 70 percent to 80 percent done leveling the surface for the support facilities and buildings due to be erected on the pad," says Petrie, now an acting deputy director of the Yucca Mountain Project's Engineering and Development Division. "Once we're done removing topsoil, grading the surface and cutting a slot into the mountain — I'd say we're looking at another month — we can start to worry about starter tunnel excavation and moving a tunnel boring machine, a TBM, into place."



Artist's conception of the swiftly-progressing ESF North Portal: offering scientists and engineers a mole's–eye–view of Yucca Mountain.



A tunnel boring machine, or TBM, similar to the one that will eventually begin tunneling under Yucca Mountain.

Why all the excitement? Because once a TBM (a device similar to the machine that dug the English Channel Tunnel) is procured and launched into the mountain, engineers can begin building the long-awaited Exploratory Studies Facility (ESF). This is a 22-kilometer (13.6-mile) network of ramps and tunnels that will afford a mole's eye view of Yucca Mountain.

The scientists and engineers charged by Congress with studying the geology and hydrology of Yucca Mountain have to rely on trenching and on drilling boreholes to fathom what awaits them underground. They've studied water samples and rock samples; they've modeled the mountain and its surrounding environs with computers; they've taken air readings and temperature readings;

Continued on page 7

Test pits and trenches have yielded some clues about the properties of rocks under Yucca Mountain. The completed tunnel system should settle many outstanding questions.

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