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Draft Mission Plan Amendment

U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Washington, DC 20585

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Department of Energy
Washington, DC 20585

August 23, 1991

To the Reader:

In November 1989, the Secretary of Energy issued the "Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program." The report established an action plan that included initiatives to provide waste acceptance in 1998 at a facility for monitored retrievable storage, and waste disposal starting in 2010 in a geologic repository. This report stated that further details on the Secretary's action plan would be provided in a revised Mission Plan.

In developing this draft Mission Plan Amendment, we adopted an approach that is different from that used for earlier versions of the Mission Plan and even different from what had been envisioned in November 1989. Specifically, we conducted a series of workshops with individuals from various affected governments and interested parties on the strategic principles that should guide the program over the coming years. We found the input of these individuals and the exchange of views informative, stimulating, and productive. In no small part, the shape and content of the draft Mission Plan Amendment attest to the impact of these workshops and the contributions of the individuals who attended them.

Written comments on the draft Mission Plan Amendment should be submitted by November 8, 1991, after which the formal comment period will be closed. Comments should be directed to:

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Additional copies of the draft Amendment can be obtained by calling (202) 586-5722, or writing to the above-mentioned address. After we have considered all comments on the document, we will make appropriate revisions and submit it to the Congress.

I hope that as our work evolves in the years to come, through the challenges and controversies that are certain to arise, all parties will remain firm of purpose, resolved to carry this important national mission to a successful conclusion. Only with such resolve will we be able to provide a system for permanently disposing of spent fuel from commercial nuclear power plants and high-level radioactive wastes from our Nation's defense activities in a manner that protects the health and safety of the public and workers and the quality of the environment.

John W. Bartlett

John W. Bartlett, Director
Office of Civilian Radioactive
Waste Management

FOREWORD

The Department of Energy's Office of Civilian Radioactive Waste Management has prepared this document to report plans for the Civilian Radioactive Waste Management Program, whose mission is to manage and dispose of the nation's spent fuel and high-level radioactive waste in a manner that protects the health and safety of the public and of workers and the quality of the environment. The Congress established this program through the Nuclear Waste Policy Act of 1982 (see Appendix A), though efforts to solve the waste-disposal problem go back several decades. Specifically, the Congress directed us to isolate these wastes in geologic repositories constructed in suitable rock formations deep beneath the surface of the earth. Such geologic disposal had first been suggested by the National Academy of Sciences in the 1950s. In 1980, it was compared against other options in an environmental impact statement and identified as the preferred alternative.

In the Nuclear Waste Policy Amendments Act of 1987, the Congress mandated that only one repository was to be developed at present and that only the Yucca Mountain candidate site in Nevada was to be characterized at this time. The Amendments Act also authorized the construction of a facility for monitored retrievable storage (MRS) and established the Office of the Nuclear Waste Negotiator and the Nuclear Waste Technical Review Board. After a reassessment in 1989, the Secretary of Energy restructured the program, focusing the repository effort on scientific evaluations of the Yucca Mountain candidate site, deciding to proceed with the development of an MRS facility, and strengthening the management of the program.

This Mission Plan Amendment is being made available in draft form for comment by Federal agencies, States, Indian Tribes, and units of local government; the utilities; the National Association of Regulatory Utility Commissioners; other interested parties; and the public. Once comments have been received and addressed, the Mission Plan Amendment will be submitted to the Congress.

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1. INTRODUCTION

We are responsible under the law for disposing of this Nation's spent fuel and high-level waste. To accomplish this mission, we are developing a waste-management system consisting of a geologic repository, a facility for monitored retrievable storage, and a system for transporting the waste.

Roughly 20 percent of our nation's electricity is generated by commercial nuclear power plants (Figure 1-1). Most of these plants use nuclear materials in the form of uranium fuel pellets encased in metal fuel rods. After the energy has been released from the fuel rods, they remain as a solid, highly radioactive waste called "spent fuel." They are removed from the reactor and put in storage, usually under water in a special spent-fuel pool at the reactor site. While spent fuel is safely stored now, it will remain radioactive for thousands of years and must be isolated from the human environment.

To date, a large quantity of the spent fuel—about 20,000 metric tons of uranium—has accumulated at reactor sites. By the year 2000, this amount will have doubled. By the time the last license for the current generation of nuclear reactors expires, an estimated total of 84,000 metric tons of uranium will have been generated.

Another type of waste that is highly radioactive and will remain so for thousands of years is high-level waste, most of which is generated in defense activities. Before disposal, this waste will be converted to a stable form (borosilicate glass) solidified in metal canisters. The quantity of high-level waste requiring geologic disposal is equivalent to about 9500 metric tons of uranium.

The United States must have a system for the permanent disposal of these wastes. Permanent disposal is important to protecting public health and safety and the environment, both at present and in the future. Furthermore, it is

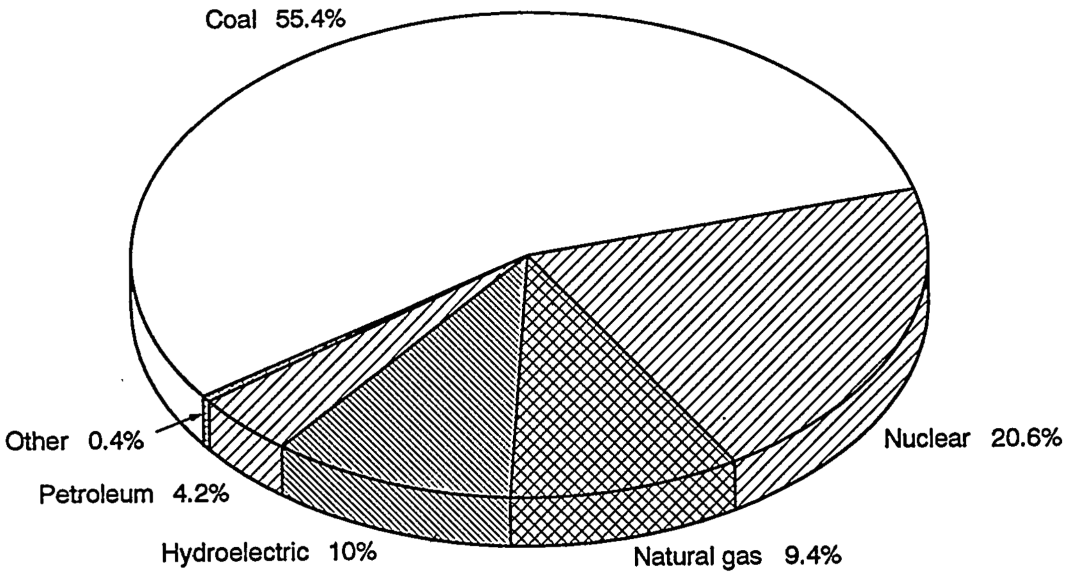


Figure 1-1. Share of electricity generation by source.

necessary to keeping a historical commitment that the problem of isolating waste* will not be left to future generations. And, as stated in the National Energy Strategy,[1] it is also important to removing institutional barriers to the development of nuclear energy.

In the Nuclear Waste Policy Act of 1982, the U.S. Congress assigned responsibility for providing permanent disposal to the U.S. Department of Energy (DOE) and created the Office of Civilian Radioactive Waste Management (OCRWM) for that purpose (Appendix A). The Act authorized the construction of one geologic repository in which the waste would be permanently isolated and specified in detail the process for siting that repository; in addition, the Act authorized the development of a waste-transportation system. The Nuclear Waste Policy Amendments Act of 1987 streamlined and focused the program. It specified one site—Yucca Mountain in Nevada—that was to be scientifically

*For brevity, the term "radioactive waste" or simply "waste" is often used in this document to mean spent fuel, high-level waste, or both.

evaluated as a candidate site for a repository, and it authorized the Department of Energy to site, construct, and operate a facility for monitored retrievable storage (MRS).

Our mission and how we plan to accomplish it

Our mission is to provide permanent disposal and to provide it in a manner that protects the health and safety of the public and of workers, and the quality of the environment. To this end, we are developing a waste-management system consisting of three components: a geologic repository in which the wastes can be permanently isolated deep beneath the surface of the earth, an MRS facility, and a system for transporting the waste. As shown in Figure 1-2, we will accept spent fuel at reactor sites and transport it to an MRS facility.

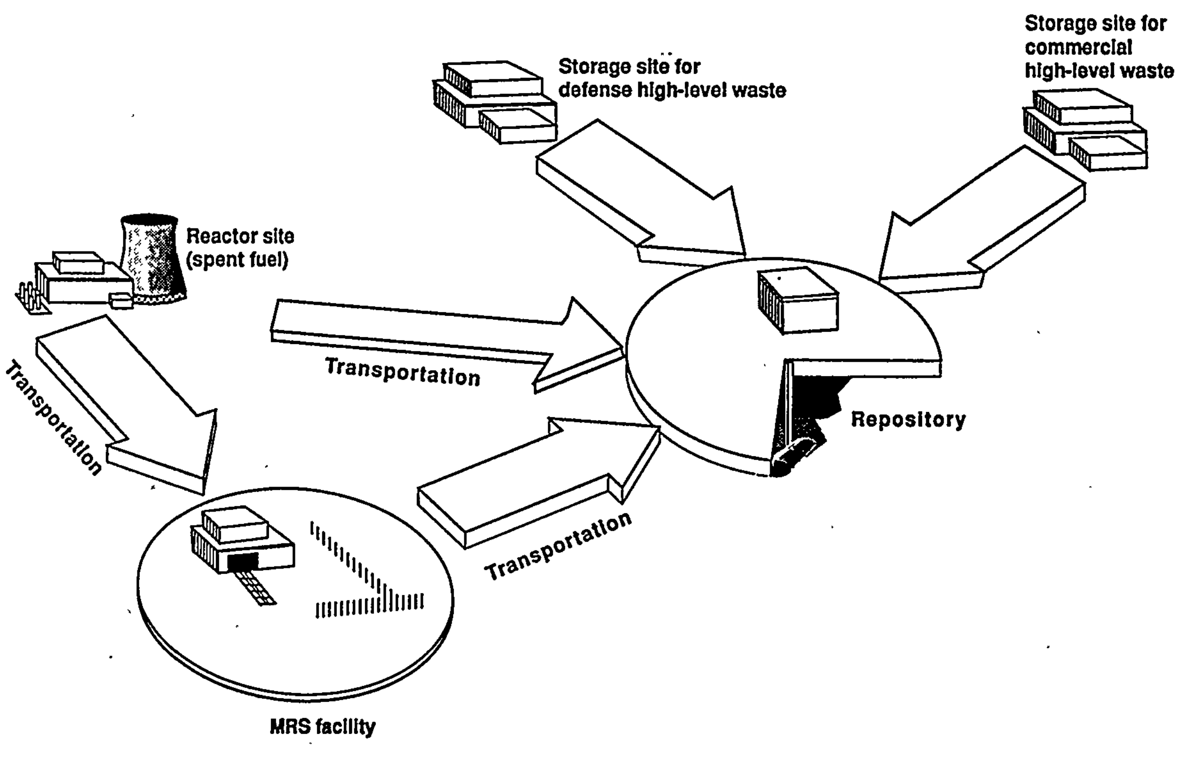


Figure 1-2. The waste-management system.

Assuming siting through the efforts of the Nuclear Waste Negotiator or removal of the statutory linkages to the repository schedule (see Chapter 5), this facility will start accepting waste by 1998, which is 12 years before the repository is scheduled to start operations. In 2010, when the repository is ready for operations, it will start receiving spent fuel from the MRS facility, though spent fuel from some reactors may be shipped directly to the repository, depending on the location of the reactor site and the MRS facility. Five years later, the repository will also start receiving high-level waste from the sites where this waste is stored.

2. FOUNDATIONS FOR THE PROGRAM

To provide foundations for the program, we have defined our mission and objectives, established the policies under which the program is to be conducted, and developed a set of strategic principles to provide guidance in program implementation.

Mission and objectives

Our mission is to manage and dispose of the nation's spent fuel and high-level radioactive waste in a manner that protects the health and safety of the public and of workers and the quality of the environment.

To direct the implementation of our mission, we have established the following objectives:

- Timely disposal capability: to establish as soon as practicable the ability to dispose of radioactive waste in a geologic repository licensed by the Nuclear Regulatory Commission.

- Timely and adequate waste acceptance: to begin the operation of the waste-management system as soon as practicable, obtaining the system-development and operational benefits that have been identified for the MRS facility.

- Schedule confidence: to establish confidence in the schedule for waste acceptance and disposal such that the management of radioactive waste is not an obstacle to the nuclear-energy option.

- System flexibility: to ensure that the program has the flexibility necessary for adapting to future circumstances while fulfilling established commitments.

Basic policies

The basic policies under which the program is conducted are as follows:

- The protection of the health and safety of the public and of workers and the quality of the environment is of paramount importance.
- The program must be conducted such that public confidence is warranted, with opportunities and means provided for meaningful participation by affected governments and interested parties.
- The program must be distinguished by its technical integrity and excellence and directed at reaching scientific consensus and public understanding.
- The program must be managed and conducted in an efficient and cost-effective manner.

Strategic principles

In developing implementation strategies and plans for the restructured program, we began by considering a number of strategic principles and identifying issues of strategic importance. And because we expect these principles to provide a long-term foundation for our program, we asked for comments from various affected governments and interested parties. Three workshops with these parties gave us the benefit of their views; they also enabled the parties to consider the views of one another. As a result of the discussions, we have established a set of strategic principles that will be used to guide decisionmaking in the program.

The principles will serve as guides for the more-detailed plans and studies that we will need to successfully conduct waste-management activities. In view of the complexity of the program and its first-of-a-kind nature, we will use the principles as guides for decisions and actions rather than rigid constraints.

Management principles

Maintain the focus of the program on permanent disposal

Disposal is the primary objective, it is our principal responsibility under the law, and success in achieving it is vital to maintaining the nuclear energy option. All program activities must be conducted in a manner that supports and facilitates permanent disposal.

Provide facilities for the timely acceptance of spent fuel

This principle is critical to achieving timely and adequate waste acceptance and obtaining the system-development and operational benefits that have been identified for an MRS facility, including the flexibility essential for spent-fuel management.

Maintain strict environmental-compliance programs

Preliminary analyses indicate that the development of facilities and waste-management and disposal operations are not likely to result in significant environmental impacts. Nonetheless, this principle is important because its implementation will ensure that we give environmental protection priority and that we closely monitor field activities for compliance with all applicable environmental-protection standards.

Ensure that funds are spent in a cost-effective manner

Given that standards of excellence are established and applied, we must maintain effective means for controlling the costs of the program. This principle will be based on optimizing the use of resources over the long term, recognizing potential impacts on the waste-management efforts of the utilities, and evaluating potential impacts on public confidence.

Maintain standards of excellence

Technical excellence has always been a fundamental requirement of the program, and its importance increases with the increasingly difficult challenges that arise as the program moves forward. It is essential for success in licensing, establishing scientific consensus, increasing public confidence, and the prudent management of resources. We will apply standards of excellence to all other aspects of the program, including institutional activities, outreach, and management.

Ensure that all quality-assurance requirements are met

Quality assurance comprises the planned and systematic actions necessary to provide adequate confidence that the product or result of an activity covered by a quality-assurance program will meet its intended purpose and/or function; it is a prerequisite for licensing. The extent to which quality assurance and procedural controls will be applied to particular items and activities will depend on their relative importance to safety, waste isolation, or program objectives.

Consider public trust and confidence in program decisions

In making management, technical, and institutional decisions for the program, we must recognize the importance of public concerns and address the potential implications for building and maintaining public trust and confidence.

Assign equal importance to institutional and technical activities

The history of the program has shown that institutional challenges are as difficult as the technical ones, and we must recognize their importance in program plans, activities, and resource allocations.

Diminish uncertainties related to spent-fuel management by the utilities

We will identify system parameters that may affect utility efforts or plans for spent-fuel management as early as practicable. We will maintain effective channels of communication with the utilities.

Provide alternatives and contingency plans

We need this principle to ensure success despite the inevitable surprises and unexpected problems that will arise in a complex, first-of-a-kind enterprise. It requires that we analyze in parallel alternatives to key components of the system so that, if our primary candidate encounters difficulties, we can come up with a workable alternative with minimized delay. It also requires that we anticipate the difficulties that might be encountered and that we develop in advance plans for minimizing their effects. While the provision of backups and contingency planning increase the initial costs of the program, they are insurance against unforeseen problems that could otherwise lead to delays and real or perceived programmatic failure.

Coordinate the technical, institutional, and management activities of the program

Implementation of this principle should enhance the integration of technical and institutional activities, contribute to the control of program schedules, and enhance the prospects for the success of the mission.

Assess our own performance rigorously

To objectively determine the adequacy of our performance and how it can be improved, we will maintain an assessment program. We will apply performance measures systematically and periodically to determine how we can remedy inadequacies and further strengthen our efforts.

Technical principles

Apply the concept of safety through defense in depth in waste management and disposal

We will emphasize safety in the design and planning for all operations involving waste handling, include backup safety systems and fail-safe designs where appropriate, and use multiple barriers against waste migration. In addition to protecting public health and safety and the environment, this approach should facilitate licensing and help to establish public confidence in safety.

Use state-of-the-art systems-engineering techniques in developing and designing waste-management facilities and operations

Systems engineering is an orderly process for the development of complex systems. It consists of defining objectives and requirements, developing a design that meets the requirements, evaluating the design against the requirements, revising the design as needed, and repeating the process with increasing detail to ensure that the requirements are complete and satisfied by the system and its components. Important features of the process are its emphasis on ensuring that all components work together, on special studies of the entire system's ability to meet requirements, and on rigorous control of the technical information used in the process. Systems engineering is essential for the success of the program because it provides the means for identifying and controlling the many interfaces among the elements of the system, coordinating the multiple scientific and engineering disciplines involved in the program, and optimizing the design and operation of the system.

Use simple and proven designs and technologies

The use of simple and proven technologies, particularly those already licensed by the Nuclear Regulatory Commission, and the use of designs that approximate those of licensed facilities should facilitate licensing and increase cost effectiveness. This principle is applicable to an MRS facility, a repository, and a transportation system.

Provide for outside review

The purpose of this principle is to ensure that, in resolving important issues and making important decisions in the program, we have the benefit of appraisal by outside experts. Such appraisal, which includes peer reviews, is important in verifying or validating assumptions, plans, results, or conclusions critical to the success of a program. It bolsters technical confidence and may also generate fresh ideas and approaches to problems. Furthermore, the use of recognized independent authorities strengthens our credibility. We will not limit the outside reviews to technical issues; we will extend them to institutional and managerial issues as well.

Institutional principles

Provide for the involvement of affected governments and interested parties in the decisionmaking process

As the organization charged with the development of the waste-management system, we have certain responsibilities that cannot be shared. One of these responsibilities is making technical and programmatic decisions. However, the views of affected governments and interested parties are essential to the decisionmaking process and will be actively solicited. The involvement of affected governments and interested parties early in the decisionmaking process will help us identify emerging issues and formulate appropriate alternatives. This will make issue resolution more productive and will also allow the program to benefit from the knowledge and experience of the affected governments and interested parties.

Work cooperatively with affected governments and interested parties

To foster productive links with affected governments and interested parties, we will consult and cooperate with them and will seek to exchange information and ideas. We will use cooperative agreements to bring additional groups into the program, both for technical advice and for the dissemination of information to their members.

Share information and data

We will share technical information and data on a timely basis and in an appropriate form. Particular attention will be given to the need of affected governments for timely information in a form useful to the conduct of their oversight responsibilities.

Provide support to educational programs

Greater understanding of the health, safety, and environmental issues surrounding waste management and disposal is key to the success of the program. It is also needed to help develop the skills necessary to meet the future human-resource needs of the program. We will implement this principle by stimulating the teaching of science at the secondary, undergraduate, and graduate levels and developing curricula and instructional materials—both print and electronic—for primary, secondary, and undergraduate studies. A related effort will foster undergraduate and graduate studies for the public-policy aspects of waste management.

Evaluate socioeconomic issues in cooperation with affected governments

We will apply standards comparable to those applied to environmental and technical issues, including independent review, to socioeconomic effects. We will also use the expertise of affected governments in identifying significant local issues, provide support to those governments to conduct their oversight responsibilities, and work with them to ensure that all significant issues are identified and considered.

In siting, designing, and constructing waste-management facilities, consider potential benefits to the host States and communities

The Nuclear Waste Policy Amendments Act of 1987 requires the Secretary of Energy, in siting Federal research projects, to give special consideration to proposals from States where a repository is located. It also authorizes the Secretary of Energy to enter into a benefits agreement with the State of Nevada concerning a repository or with any State or Indian Tribe concerning an MRS facility. Such a benefits agreement would include specific benefits, including enhanced program participation, identified in the Nuclear Waste Policy Amendments Act. Other benefits to jurisdictions willing to host a repository or an MRS facility could be developed through the Nuclear Waste Negotiator.

3. STRATEGY FOR THE PROGRAM

Because of our program's size, complexity, and duration, and the unprecedented challenges it faces, a program strategy is indispensable to the achievement of our mission. We have fashioned a strategy based on the protection of health and safety and the environment, public confidence, technical excellence, efficiency, and cost effectiveness.

Overall strategy for the program

We have used the foundations established for the program to define a strategy for accomplishing our mission. The strategy is directed at achieving the objectives presented in the preceding chapter: timely disposal capability, timely and adequate waste acceptance, schedule confidence, and flexibility. It is based on our policies and guided by the strategic principles formulated for implementing the program.

The strategy for accomplishing our mission revolves around two concepts: an integration of the waste-management system and a decoupling of the schedules for waste acceptance and waste disposal. Both concepts will help to achieve our objectives. Integration will result in a system in which each element and component is designed specifically to work with the other elements and components. To achieve integration, we will use systems engineering to rigorously identify the safety and functional requirements that the system and each of its elements must meet, and we will define our work so that all these requirements are met without extraneous efforts. This will allow us to develop the system in a timely, efficient, and cost-effective manner while meeting all requirements for safety and environmental protection.

Equally important is decoupling the schedule for permanent waste disposal, which requires the development and licensing of a geologic repository, from waste acceptance, which can be provided with a facility for monitored retrievable storage (MRS). This approach will not only allow us to provide timely and adequate waste acceptance but also help to meet the objectives of timely disposal capability, schedule confidence, and flexibility.

The advantages of decoupling waste acceptance from disposal stem from fundamental differences between a repository and an MRS facility. The repository is an unprecedented undertaking. It must safely isolate the wastes for thousands of years, relying principally on the natural barriers present at the site, and this capability for safe isolation must be demonstrated during licensing. Its development therefore requires years of scientific study to characterize the site, and challenges in licensing can be expected.

The MRS facility, on the other hand, will be a limited-lifetime plant whose safety is based on engineering, using simple and proven technologies and methods for handling and storing the waste. The uncertainties associated with its development and licensing should therefore be much smaller than those for the repository. Furthermore, since we plan to develop the MRS facility at a volunteered site, we expect a generally favorable institutional environment. In that case, the MRS facility would start receiving waste in 1998, or 12 years ahead of the repository.

The MRS facility will allow the orderly transfer of spent fuel to the Federal system, thus demonstrating the ability of the Federal Government to accept and manage the waste. It will also demonstrate our commitment to solving the waste-management problem. The institutional and licensing experience gained with the MRS facility will help in developing the repository, and the facility can serve as a flexible link between waste management at reactor sites and repository operations, thus increasing the flexibility and reliability of the total system. Finally, by providing both buffer storage and a central staging area for waste shipments to the repository in large-capacity casks hauled by dedicated trains, the MRS facility may enhance the efficiency of transportation.

Strategy for the geologic repository

To achieve the objective of timely disposal capability, we plan to develop a geologic repository licensed by the Nuclear Regulatory Commission. In the interest of protecting health and safety, the repository will be based on the principle of defense in depth—the use of backup safety systems and fail-safe designs where appropriate to protect both the workers and the public during repository operations and the use of multiple barriers, both natural and engineered, to provide the required isolation over thousands of years. The natural barriers will be provided by the characteristics of the site, and the engineered components will be designed specifically for the characteristics of the site. Our objective is stated in terms of achieving *disposal capability.* Once that is achieved, various strategies may be considered for the actual waste emplacement if they are deemed appropriate by the Commission and by affected and interested parties.

Given that safety is the primary concern, scientific investigations will be the focal point of the program, and they will not be subject to pressures from unrealistic schedules. However, we will strive to provide a repository as soon as practical.

Approach

Our strategy for achieving timely disposal capability addresses the unique technical and institutional challenges of developing a licensed geologic repository. In committing ourselves to meeting these challenges, we recognize that timeliness does not consist simply of meeting a preset schedule. To be timely, a repository must be supported by the scientific and engineering work needed to demonstrate its safety. For this reason, our strategy for providing timely disposal capability is based on the following approach:

We will strive for technical excellence in all our development efforts, using the best available expertise and methods and subjecting our work to rigorous review. An important role in the oversight of our program will be played by the Nuclear Waste Technical Review Board (see page 23). The development of disposal capability can advance properly only if our work can meet the scrutiny of the technical community, which should also contribute to public confidence.

Second, using systems engineering, we will ensure that the repository is properly integrated with other elements of the waste-management system and that all safety and functional requirements are met. We will also ensure that the activities we plan have a clearly defined purpose, including the scientific investigations we plan to conduct for site characterization, and that unnecessary activities are eliminated. Thus defined, the development of disposal capability will not incur delays that would arise from failing to identify work that must be performed or delays that would result from performing unnecessary work.

Third, we are initiating an institutional strategy (see page 21) aimed at expanding and improving interactions with affected governments, interested parties, and the general public.

We recognize that success in developing and operating the repository will depend to a large degree on our success in earning the trust and confidence of the public.

Fourth, we recognize the importance of keeping the program flexible. Because the repository program is a complex and unprecedented undertaking, the overall waste-management system must be designed and developed in a manner that permits both moderate and significant program changes to be accommodated. We will therefore design the system to provide such attributes as flexibility and adaptability. However, while pursuing the objective of flexibility, we will make a very deliberate effort to eliminate unnecessary options as soon as practicable. We are also developing a structured process for contingency planning.

We plan to continue management initiatives directed at improving efficiency and cost effectiveness. In this context, we expect significant benefits from the recently implemented contract for management-and-operating services. To contain costs, we plan to continually review all of our contracted work to identify activities that could be deferred, canceled, or consolidated as well as those that must be accelerated.

Activities

In the near term, the technical activities of the repository program will be focused on site characterization—scientific investigations directed at determining whether the candidate site at Yucca Mountain in Nevada (Chapter 4) is suitable for a repository. In the interest of technical integrity, these investigations will not be subject to unrealistic schedules.

An initiative under way is the development and early implementation of a method for evaluating site suitability. This approach may save time and resources by allowing us to modify our data-gathering and design programs to focus on characteristics identified as particularly important. And if the site should turn out to be unusable, we could end our Yucca Mountain program without further investment of time and resources.

We are deemphasizing major activities related to the designs of the repository and waste packaging until more information is available about the suitability of the site. The steps to be completed in design are the advanced conceptual designs, the license-application designs, and the final procurement-and-construction designs.

We are continuing to develop the tools and techniques needed for assessing the safety performance of the repository system. This effort will continue during site characterization, which will supply fresh insights into the phenomena that will or may occur at Yucca Mountain; moreover, the designs of the repository and the waste package will contribute additional information that must be taken into account. Nevertheless, the tools and techniques that we now have are adequate for tasks that require only the available insights and data. We have therefore begun making preliminary assessments for the early evaluations of site suitability and for guiding the site-characterization program. These preliminary assessments should advance consensus on the validity and applicability of the models we use in performance assessments.

To facilitate licensing, we are developing a licensing strategy. This strategy will include using conservative, simple designs and analyses; using available, qualified methods and approaches where possible; and gaining acceptance of methods, approaches, and assumptions by the technical community. The simple analyses will, however, need to be fully supported by the complex studies that the technical community will require in its detailed review of compliance; we also intend to perform a full set of detailed performance assessments.

Major decisions to be made

A number of decisions remain to be made in the repository program (Chapter 4). One of them is the following: should the heat load of the repository remain as currently conceived, or could an advantage be obtained from a lower heat loading? The latter would require the waste to be cooled for a long time before emplacement in the repository or a change in the design of the underground repository. Another major decision relates to the waste package: should we develop a waste package designed to exceed regulatory criteria by a significant margin? Such a waste package would reduce residual uncertainties about the safety of the repository over the long term and could contribute to public confidence, but it is likely to significantly add to costs.

Strategy for the MRS facility

To achieve the objective of timely and adequate waste acceptance, we plan to develop an MRS facility that is to start waste acceptance in 1998. To make this possible, the President's legislative package for the National Energy Strategy includes a provision to repeal the schedule linkages established in the Nuclear Waste Policy Amendments Act of 1987 (Amendments Act). This could also be achieved by congressional enactment of a negotiated siting agreement reached through the efforts of the Nuclear Waste Negotiator.

The MRS facility we envision will be safe, efficient, and cost effective. It will have built-in safety systems and redundant or diverse back-up systems. Contributing to efficiency and cost effectiveness will be the approach selected for MRS design and development. The technologies we have identified as feasible should allow an MRS design that can be easily implemented and licensed.

The Amendments Act allows a dual approach to MRS siting: (1) siting by the Department of Energy, through a process of survey and evaluation, and (2) siting through the efforts of the Nuclear Waste Negotiator. (The Negotiator, whose office was established by the Amendments Act, was appointed by the President and approved by the Senate in August 1990.) Our strategy is based on siting through the Negotiator, but we are developing a contingency plan for siting the MRS facility and will decide on the basis of the MRS schedule and status of external efforts as to the appropriateness of implementing that contingency plan. Technically suitable sites for the facility can be found throughout the continental United States.

In developing a proposed agreement with the Negotiator, a host can negotiate for itself an active role in MRS development and operations. By participating in decisionmaking and by exercising rigorous oversight of MRS activities, the host can assure itself that the MRS facility performs to its satisfaction, meets community standards, and serves community goals.

> ***The MRS facility will be safe, efficient, and cost effective. We expect that it will be sited through the efforts of the Nuclear Waste Negotiator.***

Our current plans are based on the statutory storage-capacity limits specified in the Amendments Act for an MRS facility sited by the Department of Energy: 10,000 metric tons before the start of waste acceptance at the repository and 15,000 metric tons at any time thereafter. This capacity would provide enough Federal storage, between the start of operations at the MRS facility and at the repository, to substantially reduce the need for utilities to add new storage capacity at existing facilities after 1998 and to be able to initiate the orderly decommissioning of reactors.

> ***The host can assure itself that the MRS facility performs to its satisfaction, meets community standards, and serves community goals.***

An MRS facility must have facilities for both handling and storing spent fuel, and there are several simple and proven concepts for these functions. We have identified more than 20 combinations of possible storage-and-handling concepts that would allow an MRS facility to be constructed quickly and meet our requirements. They vary in development time and costs. Some are modular; a facility based on these concepts could be constructed and ready to accept spent fuel in a year or less, and it could be expanded to increase the capability for fuel acceptance.

Licensing should be expedited by our choice of a simple and proven design. To further facilitate the process, we would prefer to use technologies already licensed or certified by the Nuclear Regulatory Commission or a design that closely approximates that of existing licensed facilities. Furthermore, to the extent practical, we plan to select a design that will be suitable for expedited licensing and certification and independent of site-specific conditions. We also intend to conduct prelicensing interactions with the staff of the Commission to identify licensing issues and begin working to resolve them. And to provide the staff of the Commission additional time for their safety review, we plan to submit the safety analysis report for the MRS facility some 12 months ahead of the license application.

Strategy for transportation

To help achieve the objective of timely and adequate waste acceptance, we are developing a transportation system. We plan to build on the experience and excellent safety record of radioactive-materials transportation in the United States to provide a transportation system that is safe, efficient, and acceptable to the public. As directed by the Congress, private industry will be used to the fullest extent possible in each aspect of transportation, including the development and procurement of shipping casks, the transportation support system, and associated services. The capability to accept and ship spent fuel will be established in time to support the start of MRS operations.

To ensure safety in transportation, we will, as required by the Amendments Act, use only shipping casks whose designs have been certified by the Nuclear Regulatory Commission, and we are therefore working with the Commission to address cask-certification issues. We will also comply with the regulations of the Commission regarding advance notification of State and local governments before transporting spent fuel or high-level waste.

> ***We recognize that the participation of interested parties is essential to foster public confidence in the safety of waste transportation.***

We recognize that the participation of interested parties is essential to promote better understanding and to foster public confidence in the safety of waste transportation. We will continue to work with interested parties to ensure that their concerns are identified, evaluated, and appropriately addressed. We use a variety of mechanisms and forums to provide opportunities for participation.

For shipping spent fuel from reactor sites to the MRS facility, we are developing new-generation casks, with capacities greater than those of existing casks, for shipments by both truck and rail or barge, and we are planning for the acquisition of existing casks to complement the casks being developed. We will also establish the capability for transportation operations. Besides the shipping casks and other equipment, this will require the procurement of the services of contractors who will arrange carriage, maintain equipment, inspect equipment, plan and schedule operations, and train personnel. In addition, we will provide technical assistance and funds to States for training the public-safety officials of local governments and Indian Tribes through whose jurisdictions wastes will be shipped.

Building trust and confidence

Recognizing that success in this undertaking will depend to a large degree on our success in earning the trust and confidence of the public, we are initiating an institutional strategy aimed at expanding and improving our interaction and our communication with affected governments, interested parties, and the general public.

With regard to interaction, our plans reflect a continuing effort to find additional and better ways to involve interested organizations and the public in our program, and particularly in providing input for program decisionmaking. We believe that interested parties will have more confidence in decisions in which they participate and that their participation will produce better decisions and ultimately a stronger program. We will therefore establish a Director's forum for representatives of affected governments, interested parties, and members of the public. The forum will meet regularly to exchange information and individual views on upcoming program decisions, policy alternatives, and the effectiveness of our institutional efforts. To support the work of the forum, we are establishing a process for identifying upcoming technical, institutional, and management issues of potential concern to affected governments and interested parties; working with forum representatives to select issues for consideration by the forum; and producing background information and analyses to help the forum consider issues.

Our communication plans focus on effective, two-way communication. They not only include efforts to improve the clarity, consistency, and timeliness of the information we provide but also recognize the need to listen and respond to what interested parties and the public are saying about our program.

Our plans recognize the need for continued financial support to affected governments so that they can conduct effective interaction and communication with us. We also recognize the need to allocate sufficient staff and other resources to meet our own responsibilities specified in these plans.

We are initiating an institutional strategy aimed at expanding and improving our interaction and our communication with affected governments, interested parties, and the general public.

To gain institutional experience in transportation, we will monitor the transportation program for the Waste Isolation Pilot Plant developed by the Department of Energy in New Mexico for the disposal of transuranic radioactive waste from defense activities. The purpose is to ensure a coordinated approach to transportation. And we intend to continue working closely with affected governments and interested parties to address the issues involved in developing the transportation system, such as the designation of preferred routes and training for emergency response.

Program oversight

Oversight for our program is provided by the Nuclear Regulatory Commission and the Commission's Advisory Committee on Nuclear Waste; other Federal agencies with jurisdiction or special expertise, such as the Environmental Protection Agency and the Department of Transportation; affected governments; and the Nuclear Waste Technical Review Board, which, as discussed below, plays a special role. In addition, we have traditionally used peer reviews by organizations both directly involved in the program and outside it, including the National Academy of Sciences, the national laboratories, and experts in particular areas. Our program is also examined by other entities, such as the

General Accounting Office, the utilities, and the National Association of Regulatory Utility Commissioners.

> ***The Nuclear Waste Technical Review Board not only provides valuable expertise that strengthens the program technically, it provides a forum in which affected governments and interested parties can observe technical deliberations.***

We intend to expand our current peer review of technical and institutional work. For those issues in which peer review is appropriate, we plan to implement a formal process for the selection of the members of peer-review panels to ensure independent and objective reviews. We intend to make our peer-review process as open as possible and document the program changes that result from peer reviews. We intend to respond to the recommendations of each peer review and to incorporate the recommendations that are deemed appropriate into our plans and operations. We will use the peer-review process in conjunction with applicable quality-assurance procedures, and the findings will be considered part of our management decisionmaking process.

The Nuclear Waste Technical Review Board is an independent group created by the Congress to review our technical work. The members of the Board are nominated by the National Academy of Sciences and appointed by the President of the United States. They are eminent experts in various scientific disciplines relevant to our program, and they have exercised their responsibilities actively. The Board holds numerous meetings open to the public and reports at least twice each year to the Congress and the Secretary. The Board not only provides valuable expertise that strengthens the program technically, it provides a forum in which affected governments and interested parties can observe technical deliberations. The oversight it provides for the program should help to earn the confidence of the public.

Management strategy

A fundamental element of our management strategy is managing for quality. It includes not only a formal program of quality assurance but also quality in all aspects of our work.

We have in place a quality-assurance program that meets the requirements of NQA-1, the consensus standard[2] for the application of quality assurance to nuclear facilities, and the requirements of the Nuclear Regulatory Commission.[3] The development and implementation of this program represents one of the largest and most concentrated commitments of time and effort since the inception of the waste-management program. Effective implementation of our quality-assurance program will ensure that activities involved in accomplishing our mission will be performed in a manner that protects the health and safety of the public and workers.

A program as complex and long-lasting as ours requires good planning and control. To provide this control we will use a set of integrated baselines—that is, reference sets of data and requirements that are strictly controlled—for technical work, costs, and schedules. These baselines are controlled at three levels of detail corresponding to the three levels in our management hierarchy: the Department level (the Chairman of the Energy System Acquisition Advisory Board, currently the Under Secretary), the program level (the Director of the Office of Civilian Radioactive Waste Management), and the project level. To control changes to the program, we have set for each baseline thresholds that may not be exceeded without approval by the appropriate level of management. And a change-control board has been established at each of the three levels of management; these boards are responsible for ensuring that the potential effects of proposed changes, including effects on costs and schedules, are identified and weighed in deciding to change a baseline. Significant deviations from a baseline require corrective action to remove or mitigate the problem or a change in the baseline to the extent necessary to accommodate the deviation.

To enhance efficiency and to assist in implementing the program, we have developed a management systems improvement strategy (MSIS).[4] This strategy relies heavily on a rigorous analysis to define in detail the functions to be performed by the waste-management system and each of its elements—the repository, the MRS facility, and the transportation system. The MSIS provides a framework that will enable us to accommodate the unique characteristics of the program and to accomplish our mission. It is expected to improve the technical baseline and other major management documents.

Included in the MSIS approach is the broadened use of systems engineering to plan, control, and integrate technical activities. Specifically, systems engineering is used to specify the sequence of technical activities necessary to define the requirements the system must satisfy, to develop the system, to relate the system elements to each other, and to determine how the system can be optimized to most effectively satisfy the requirements. It is an iterative process in which the system is evaluated and optimized at different phases of analysis and design in order to further define or refine the requirements. Its expanded use will allow us to evaluate and use the most appropriate technology and expertise to provide waste management and disposal in a manner consistent with our basic policies.

One of the benefits we expect from the management systems improvement strategy is an increase in cost effectiveness—a strategic principle for the program. Two aspects of cost effectiveness are important: one is cost-effective development and operation of the waste-management system; the other is cost-effective management. A key element for the latter is a sound basis and method for developing cost estimates. We therefore subject our cost analyses to regular external review.

We feel that, in addition to the external reviews discussed under "Program oversight," self-assessment is important and have made it a strategic principle. We will expand our current assessment program to objectively evaluate our performance. We will regularly and systematically apply performance measures to determine how we can strengthen our efforts. And we will involve external parties in the assessment program through a variety of mechanisms to assess how well we are doing in implementing our strategic principles.

Contingency planning

To help us in achieving the objective of flexibility, we are developing a structured and documented system of contingency planning. We recognize that contingency planning is vital to the success of a complex, controversial and first-of-a-kind effort like ours. Establishing a systematic and sustained process of contingency planning will help in making timely, informed, and cogent decisions.

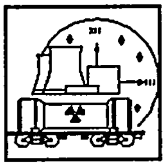
We have established a basic framework for identifying, screening, and analyzing contingencies, which include both potential obstacles to progress and potential opportunities for advancing our efforts. We have begun to compile an initial broad list of contingencies and developed and applied a set of screening criteria for determining priorities among those contingencies.

Among the situations to be addressed earliest is what we should do if we obtain all the permits for the activities needed to adequately characterize the Yucca Mountain candidate site but find that the site is neither suitable nor licensable. The law requires us to make recommendations to the Congress within 6 months after the site is declared unsuitable. In that context, we could evaluate a range of contingency measures, including, for example, laying the groundwork for a possible new site-selection process.

As already mentioned, we prefer the MRS facility to be sited through the efforts of the Nuclear Waste Negotiator. If protracted problems ensue or if the prospects of timely siting diminish, we will examine alternative approaches, including, for example, negotiating directly with potential volunteers; approaching private-sector third parties to site, design, construct, and operate a licensed MRS facility under contract; or pursuing a policy that facilitates other forms of interim storage.

We are, in short, establishing as a regular and integral part of the way we do business a step-by-step process for timely analysis and action on contingencies that could significantly affect, for good or ill, the achievement of our key goals and objectives. This process will involve defining contingencies of the highest priority, developing a full range of options, analyzing and evaluating those options, framing a final set of key options and recommendations, and laying out the timeframe for key decisions and actions on those options.

4. THE REPOSITORY



To provide permanent disposal for spent fuel and high-level waste, we plan to construct a repository deep beneath the surface of the earth and have been conducting investigations at a candidate site in Nevada to determine its suitability. Before the repository can be built, it will be necessary to determine, mainly through extensive testing both from the surface and underground, whether the repository system will be able to provide the required isolation over thousands of years.

To provide timely disposal capability, we will develop a geologic repository for spent fuel and high-level waste. Since these wastes remain radioactive for thousands of years, the repository will use defense in depth—that is, a system of multiple barriers, both natural and engineered—to isolate these wastes. In addition to providing isolation, the repository must be safe in operation, while it is receiving and handling the waste.

Before we can build the repository, however, we must determine whether the candidate site is suitable, design the repository and the packages that will contain the waste, and receive approval (i.e., a construction authorization and later a license to receive and possess waste) from the Nuclear Regulatory Commission (NRC). We also recognize that for the repository program to succeed, we must earn the trust and confidence of the public (Chapter 7).

What a repository is and what it will do

To accomplish its long-term mission, the repository will be a system of three components, with each component providing barriers for waste isolation. As shown in Figure 4-1, these components are the natural system, the repository, and the waste package.

The natural system, often called simply "the site," consists of the host rock in which the repository would be constructed and the surrounding rock formations. The repository portion of the system consists of various underground structures

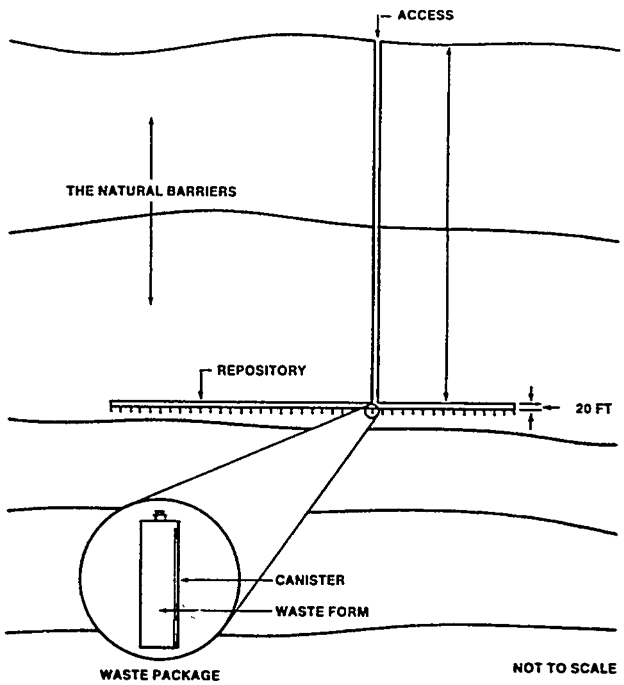


Figure 4-1. Artist's conception of the complete repository system.

and components, such as the structures used to seal the shafts and other openings to the underground and any material with which underground tunnels and disposal rooms may be backfilled after waste emplacement. The waste package consists of the waste form, the disposal container in which the waste form is encapsulated, and any other materials or features designed to separate the waste from the host rock.

A repository will consist of surface facilities, underground facilities, and shafts and ramps connecting the surface and the underground facilities (Figure 4-2). The purpose of the surface facilities would be to receive the waste and to prepare it for permanent disposal in the repository. The surface facilities would include a waste-handling building equipped for receiving and inspecting waste and transferring it underground. They would also provide various support functions, such as ventilation, utilities, and administration.

The underground facilities would be constructed at a depth of about 1000 feet below the surface. Our current conceptual design[5] shows three main horizontal passageways, or drifts, excavated parallel to one another. Each of these drifts

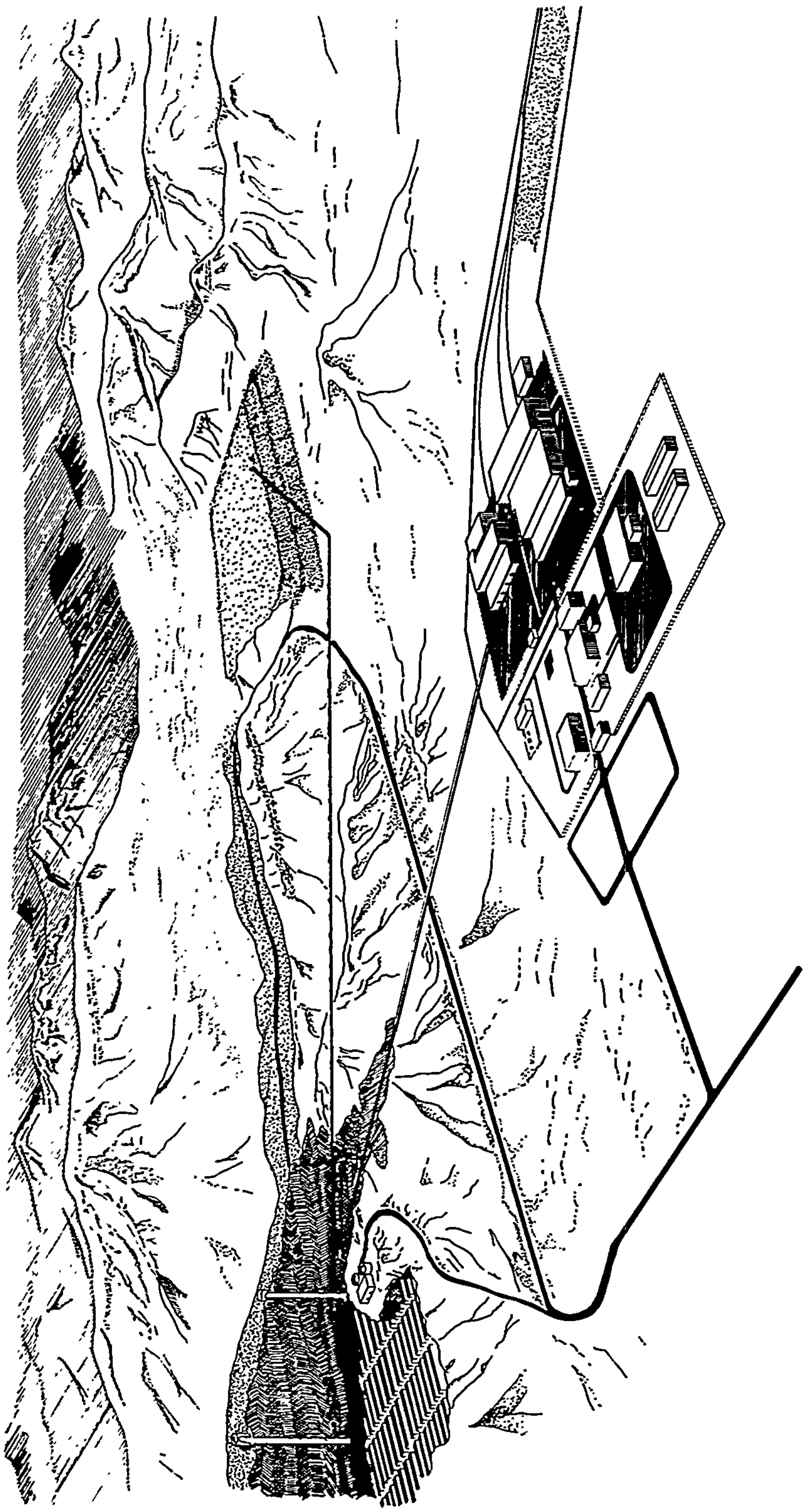


Figure 4-9. An artist's conception of a repository at Yucca Mountain, showing a cutaway view of the underground repository, the surface facilities, and, on the right, the two-tiered pile of rock mined out from the repository.

would serve a number of waste-emplacement panels, which in turn would consist of a number of rooms in which the waste would be emplaced.

When waste arrives at the site, it will be unloaded in the waste-handling building and transferred to a packaging station in a "hot cell," a room that is shielded against radiation and equipped with remotely controlled equipment. We would use the hot cell to load the waste into disposal containers. We would transfer the containers to another station, where they would be sealed, and move them to a surface vault for temporary storage before transfer underground and emplacement in the disposal rooms. We would use specially designed transfer casks and transporters for the transfer and emplacement operations.

The waste emplaced in the repository must be retrievable for up to 50 years after the start of emplacement operations, which are currently expected to last 26 years. An additional monitoring period of up to 24 years after the completion of emplacement operations may therefore be necessary to satisfy this requirement for retrievability. During both of these periods, we will conduct various tests to provide assurance that the repository is performing as expected. When these tests are completed, we will submit an application to the Nuclear Regulatory Commission for a license amendment to decommission and permanently close the repository. We will prepare the repository for closure by permanently sealing the shafts and ramps. The surface facilities will be decontaminated and decommissioned, and the surface above the repository will be returned to its natural state to the extent practicable. Permanent site markers must also be erected to warn future generations of the presence of a repository.

The siting of a repository

Because of the importance of the site to the performance of the overall repository system, we have spent many years in a search for repository sites. In 1983, a formal framework and process for this search were provided by the Nuclear Waste Policy Act (Appendix A). After the Act was signed into law, we formally identified nine potentially acceptable sites for the first repository. In May 1986, the Secretary of Energy nominated five sites as suitable for characterization and recommended that three of them be characterized to determine whether they were indeed suitable for a repository.[6] The three candidate sites were the Deaf Smith County site in Texas, the Hanford site in the State of Washington, and the Yucca Mountain site in Nevada. The Secretary's recommendation was approved by the President. However, in December 1987, when the Nuclear Waste Policy Act was amended, the Congress directed us to characterize only one site, the Yucca Mountain candidate site, and to stop all other siting activities elsewhere.

If the candidate site is found to be suitable, the Secretary of Energy will submit a report to the President recommending Yucca Mountain for development as a repository. In the reference schedule, this event is shown occurring in early 2001. By law, this report must be accompanied by a comprehensive statement of the basis for the recommendation; this statement is to include an environmental impact statement and is to be made available to the public. If the President approves, the recommendation will go to the Congress.

If the candidate site is found suitable and is recommended for a repository, the State of Nevada may submit a notice of disapproval to the Congress. This will prevent its use for a repository unless the Congress passes a joint resolution overriding Nevada's "veto" within the next 90 days of continuous session. If at any time we find that the Yucca Mountain candidate site is unsuitable, we will stop all work at the site and so inform the Congress, as required by law.

Within 60 days after the Congress has received this recommendation, the State of Nevada may submit a notice of disapproval to the Congress. This will prevent the development of the site as a repository unless the Congress passes a joint resolution of repository-siting approval within the next 90 days of continuous session. If the State's notice of disapproval is not overturned by the Congress, the candidate site cannot be used for developing a repository. If no notice of disapproval is submitted, or if a notice of disapproval is overturned by a joint resolution, then the site designation will become effective. At that time, the Secretary will submit a license application to the Nuclear Regulatory Commission, seeking authorization to construct the repository. In the reference schedule, this submittal is shown to occur in late 2001. The Commission will review the application and decide, on the basis of this review and information presented in hearings conducted under administrative law procedures, whether to authorize the construction of the repository. If authorization from the Commission is received, construction may begin.

If at any time during site characterization we find that the Yucca Mountain candidate site is unsuitable, we will stop all work at the site and so inform the Congress and the Governor and legislature of Nevada, as required by law. We will do the same if, at the end of site characterization, we reach the conclusion that the candidate site is unsuitable for a repository. We also must report to the Congress within 6 months our recommendations for further action to ensure the safe, permanent disposal of spent fuel and high-level waste, including the need for new legislative authority.

Status of the Yucca Mountain candidate site

The Yucca Mountain candidate site has not been selected for a repository. Rather, it has been designated by the Congress as the only candidate repository site to be characterized at this time. We will conduct a program of detailed investigations and suitability evaluations at the Yucca Mountain candidate site to determine whether it will be suitable for development of a repository. If the candidate site is found to be suitable, then we will have to demonstrate to the Nuclear Regulatory Commission that the repository system, including the site, meets regulations for radiation safety during operations and for long-term isolation. The plans, activities, and results of the investigations and evaluations program will be reviewed on a continuing basis by the affected governments, the Nuclear Regulatory Commission, the Advisory Committee on Nuclear Waste, the Nuclear Waste Technical Review Board, and others external to the program.

Strategy for developing the repository

In the near term, our repository program will be focused on the scientific investigations needed to determine whether the Yucca Mountain candidate site has any features that would indicate that it is not suitable for a repository. This site-characterization program will include surface-based testing and investigations conducted in an exploratory-studies facility constructed to provide access to

The Congress directed us to characterize one site, Yucca Mountain in Nevada. But Yucca Mountain is only a candidate site. It has not been selected for a repository, and it cannot be selected until we complete extensive studies of its suitability.

the underground rock formation in which a repository would be built. In keeping with our commitment to technical excellence and integrity, the site-characterization program will be free from the pressures of unrealistic schedules.

We will also continue to develop our capability for performance assessment—the analyses needed to demonstrate that the repository would meet regulatory requirements designed to protect health and safety. We are using preliminary performance assessments to guide site characterization and to assist in the early evaluations of site suitability.

As part of our licensing strategy, we intend to continue frequent interactions with the staff of the Nuclear Regulatory Commission to define issues and strive for early resolution, before the submittal of the license application.

We are deemphasizing new design work on the repository and the waste package. Full-scale design activities will be resumed after more data from site characterization are available.

Description of the Yucca Mountain candidate site

The Yucca Mountain candidate site is in Nye County, in southern Nevada, approximately 100 miles northwest of Las Vegas (Figure 4-3). The site is in an arid region with sparse vegetation and few people (Figure 4-4). It is on various Federal lands (Figure 4-5): public lands managed by the Bureau of Land Management of the Department of the Interior; the Nellis Air Force Range, which has been withdrawn from the public domain for use by the Air Force

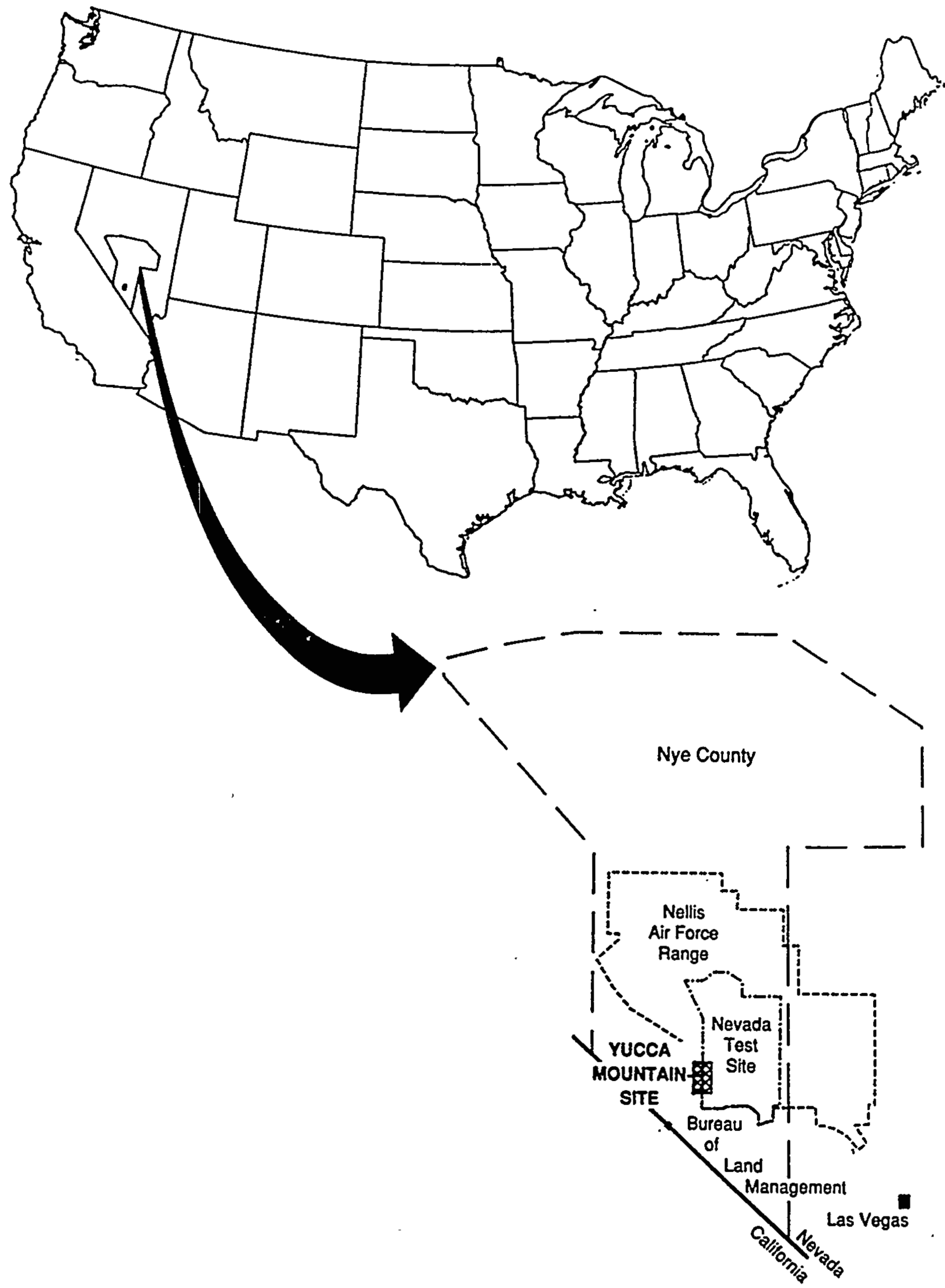


Figure 4-3. Location of Yucca Mountain candidate site.

Figure 4-4. Yucca Mountain.

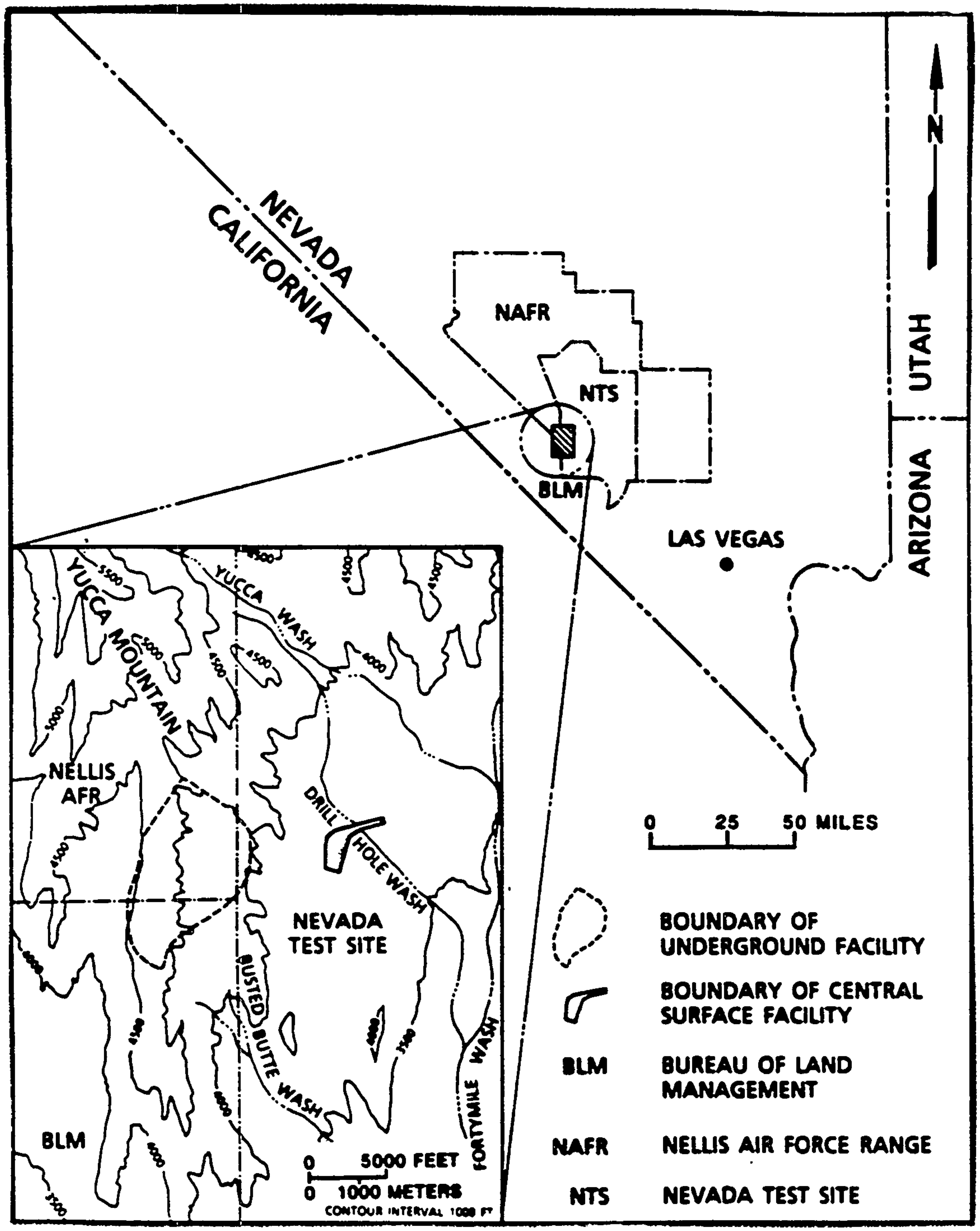


Figure 4-5. Boundaries of the Yucca Mountain candidate site.

(the Department of Defense) but is managed by the Bureau of Land Management; and the Nevada Test Site, which has been withdrawn from the public domain and reserved for use by the Department of Energy.

At the Yucca Mountain candidate site, it would be possible to construct a repository in the "unsaturated zone"—the rock mass between the surface of the land and the water table. The unsaturated zone is thick enough to allow the construction of a repository from 660 to 1300 feet above the water table. Because the rocks in which the potential repository would be located are unsaturated (i.e., the pores within the rocks are not completely filled with water), the amount of ground water moving through the rocks is expected to be very small. This characteristic is important because the flow of ground water is the most likely mechanism for transporting radionuclides from a repository to the accessible environment.

The purpose of site characterization is to obtain the information needed to determine whether the candidate site is suitable for a repository; to develop more-advanced designs for the repository and the waste package; and if the site is suitable, to demonstrate that the repository will comply with licensing requirements.

However, we must learn about the rates, pathways, and mechanisms of groundwater flow in the unsaturated rocks. Concern has also been expressed about the potential for the natural hazards of volcanism, faulting, and earthquakes to occur during the period of waste isolation and, depending on the nature of the event, to affect the ability of the site to isolate the waste. In addition, we must assess whether the site is likely to contain any mineral resources that could attract exploration in the future. Activities associated with such exploration could compromise the integrity of the repository.

Site characterization

Site characterization is required by the Nuclear Waste Policy Act, by the siting guidelines[7] we issued as 10 CFR Part 960 and by the regulations of the Nuclear

Regulatory Commission in 10 CFR Part 60.[8] Its purpose is to acquire the data that will allow us to evaluate whether a repository at Yucca Mountain can be operated without undue risk to the public and workers and can provide safe isolation over the long term. In particular, its purpose is to obtain the information needed to (1) determine whether the candidate site is suitable for a repository; (2) develop more-advanced designs for the repository and the waste package; and (3) if the site is suitable, demonstrate to the Nuclear Regulatory Commission that a repository at the candidate site will comply with licensing requirements.

To occupy and use land for site characterization, we have been granted a right-of-way reservation for a portion of the public lands managed by the Bureau of Land Management. The right-of-way to a portion of the Air Force lands also managed by the Bureau (Figure 4-4) was received on October 11, 1989.

On December 27, 1988, we filed an application with the Bureau of Land Management for administrative withdrawal of approximately 4255 acres of public land at the Yucca Mountain candidate site. The purpose of this withdrawal is to prevent interference with site characterization and to ensure that scientific studies for site characterization are not invalidated. The Bureau published a notice[9] of the withdrawal proposal on January 13, 1989, and at that time the lands were segregated from the public-land laws, including mining laws, for a period of 2 years pending a final decision by the Secretary of the Interior. Effective September 25, 1990, the Bureau issued Public Land Order 6802 withdrawing this land from mining and mineral leasing laws for a period of 12 years.[10]

Because Yucca Mountain is inhabited by the desert tortoise, a threatened species, it was necessary to gain approval from the Fish and Wildlife Service to conduct site characterization. The Service has issued an opinion that the proposed activities are not likely to jeopardize the continued existence of the desert tortoise.

We have had difficulty with obtaining from the State of Nevada the environmental permits needed for site-characterization activities like drilling and the construction of an underground exploratory-studies facility. (Following litigation, the State issued an air-quality permit in June 1991 and an undergroundinjection-control permit in July 1991.) Recognizing the importance of proceeding with the repository program, the President has included in the legislative proposals for the National Energy Strategy[1] provisions that the appropriate Federal agencies, rather than the State of Nevada, process the requisite environmental permits.

The Site Characterization Plan

In accordance with the Nuclear Waste Policy Act, we prepared a detailed Site Characterization Plan (SCP) to investigate the suitability of the candidate site, provide data for the designs of the repository and the waste package and ultimately to provide data for licensing. A consultation draft of this plan was released in January 1988[11] for comment by the Nuclear Regulatory Commission and the State of Nevada and was made available for review by other parties. We revised the SCP to reflect the comments received during the comment period and our own internal review. The statutorily required SCP was submitted in December 1988 to the Nuclear Regulatory Commission and the Governor and the Legislature of the State of Nevada for their review and comment.[12] The SCP was also made available to the affected units of local government, other interested parties, and the public. Public hearings were held to receive public comments on the SCP.

The SCP presents an orderly and strategic framework for site characterization that is based on regulatory requirements for siting and licensing. The SCP has also been useful as a vehicle for early interactions with the NRC staff and other external review groups on a spectrum of technical issues.

The SCP is a comprehensive multivolume document that discusses, and presents the rationale for, more than 100 studies comprising some 300 separate activities. More-detailed descriptions will be given in study plans, which we are preparing for each study. Approximately, half the studies outlined in the SCP involve surface-based testing, roughly 10 percent involve in-situ testing or other underground studies in the exploratory-studies facility, and the remainder are mainly laboratory and modeling studies.

Issuing the SCP was a major milestone in the repository program. The SCP presents an orderly and strategic framework for site characterization that is based on the regulatory requirements for siting and licensing. In addition to guiding the scientific investigations at Yucca Mountain, the SCP is useful as a vehicle for early interactions with the NRC staff and other external review groups on a spectrum of technical issues.

To ensure that all the required information will be collected and available when needed for design or performance assessment, we used two organizing principles for the site-characterization program: the issues hierarchy and a general strategy for issue resolution. The issues hierarchy was developed from the DOE siting guidelines in 10 CFR Part 960 and the NRC regulations in 10 CFR Part 60; it provides a basis for planning a site-characterization program and for explaining why the planned program is adequate and necessary. To resolve the issues in the issues hierarchy, we have adopted a general strategy that guided the development of specific plans for resolving each issue. This general strategy consists of four distinct parts: issue identification, performance allocation, data collection and analysis, and the documentation of issue resolution. Detailed descriptions of this general strategy and the specific strategies developed for each issue are given in Chapter 8 of the SCP, and brief summaries of the strategies can be found in the SCP Overview.[13]

Key issues to be resolved during the site-characterization period:

1. ***Would a repository at Yucca Mountain safely isolate the waste over the long term?***

2. ***Would the repository be safe during active operations, meeting regulatory requirements for radiation safety?***

3. ***Would the construction, operation, closure, and decommissioning of a repository at Yucca Mountain be feasible with reasonably available technology?***

The SCP is the initial effort at constructing a site-characterization program by deriving it from the needs of the rest of the repository program. Changes, reevaluations, and redirections are an indispensable part of site characterization, and we have plans, such as the Test and Evaluation Plan,[14] for bringing them about. Changes to the site-characterization program will be considered when new data have been obtained, analyses have been completed, or comments from both internal and external sources are received. Such changes will be documented in new or revised study plans and reported in the periodic progress reports that we are required to prepare and issue during site characterization. These reports are to be submitted to the Nuclear Regulatory Commission, the Governor and the legislature of the State of Nevada, and affected units of local government. We also make them available to the public.

Major initiatives in site characterization

We have recently taken major initiatives in our plans for site characterization. The most important of these are establishing a process that will result in early evaluations of site suitability, discussed below, and improving the design for the underground testing facility, discussed on page 44. To this end we have performed an initial evaluation of priorities for site-characterization tests and evaluated alternatives for the underground testing facility. In addition, we have completed an evaluation of the risks and benefits of investigating the rock layers beneath the candidate repository horizon. These three tasks were coordinated to ensure consistency among analytic approaches, where appropriate, and consistency in assumptions and data.

> ***We recognize the importance of making early evaluations of site suitability and have changed the priorities for our site-characterization program to focus on those features or conditions that might indicate the candidate site is not suitable.***

Early evaluations of site suitability

We recognize the importance of making early evaluations of site suitability and have changed the priorities for the site-characterization program to focus on those features or conditions that might indicate the candidate site is not suitable. If the early evaluations indicate that the candidate site merits further study, we will continue our investigations, making additional evaluations as more information is collected and as performance-assessment tools are refined. Early evaluations of site suitability, made before completing an extensive testing program, will enable the site-characterization program to be as cost effective as possible.

We have developed an activity plan for the early evaluation of site suitability. In accordance with this plan, a core team of experts is developing a general method for site-suitability evaluations and applying this method to the early assessment of the Yucca Mountain site.

The principal basis for these early evaluations will be the DOE siting guidelines in 10 CFR Part 960.

The principal basis for this early assessment (and for later evaluations if we continue with site characterization) will be the siting guidelines we issued as 10 CFR Part 960. The siting guidelines specify both disqualifying and qualifying conditions for characteristics important to the near- and the long-term safety of a repository, such as geohydrology, geochemistry, climatic changes, and tectonics.

An evaluation of the suitability of the candidate site was conducted in 1986 and reported in the environmental assessment of the site.[15] That 1986 assessment reviewed the available information about the site and evaluated the ability of the site to meet each guideline. We have collected more information since that assessment. Our current evaluation will use this new information along with the information available in 1986.

We will submit the evaluation method and the results of the early evaluation to a peer review. We also plan to seek the involvement of affected governments and interested parties in the early evaluation of site suitability.

Setting new priorities for testing

We have recently completed an extensive evaluation of the priorities for surface-based and in-situ testing.[16] This evaluation was performed by a task force that had two main objectives:

1. To develop a method that can be used throughout site characterization to reevaluate priorities for testing as new information is gained.

2. To establish testing priorities by evaluating the relative importance of potential concerns and the effectiveness of tests that could investigate these concerns.

The potential concerns are derived from the potentially adverse conditions and disqualifying conditions identified in the siting guidelines, the potentially adverse conditions identified in the NRC regulations (10 CFR Part 60), and other significant conditions that could lead to a finding that the candidate site is unsuitable.

The initial phase of the test-priorities task focused on concerns about the performance of the repository over the long term, after permanent closure. The methods that were developed and used by the task force were based on a formal decision analysis, including probability assessments and probabilistic analysis as essential features. The task force considered the likelihood that specific unsuitable conditions or surrogate indicators of those conditions are present at the candidate site; the estimated consequences (releases of radioactive material) if those conditions or indicators are present but not detected; and confidence in the accuracy of tests for detecting those conditions or indicators.

The task force adopted an iterative and phased approach to determining priorities, which produced an initial set of recommended test priorities on an expedited schedule. We have examined these initial recommendations and have considered them in establishing priorities for early site-characterization activities. Consequently, our emphasis at the candidate site will be on two things:

1. The information needed to determine the potential for gaseous releases over the long term.

2. Studies to resolve the geologic complexity of the site as related to radionuclide migration by ground-water transport.

We also intend to begin onsite prototype dry drilling and coring followed by drilling into the unsaturated zone as soon as the necessary permits are received.

The exploratory-studies facility

We will construct an exploratory-studies facility (ESF) at Yucca Mountain to provide access to the potential host rock for a repository and evaluate the geologic, hydrologic, geochemical, geomechanical, and thermal conditions in the potential host rock and the surrounding units. This facility, originally called the "exploratory-shaft facility," was to consist of two vertical shafts, an underground test facility, and horizontal drifts excavated underground to characterize the major geologic structures.

In reviewing our plans, the Nuclear Regulatory Commission and the Nuclear Waste Technical Review Board recommended that we should consider extending the exploratory drifting to ensure that the data collected are representative of the site and to identify structural features that may not be detected from the surface.[17] The Board also suggested using mechanical mining to minimize the potential for interference resulting from disturbances of the host rock and to accelerate the underground excavations.

These recommendations led to a major undertaking known as the ESF alternatives study, which we have recently completed. The study was a comprehensive, formal evaluation of configuration and construction alternatives for the exploratory-studies facility. This study also considered preferred repository options to the extent necessary to ensure coordination of the exploratory-studies facility and the repository.

The ESF alternatives study was designed to select from alternative ESF and repository configurations those that would most nearly meet the following objectives:

1. Maximizing the value of the information that tests in the exploratory-studies facility could provide.

2. Maximizing the ability of the ESF-repository combination to comply with the regulations that govern a repository system.

3. Minimizing the adverse effects that the ESF-repository combination will have.

To examine the ability of each configuration to meet the first two objectives, we convened a panel of experts familiar with the proposed testing program, its objectives, and the details of the alternative configuration. The members of the panel, using formal decision-analysis procedures, considered all the characteristics of a configuration that might contribute to the outcome of testing in it. This process produced numerical ratings for the alternatives. Among the ESF alternatives rated highest were the alternatives in which testing had the smallest probability of producing false results—that is, of incorrectly rejecting a suitable site or of incorrectly accepting an unsuitable site.

The second objective was handled in a similar way. Experts rated each configuration on its ability to contribute successfully to the licensing process.

The evaluations against the third objective used a different method that required somewhat more elaborate input from a number of expert panels. Separate panels evaluated each ESF-repository combination for several types of potentially adverse effects it might exert on postclosure health and safety, preclosure health and safety, the environment (i.e., aesthetic, historical, and biological properties of the site and its surroundings), the socioeconomic structure of the surroundings, the cost of the repository system, and the construction schedule. The panels produced a rating that expressed, for each configuration, its ability to minimize adverse effects.

An important feature of the methods used in the ESF alternatives study is their ability to allow detailed study of the ratings. With the detailed information produced in the study, it is possible to determine which of the evaluation topics have the most important effects on the ratings and to examine the effects of changing the assumptions made in the studies. Examinations like these can give confidence that the studies themselves are adequate and that the results are not unduly dependent on quantities that cannot be well understood until site characterization has produced additional data.

We will decide on the configuration for the exploratory-studies facility when full documentation is ready, the recommended alternative is analyzed in terms of the requirements identified through a functional analysis, and preliminary design studies have been completed. This entire process has been discussed comprehensively in public meetings with the Nuclear Waste Technical Review Board and with the NRC staff. Once the final selection is made, we will proceed with the detailed design of the exploratory-studies facility.

The Calico Hills study

We have also conducted a study, closely coordinated with the ESF alternatives study, to determine whether in-situ testing should be conducted in the Calico Hills rock unit that lies below the candidate repository horizon. This study resulted from a recommendation by the NRC staff that we conduct analyses that would further investigate the effects of penetrations into the Calico Hills unit. We therefore made a commitment to analyze the benefits of testing and the possible risk of affecting the performance of the site by penetrating the Calico Hills unit. We also made a commitment to consult with the NRC staff regarding the results of these analyses before excavating in the Calico Hills unit.

The initial steps in the Calico Hills study included summarizing the types of data that would be needed from the Calico Hills unit, identifying applicable testing techniques, developing alternative testing strategies, and finally establishing and implementing a method for a comparative evaluation of the testing strategies. The primary recommendation resulting from the study is that the capability for extensive drifting and testing in the Calico Hills unit within the potential repository block should be accommodated in the design of the exploratory-studies facility.

The results of the ESF alternatives study, which incorporate the recommendations of the Calico Hills study, indicate that an exploratory-studies facility providing access to both the candidate repository horizon and the Calico Hills unit through mechanically excavated ramps could provide advantages over the original configuration of the exploratory-studies facility.

Activities planned for site characterization

Surface-based testing

New surface-based testing will consist of two general types of activities: tests performed at the ground surface and tests performed in boreholes. In addition, samples obtained from both the surface and underground will be tested in laboratories. These tests are described in Section 4.1 of the SCP Overview.[13] Some new surface-based-testing activities will require site preparation, including the construction of access roads and graded pads for deep drilling.

Mapping. We plan extensive mapping of various geologic features in the area of Yucca Mountain. In addition to gathering detailed geologic data, this activity will provide information about hydrologic conditions by identifying surface fracture systems that may be correlated with underground fracture systems. Large-scale geologic mapping will cover about 50,000 acres. We will do detailed surface mapping of rock types and landforms at the candidate site; we may dig some soil pits to support this effort. In addition, we will map exposed bedrock and measure faults and other fractures. These studies will not require trenching or drilling, but they may require some clearing of the surface material over the bedrock.

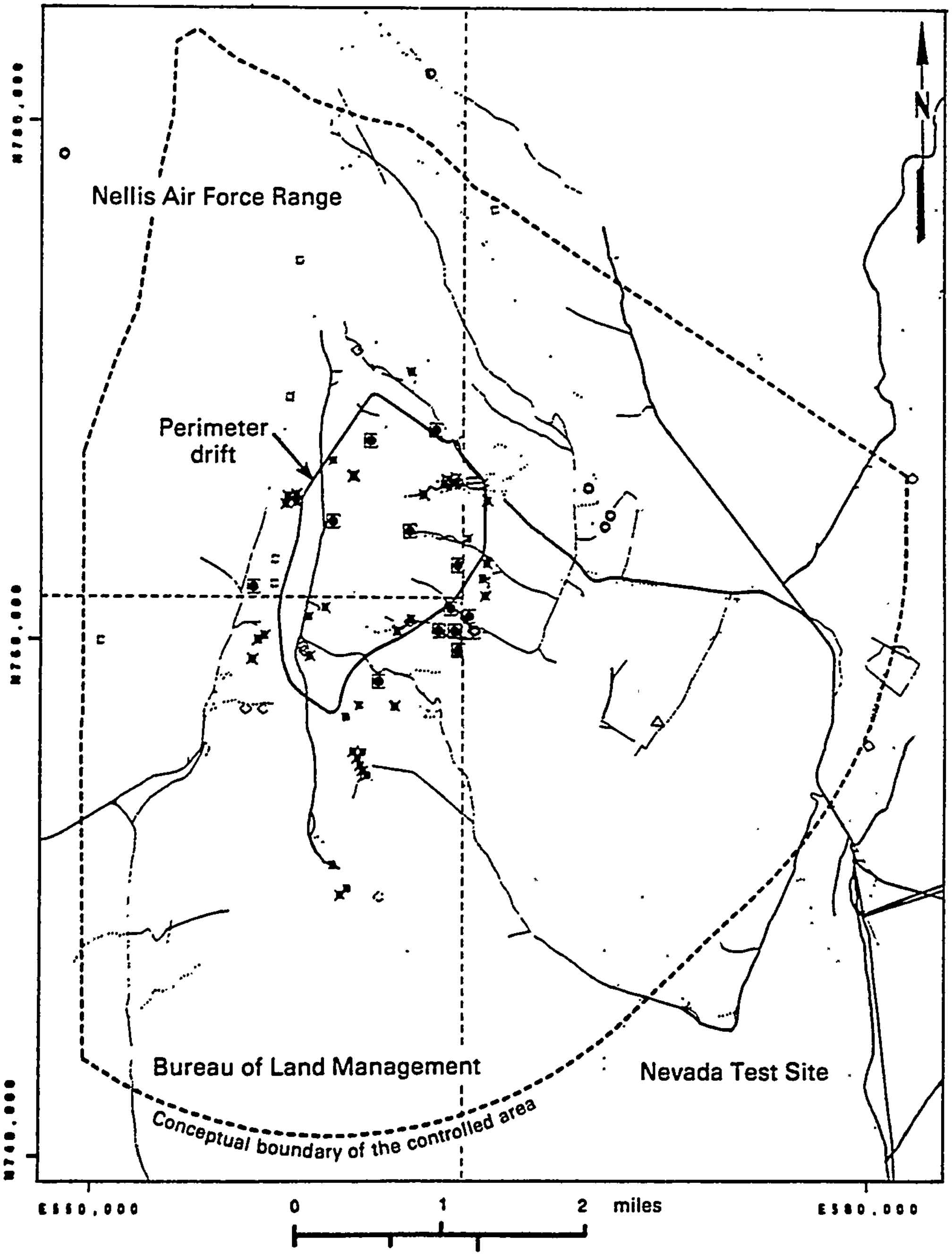
Trenching. Trenching is used for detailed studies of faults and the characteristics of soils and rocks; it is also used to examine any evidence of past climates, because it allows geologists to directly observe a continuous geologic section. In the area of Yucca Mountain, we plan to excavate approximately 25 new trenches (about 40 trenches have already been excavated) in order to determine the timing of faulting, the amount of fault displacement, and to look for any evidence of recurrent displacement. The study of surface characteristics and investigation of evidence of past climates will also require new trenches, possibly as many as 40, but these trenches will be shorter, and shallower, than those excavated for fault studies. These trenches will be excavated by bulldozers or backhoes. Their locations will be selected from aerial photographs and field reconnaissance.

Geophysical surveys. Geophysical surveys performed at the surface will provide underground information on faulting, and the spatial distribution of rock characteristics and structures away from boreholes. One technique, seismic surveying, should help establish the two- and three-dimensional patterns of faults, lateral and vertical changes in rock characteristics, the extent and thickness of surficial deposits, and the nature of deep structures under the rocks being considered for the repository. Other geophysical surveys will measure gravitational and electromagnetic characteristics and detect anomalies. The integrated approach to using different geophysical and geologic methods that we will conduct will allow greater precision in determining the geometry and characteristics of structural and stratigraphic features.

Exploratory drilling. Exploratory drilling is used to characterize underground conditions from the surface. At Yucca Mountain, we will use exploratory drilling to reduce uncertainty in conceptual models of geologic and hydrologic conditions by determining how geologic, hydrologic, geomechanical, and geochemical conditions vary over the area of the site. We will use cores, geophysical logs, and other testing data from boreholes to infer the lateral and vertical distribution of the physical parameters needed for preparing three-dimensional models of the site.

The surface-based drilling program is divided into two major parts: feature drilling and systematic drilling. The locations of feature-sampling boreholes are chosen to investigate structures of interest (e.g., faults or volcanic features). The locations of boreholes in the systematic-drilling program, on the other hand, are chosen with the objective of measuring statistical variability across the site and for ensuring that the data collected are representative of conditions at the site.

We plan to drill some 330 boreholes, in addition to the 200 existing ones. The locations of the major proposed and existing holes are shown in Figures 4-6 and 4-7, respectively. Most of these proposed boreholes will be less than 100 feet deep. The remainder will vary in depth, to a maximum of about 5000 feet. The deepest holes will penetrate into the rocks below the candidate repository horizon and the water table. The depth will depend on the geologic and hydrologic data needed from the rocks above and below the water table. For most boreholes, we will use dry drilling and coring, as described on page 51. When the repository is prepared for permanent closure, all boreholes will be sealed.



- Shallow boreholes in the unsaturated zone (less than 100 feet)
- Unsaturated-zone boreholes
- Holes for the systematic drilling program
- Coreholes
- Saturated-zone and water-table boreholes
- Trenches
- Exploratory shafts
- Light-duty roads
- Unimproved roads

Figure 4-6. Locations of major proposed surface-based tests in the vicinity of the site.

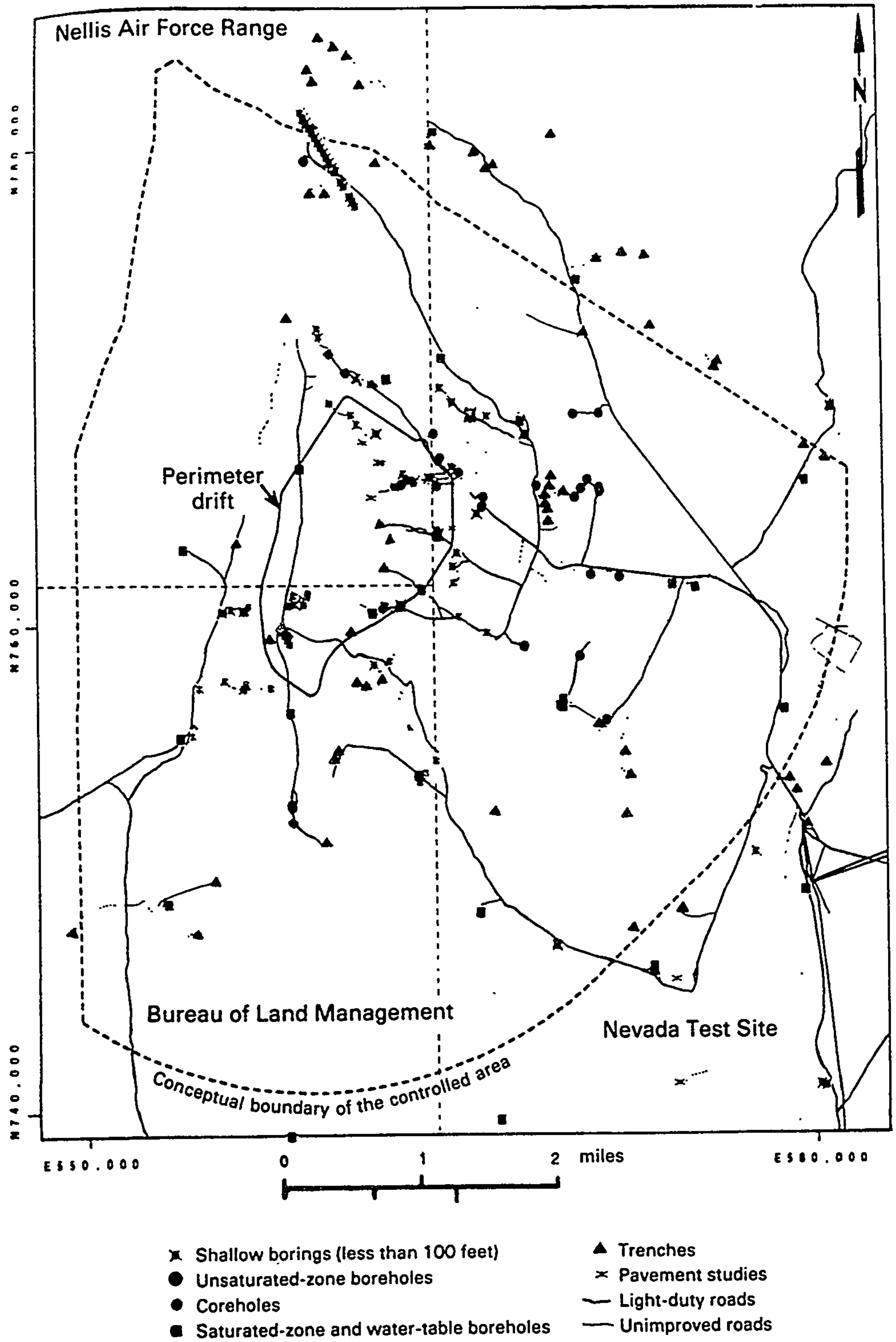


Figure 4-7. Locations of ongoing surface-based tests in the vicinity of the site.

Other activities. Other activities performed at the surface include the continuation of monitoring activities for streamflow, meteorological conditions, seismic activity, and ground-water conditions.

Prototype drilling and coring

The characterization of rocks and ground water in the unsaturated zone at Yucca Mountain presents considerable challenges. We must minimize or avoid contaminating the rock surrounding the borehole and the samples removed from the borehole (rock cores or water) by drilling fluid. The testing and sampling should be conducted under conditions that are as close as possible to the original conditions in the rock. To achieve these goals, we plan to use dry drilling and coring for many boreholes at Yucca Mountain, rather than standard drilling techniques, which use drilling fluids. Because the combination of dry drilling and coring is unconventional, we must determine the applicability of these techniques. We have therefore established a prototype dry-drilling and coring program. The objectives are to develop and evaluate equipment for dry drilling and coring, to develop methods, and to prepare technical procedures for the use of these techniques in a dry environment.

In 1989 and 1990, we completed prototype dry drilling and coring in volcanic tuff in Arizona and Utah, going to a depth of approximately 1600 feet. The purpose was (1) to collect information needed for developing appropriate drilling and coring procedures, refining equipment, and developing a more rigorous drilling schedule and (2) to determine how many new dry-coring drilling rigs will be needed to maintain a reasonable schedule. This includes establishing rates of drilling and coring, and assessing the quality of drill bits. We plan to continue the prototype dry drilling and coring in Nevada, using a drill rig that has been built specifically to achieve the goals of the unsaturated-zone drilling program. This rig is a larger version of the one used in Arizona and Utah and incorporates many features developed during that phase of prototype drilling.

Underground testing

The Site Characterization Plan describes 34 tests in the exploratory-studies facility to gather data for evaluations of site suitability, for input to repository design, and for performance assessments. These tests will provide data required for an adequate evaluation of the safety of the potential repository and its ability to isolate the waste.

The tests planned for the exploratory-studies facility include geologic mapping of the surfaces of excavations to record the condition of the host rock and overlying strata. We will use this information to design ground support, identify test locations, assess suitability for waste emplacement, and provide input to models of hydrologic behavior for performance assessment.

We will also study the mineralogy and petrology of the host rock and overlying as well as underlying units. The results of these tests will provide a detailed picture of any variability in the geochemical properties of the rocks that might affect radionuclide migration and a history of any alterations that may have occurred in the rocks. This alteration history might indicate climatic fluctuations or changes in hydrologic conditions that may be unfavorable for waste isolation. We have also planned a series of hydrologic tests to evaluate flow processes under controlled test conditions in the host rock.

We will examine the hydrochemistry of water samples gathered in the unsaturated zone, looking for insights into the natural tendency of water to migrate through the unsaturated zone. We also plan to determine the diffusion properties of the rock, using a nonradioactive tracer. And we will examine how chlorine-36, an isotope that is present in the ground water, migrates. The concentration of this isotope in ground water is increased by atmospheric tests of nuclear weapons and can indicate the length of time required for water to travel through the rock. Fast travel times might indicate that the site might not provide a reliable primary barrier to radionuclide migration. Ground-water travel will also be addressed by studies of hydrologic properties, particularly the flow of ground water along faults and fractures, and through the rock matrix. We will investigate these properties by both drilling and drifting through the faults and other major structures.

We will perform experiments with heaters to determine how the heat emitted by the waste would affect the underground environment. This information is necessary in designing the underground repository, to ensure that thermal effects on the rock are within acceptable limits and do not affect waste isolation by creating pathways for the migration of radionuclides. Experiments at various scales will ascertain thermal effects in the immediate vicinity of the waste package and those expected at some distance from the waste package.

In addition, we plan a series of geomechanical tests to evaluate how underground openings are likely to behave during the construction and operation of the repository and after its permanent closure. These tests will evaluate such things as deformation in the strata surrounding the drifts, the response of the rock mass to mechanical stress, the extent to which the rock is disturbed during excavation, and the stability of drifts in the exploratory-studies facility.

Our plans for underground testing have been reevaluated as part of the ESF alternatives study. We will modify the testing program as appropriate to reflect the final ESF configuration and testing in the Calico Hills unit. While the overall objectives will be similar to those described above for the current ESF configuration, some changes in priority could result. As a result of the emphasis on early site-suitability evaluations, testing in the Calico Hills unit could be assigned a high priority.

Decisions to be made about site characterization

- ***What activities should be conducted if we fail to obtain all the needed permits from the State?***
- ***What is the preferred configuration for the exploratory-studies facility?***
- ***What method will be used to decide whether we have sufficient data for evaluating site suitability?***
- ***Should we pursue a prototype test facility at another location?***

Decisions to be made

In addition to selecting the preferred configuration for the exploratory-studies facility and completing the method for site-suitability evaluations, we will have to make several important decisions in the near term.

The most important decision about site characterization at present is what activities we should conduct in the event there is a significant delay in obtaining all the needed permits from the State. If we cannot conduct our planned program of extensive surface-based drilling or construct the exploratory-studies facility as now scheduled, there are nonetheless important things to be accomplished, such as continuing our geologic and meteorological monitoring of the site, continuing the development of our performance-assessment capability, and resolving some site-suitability and licensing issues. We will also determine whether it would be practical and useful to conduct prototype and analog testing at another location.

Performance assessment

Performance assessment is a major part of our effort to characterize and evaluate the suitability of the Yucca Mountain candidate site. In addition, it will provide estimates of the safety performance of a repository system at that site—that is, ability to comply with the numerical criteria specified in regulations issued by the Nuclear Regulatory Commission[8] as 10 CFR Part 60 and the Environmental Protection Agency[18] as 40 CFR Part 191. (Subpart B of 40 CFR Part 191, which contains the standards for disposal, has been vacated and remanded to the Environmental Protection Agency for further consideration.)

To assess safety, we must estimate the performance of the repository system for thousands of years into the future. Early steps in performance assessment call for the development of techniques for estimating the behavior of the repository system under current conditions and under the different conditions that may occur in the future. These techniques usually rely on mathematical descriptions of the system, called "models." Building the models requires an understanding of the features of the site, of the events and processes that are likely to occur there, of the design of the repository, and of the characteristics of the waste and waste packages to be emplaced there.

We are developing the models needed for performance assessment in an iterative process that also provides guidance to site characterization and design. The models are first based on a general understanding of the physical mechanisms operating on the repository system. As site-characterization data become available, we use them to test the models and make preliminary estimates of the performance of the system and the suitability of the site. The results of these exercises are useful both for refining the models and for learning what types of data are most needed for licensing. This process is repeated throughout site characterization.

The importance of site characterization to the development of the performance-assessment models can be seen by considering one of the processes at the candidate site—namely, the movement of ground water through the unsaturated rocks (Figure 4-8). The ability of the site to isolate waste and comply with regulations will depend heavily on the rate at which radionuclides may be transported by ground water to the accessible environment. A model of ground-water movement is therefore important for estimating the behavior of the repository system. At the current stage of understanding of the Yucca Mountain candidate site, several models might explain the facts that we know about ground-water movement. The water may, for example, move slowly and only through pathways that allow little, if any, of it to reach the waste; it may move in brief episodes through fractures in the rock, fractures that may or may not allow water to reach the waste; or it may move in other ways that have been suggested. To build acceptable models of ground-water movement, we need to obtain data that can be used to evaluate such possibilities. The

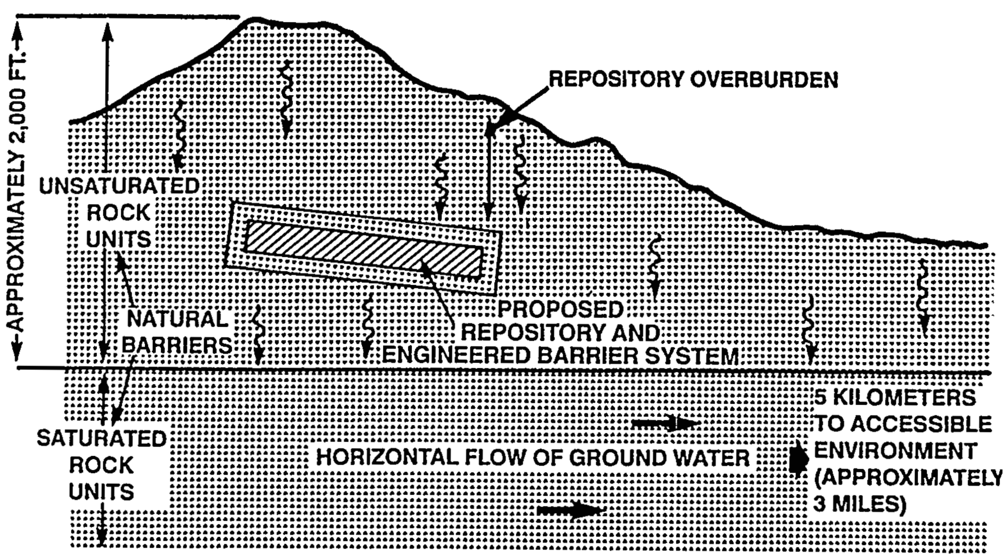


Figure 4-8. Illustration of possible water movement through the repository.

performance-assessment models must also address many phenomena besides ground-water movement, such as the movement of gases and the effects of changing climate.

We also use this iterative process to refine the design of the repository. As we complete more-advanced designs, we use them in performance-assessment models. We use the resulting estimates of system performance to determine what refinements are needed in the models and what aspects of design could possibly be modified to improve performance.

Once sufficient site-characterization data have been collected and the necessary models have been fully developed and tested, performance assessment will provide the analyses needed for assessing compliance with the regulatory criteria. If the site is found suitable, these analyses will support the license application to construct a repository and, later, the license amendments to operate and close the repository.

Design

Conceptual designs for the repository and the waste package were completed for the Site Characterization Plan. The next phase in the design process is the advanced conceptual design, which will be followed by the license-application design and the final procurement-and-construction design.

Design phases

In the advanced conceptual design, our objective is to develop appropriate solutions to the design-related licensing issues identified through consultation with the Nuclear Regulatory Commission as established by the procedural agreement we signed with the Commission.

The license-application design, planned to begin in mid-1996, should complete the resolution of design and licensing issues identified and assessed in earlier design phases and is intended to develop the design of the items necessary to demonstrate compliance with the design requirements and performance objectives of 10 CFR Part 60 for the "quality-affecting" scope of work. We plan to develop sufficient design information during the license-application design to meet the requirements of 10 CFR 60.31 (requirements for the construction authorization) for the license application. We will also fully integrate the design requirements resulting from detailed safety and reliability analyses into the license-application design in order to form the basis for information required in the safety analysis report, which will be included in the license application. During this design effort we will continue to report site-characterization data and their effect on the design process in the periodic progress reports.

In the final procurement-and-construction design, we intend to develop the final drawings and specifications for procurement and construction. This design phase will emphasize the completion of design of ancillary support items, final design refinement for the items necessary to demonstrate compliance with the design criteria and performance objectives of 10 CFR Part 60, the development of construction bid packages for all systems, and the development of final construction and procurement schedules.

To be cost effective, we are deemphasizing major activities related to advanced designs for the repository and the waste package until more information about the site is available.

Major activities related to the advanced designs for the repository and the waste package have been deemphasized until more information is available about the suitability of the site for a repository. The purpose is to conserve resources and to concentrate on an early evaluation of the suitability of the site. However, we recognize that the design of the systems, components, excavations, structures, and barriers must be substantially completed for a comprehensive evaluation of the suitability of the site. If the site is found to be suitable for a repository, these designs must also be complete so that compliance with the performance objectives in 10 CFR Part 60 can be demonstrated at the time the license application is submitted to the Nuclear Regulatory Commission. Our plans for design are directed at this goal.

Support from performance assessment

As already mentioned, to help in managing the design of the repository and the waste package, we will use performance assessments; the assessments will help us to determine whether the designs can be expected to meet the requirements placed on the behavior of the system. The estimates of uncertainties in the system's behavior will also be useful to design; if design changes can reduce the uncertainties, they will be considered in the continuing design program.

The design of the repository

As discussed on page 44, we have recently completed an evaluation of alternative configurations for the exploratory-studies facility, including repository-design concepts that would be compatible with these configurations. The evaluation was prompted by discussions with the Nuclear Regulatory Commission and the Nuclear Waste Technical Review Board; it will form the basis for design studies leading to the selection of a configuration for the exploratory-studies facility. The repository-design concept described here was developed before this evaluation and will be changed appropriately when a decision is made about the configuration of the exploratory-studies facility.

As shown in Figure 4-9, a repository at Yucca Mountain would consist of surface facilities, underground facilities, and shafts and ramps connecting the surface and the underground facilities. When we prepare the repository for permanent closure, we would construct seals for the shafts, ramps, and exploratory boreholes. These design features are briefly described below; the descriptions are based on the current conceptual design,[5] which was prepared as a basis for planning site characterization.

Surface facilities. The purpose of the surface facilities would be to receive the waste and to prepare it for permanent disposal in the repository. The surface facilities would consist of facilities for waste receiving and inspection, for limited temporary lag storage for waste-handling operations, for providing access portals and ventilation for the repository, and for providing general support, access, and utilities. We would be able to reach the site by both rail and highway.

In the waste-handling building, we would unload the spent fuel and other high-level radioactive waste from the shipping cask in which it arrives and transfer it

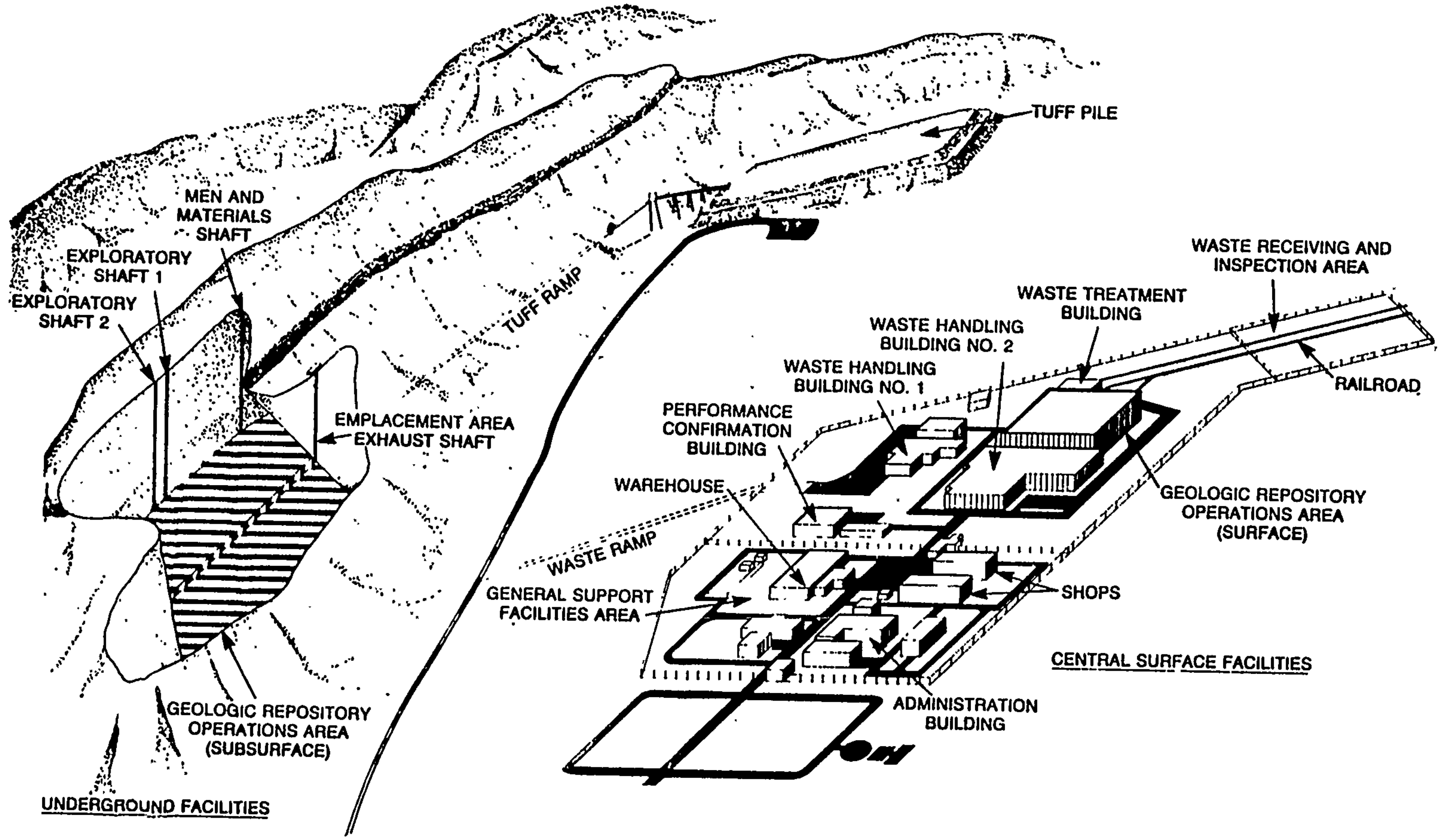


Figure 4-9. Repository at Yucca Mountain.

to a packaging station in a "hot cell"—a room that is shielded against radiation and equipped with remotely controlled equipment. We would use the hot cell to load the waste into disposal containers. We would then transfer the containers to another station, where they would be sealed. We would move the sealed containers to a surface vault for temporary storage before transfer underground and emplacement in the disposal rooms. We would use specially designed transfer casks and transporters for the transfer and emplacement operations.

Other planned surface facilities include a facility used for testing the quality of the sealed waste packages; the decontamination building, which we would use to decontaminate any contaminated components and equipment; and the waste-treatment building, which we would use to prepare the low-level radioactive wastes produced at the repository for offsite disposal. Support facilities would include laboratories and such services as security, fire protection, administration, monitoring, and maintenance.

Shafts and ramps. As currently envisioned, the surface facilities would be connected to the underground area of the potential repository through two ramps and four shafts. We would use one of the ramps to transport the waste containers from the surface to the underground and to provide a fresh-air supply for the waste-emplacement area—that is, the underground area that was already excavated and in which waste was being emplaced. The second ramp would be used to assist in excavating and constructing the repository and for removing mined rock from the underground; it would also serve as the primary exhaust airway for the underground areas that are being excavated.

Our current plans call for the construction of four shafts for the repository. We would use these shafts to help ventilate the waste-emplacement and construction areas and to provide access for workers and materials.

Underground facilities. We would construct the repository at a depth of about 1000 feet below the surface, in the unsaturated zone. According to the current conceptual design, the underground repository would have three main horizontal passageways, or drifts, excavated parallel to one another. Each of these drifts would serve a number of waste-emplacement panels, which in turn would consist of a number of rooms in which the waste would be emplaced (Figure 4-10). We would bore vertical holes into the floor of these rooms and insert the waste

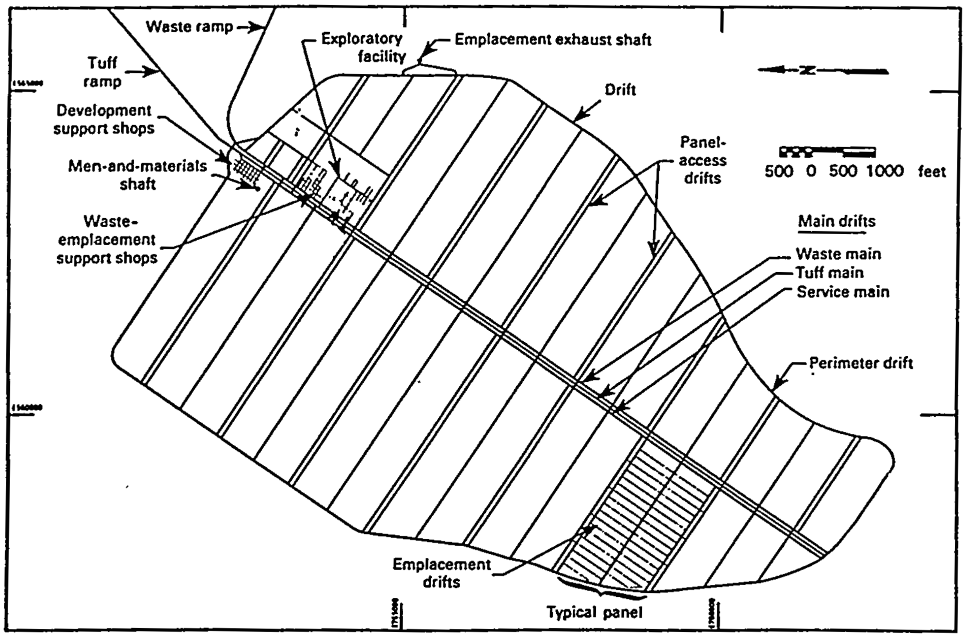


Figure 4-10. Layout shown in the conceptual design for the underground repository with vertical waste emplacement.

containers into them (Figure 4-11). While vertical emplacement is the current choice, we have not rejected horizontal emplacement. In this approach, the waste-emplacement boreholes would be bored horizontally into the walls of the emplacement panels.

Waste emplacement would begin long before all of the repository has been excavated: it would begin in one panel as soon as two of the waste-emplacement panels had been completely developed. This approach would allow underground development and waste emplacement to proceed simultaneously, with the development of the repository continuing for many years. We would provide sufficient separation between development and

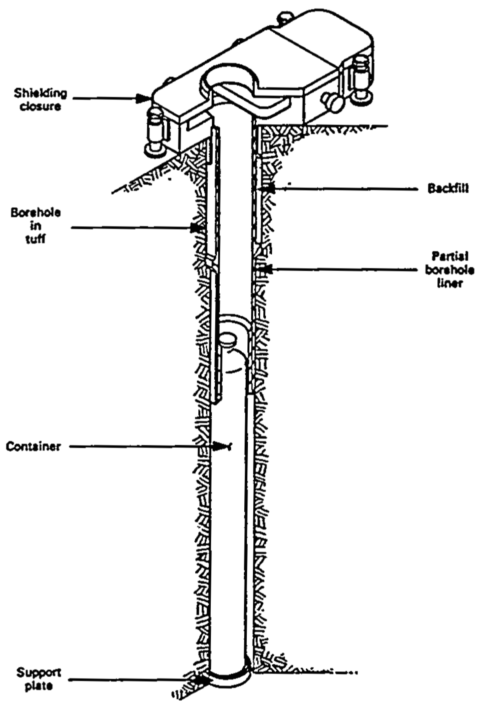


Figure 4-11. Vertical waste-emplacement borehole.

emplacement operations so that underground construction workers would be isolated from waste-handling activities.

Postclosure seals. The permanent closure of the repository would require the sealing of all shafts, ramps, exploratory boreholes, and other underground openings. The design objective for seals and backfill is to reduce, to the extent practicable, the potential for creating preferential pathways for ground water or radionuclide migration.

The design of the waste package

If a repository is developed at the Yucca Mountain candidate site, the principal engineered barrier will be the waste package. The waste package will be designed to meet various functional and regulatory requirements, including the need to maintain the option to retrieve the emplaced waste should the need to do so arise at any time before the closure of the repository. For the post-closure period, these requirements include providing substantially complete containment for the waste for at least 300 to 1000 years and thereafter controlling the rate of release from the engineered-barrier system to some small fraction of the inventory present.

In the current conceptual design,[19] the waste package consists of the waste form and a disposal container. There are two types of waste form: spent fuel from commercial nuclear reactors and vitrified high-level waste (Appendix B). The current design of the disposal container calls for a single-walled metal cylinder. The containers for both waste forms would be constructed of the same corrosion-resistant material, but those for spent fuel would be larger. Several materials are being considered for the container, and other design concepts will also be evaluated.

Design process. The process for the design of the waste package consists of the same phases as those described above for the repository. The advanced conceptual design of the waste package will be preceded by a number of studies, including evaluations of alternative materials and designs, the selection of materials and designs for the disposal containers, and the evaluation of conditions inside the waste package. We are continuing work on the development of geochemical characteristics and reaction models for the waste-emplacement environment in the vicinity of the waste package. We are also conducting studies of the characteristics and behavior of waste-form materials and of candidate container materials for the conceptual design.

Long-lived waste packages. One of the strategic issues that we recently discussed with affected governments and interested parties was the desirability of waste packages that would exceed regulatory standards by a significant margin. Several options have been proposed that would provide substantially complete containment of radionuclides for very long periods of time, possibly thousands of years. Such a waste package might offer significant advantages in licensing, and it might also help increase public confidence. Such a package would not be intended to compensate for any serious deficiencies that might be discovered at the site.

To help us choose among options, we are initiating a major and novel effort to consider new design concepts. First, we asked the industry to submit qualifications for waste-package design. We then selected the most qualified applicants, gave them the waste-package requirements and the available information about the site, and asked them to prepare design concepts. The concepts that seem to be most promising will be evaluated and considered for further development.

Decisions to be made

A number of decisions are to be made in relation to the design of the repository and the waste package, including those shown in the box on the next page. In addition to choosing a method of waste emplacement and deciding whether the waste package should exceed regulatory requirements by a significant margin, we are faced with other design-related decisions. Interested parties have suggested that among the most important of these is whether, and for how long, the waste should be cooled before emplacement in the repository. The heat emitted by the waste will affect the properties of the host rock and the flow of fluids (both liquids and gases), which is the principal mechanism for transporting radioactive materials from the repository to the human environment. In theory, the heat will create, near the emplaced wastes, fluid-flow patterns that differ from the natural flow patterns, and these altered patterns may affect the ability of the repository system ability to isolate the waste.

Decisions related to design

1. ***Should the heat load of the repository remain as currently conceived, or could an advantage be obtained from a lower thermal loading? If a lower thermal loading is desirable, should it be achieved by cooling spent fuel for a longer period of time or by changing the spacing or the design of waste packages in the underground repository?***

2. ***Should the waste package be designed to exceed minimum regulatory requirements by a significant margin?***

3. ***Should the waste packages be emplaced vertically, into the floors of the disposal rooms, or horizontally, into the walls of the rooms?***

Our current strategy is to design the repository and the engineered-barrier system to be able to meet the performance objectives of the Nuclear Regulatory Commission for waste containment and isolation over the range of expected environmental conditions, including relatively high initial temperatures and the presence of water in the pore spaces of the rock surrounding the waste packages. This strategy is expected to add conservatism to the design of the engineered-barrier system in that the heat from the waste may actually help keep water from reaching the majority of containers for up to hundreds of years. However, there are uncertainties as to what happens in the host rock before and after the temperature rise due to the waste-induced heat has reached a peak (the thermal pulse) and the rock cools. As part of the site-suitability determination, we will have to evaluate the capability of the natural system to continue to provide for adequate waste containment and isolation under the expected heat loading. We will need to be able to demonstrate during licensing that we understand the effects of the thermal pulse on the repository and the engineered-barrier system and that the performance of all elements of the system is acceptable with respect to established standards.

The heat produced by the waste emplaced in the repository and the resulting repository temperatures may be reduced by cooling the spent fuel and high-level waste for extended periods before disposal. Such cooling may, to some extent, reduce the attendant uncertainties about the long-term performance of the repository and the engineered-barrier system. Cooling may also enable repository designers to put more fuel in each emplaced waste package, thus reducing the volume of rock excavated and the costs of underground development and operation. However, to get the maximum benefit from cooling, extended storage (on the order of several decades) is required, which increases the costs of storage. The heat load could also be reduced by decreasing the amount of spent fuel in each waste package or by increasing the spacing between waste packages, but this would require either more waste packages or the construction of a larger waste-emplacement area in the underground repository.

The actual heat loading to be used as a basis for the next phase of repository design has not been selected. It will be based on a number of factors, including data from site characterization, decisions about the design of the waste package and other engineered barriers, assessments of performance, and our ability to demonstrate performance with acceptable confidence. The effect of heat loading on working conditions in the underground repository must also be considered. A decision to require lengthy cooling for spent fuel would have implications for the entire system, including the MRS facility and transportation. These issues are being studied.

Safety

One of the main tasks of the repository program is achieving and demonstrating safety through compliance with the requirements of applicable laws and regulations.

Requirements for the suitability of a candidate site are given in our siting guidelines, 10 CFR Part 960. The construction, operation, and closure of a repository are activities that can only be undertaken under authorization or license by the Nuclear Regulatory Commission, under the regulatory requirements specified in 10 CFR Part 60, which also implement and enforce the requirements of the Environmental Protection Agency in 40 CFR Part 191. This legislated system of checks and balances is designed to ensure adherence to the basic policy of protecting health and safety and the quality of the environment.

Licensing

A repository is to be licensed by the Nuclear Regulatory Commission under 10 CFR Part 60. Until we submit a license application to the Commission, the relationship between the two agencies is one of informal consultation between a prospective applicant and the staff of the Commission. To facilitate that relationship, a procedural agreement identifying the guiding principles for interface during site characterization has been executed.[20] Consistent with this agreement, a number of technical meetings and technical exchanges have taken place and are scheduled to continue. A schedule for planned interactions is established jointly between us and the staff of the Commission. In addition to the interactions with the staff of the Commission, we also present certain technical issues to the Advisory Committee on Nuclear Waste and provide periodic briefings to the Commissioners on the status of the program. All such meetings are open to interested parties.

Our interactions with the staff of the Nuclear Regulatory Commission are essential vehicles for exchanging technical information and for resolving technical and licensing issues. They have increased the shared understanding of the Yucca Mountain site.

These interactions are essential vehicles for exchanging technical information and for resolving technical and licensing issues. Specific topics have included alternative configurations for the exploratory-studies facility, performance assessment, the hydrology and geochemistry of the unsaturated zone, the significance of the calcite-silica deposits at the site, the assessment of faulting and volcanic hazards, the Calico Hills study, and the testing and modeling of radionuclide retardation. Technical exchanges on these subjects have increased the shared understanding of the Yucca Mountain candidate site.

Formal licensing proceedings will start with the submittal of the license application. The license application will contain general information about the site and the potential repository, a safety analysis report, and an environmental impact statement. The safety analysis report will include a description of the site, a description of the design of the repository and the waste package, and the results of performance assessments required to demonstrate that the repository will comply with the applicable regulations.

The Congress has allowed the Nuclear Regulatory Commission a period of 3 years, with a possible 1-year extension, in which to review the application and decide whether a construction authorization for the repository should be granted. During this period, the Commission will conduct a technical review of the license application and issue a safety evaluation report that will contain the conclusions of the Commission's staff. The Atomic Safety and Licensing Board of the Nuclear Regulatory Commission will then conduct an adjudicatory public hearing on the issues and issue an opinion. The findings of the Board may be appealed to the Commission. If the Board finds that the application satisifies all regulatory requirements, construction could commence while administrative or judicial appeals are pending, if the Commission so authorizes.

When the repository is ready to start receiving waste, we must submit an updated license application to the Commission. The Commission will review the application and, if the finding is favorable, will issue a license to receive and possess radioactive waste at the repository. The repository will then start receiving waste and emplacing it underground.

Once the waste has been emplaced and the performance-confirmation program has been completed, we will submit an application to the Commission for a license amendment to decommission and permanently close the repository.

Approach to the demonstration of performance

General approach. Assessment of the long-term safety of a geologic repository is unprecedented in regulatory experience. To evaluate performance, three factors must be addressed: cumulative releases of radioactive material to the accessible environment over a period of 10,000 years after closure, doses received by individual members of the general public during the first 1000 years after closure, and the concentrations of radionuclides in the environment. The evaluations of these factors will consider the processes and events that could significantly affect the safety performance of a repository.

The general approach is to identify both the anticipated and unanticipated processes and events that could occur, develop a set of scenarios that describe the ways in which these processes and events could affect the performance factors, evaluate these factors under the conditions of these scenarios, and combine the results for the scenarios into a comprehensive evaluation of the performance of the repository system. Scenarios will be developed for both the expected performance of the system and for conditions arising from unexpected processes and events. Mathematical models that describe the various scenarios will be developed for use in evaluating consequences and determining the probabilities of the scenarios.

The reduction of uncertainties. The ability to reduce uncertainties in predictions of the long-term safety performance of the repository to an acceptable level is a major technical issue in the demonstration of compliance. Efforts to deal with these uncertainties will include the use of conservative designs for the engineered components of the repository, the development and evaluation of alternative conceptual models of the site, analyses that bound the uncertainties, and uncertainty and sensitivity analyses to evaluate the significance of events and processes that remain uncertain after site evaluation and the application of expert judgment. Reviews of these efforts by the scientific and technical community will be an integral part of this approach.

Performance confirmation. Even after site characterization is completed, we plan to continue selected long-term surface-based monitoring activities and underground tests. We will continue long-term underground tests and also start new testing and monitoring as part of a performance-confirmation program required by the Nuclear Regulatory Commission. The performance-confirmation program will continue for many years, through the construction of the repository and waste emplacement. It will end only when there is adequate assurance that the repository is performing as expected and the Commission allows us to permanently close the repository.

Licensing strategy

We are developing a licensing strategy that will result in the most efficient, scientifically based development of a repository. It will include the elements listed in the box on the next page.

In keeping with the licensing-strategy element that calls for conservative, simple analyses, the probabilistic analyses of compliance will be based on conservative

Our licensing strategy includes—

- *Defining, understanding, and clarifying regulatory requirements.*
- *Identifying and resolving regulatory, technical, and institutional uncertainties; working to simplify regulatory processes.*
- *Developing and collecting data (including information about the site) for the license application and ascertaining that the data are adequate and sufficient before submitting the license application.*
- *Using conservative, simple designs and analyses.*
- *Using available, qualified methods and approaches where possible.*
- *Performing all work for the license application under a quality-assurance program accepted by the Nuclear Regulatory Commission.*
- *Gaining acceptance of methods, approach, and assumptions by the technical community.*
- *Demonstrating that the approach to siting, design, operation, and closure is conservative with respect to requirements.*

assumptions. At the same time, we realize that analyses derived entirely from conservative assumptions are likely to give a distorted impression of the repository system's future behavior. Such analyses must be supplemented by estimates that are more realistic if we are to succeed in communicating a truer account of the way the system will perform.

Moreover, the strategy's call for simplicity is a challenge that the program intends to meet. Some of the most illuminating analyses, especially non-probabilistic calculations, are themselves simple. And simple summaries of the more complicated analyses can be prepared as an aid to communication. The simple analyses will, however, need to be fully supported by the complex studies that the technical community will require in its detailed review of compliance.

While simple studies and explanations are indispensable, we also intend to perform a full set of detailed performance assessments.

The demonstration of compliance with the regulations of the Environmental Protection Agency will require the use of probabilistic methods. The models available for such analyses are at an early stage of development, and, at best, any demonstration that relies solely or mainly on such methods is unlikely to prove convincing. We recognize that the demonstration of safety will be a challenge and cannot rely on a single performance assessment. We have decided on two initiatives. One is an attempt to reach consensus with the Environmental Protection Agency and the Nuclear Regulatory Commission on interpreting the regulatory standards and identifying the best means for contributing to issue resolution.

The other initiative is conducting repeated performance-assessment exercises with the existing data base and probabilistic models and subjecting the approach and results to peer review. As these exercises are repeated, the data base will be improved by the continuing program of site evaluation and analysis, and the assessment methods will be refined, enhancing the capabilities of the models used in demonstrating compliance.

Protection of the environment

Environmental policy

By accomplishing our mission and isolating the radioactive waste from the human environment, we will make the environment safer for future generations. But we also intend to ensure that the accomplishment of our mission is effected in a manner that is environmentally safe and sound. In accordance with this policy, we are committed to meeting all applicable environmental requirements set forth by Federal, State, and local laws and regulations, executive orders, and orders of the Department of Energy. Finally, the program is being carried out in accordance with the 10-point initiative announced by the Secretary of Energy on June 27, 1989, and issued to ensure that all activities are carried out in full compliance with environmental statutes and regulations, and the Department's Order 5440.1D[21] of February 22, 1991, on compliance with the National Environmental Policy Act of 1969.

Protection of the environment

Our general plans for compliance with environmental regulations during site characterization are described in the Environmental Regulatory Compliance Plan.[22] This plan describes a comprehensive program of action to ensure compliance with applicable environmental laws and regulations; it describes site-characterization activities that may trigger environmental regulatory requirements, identifies pertinent environmental laws and regulations, describes the processes that we will use for compliance with environmental regulations, and specifies the environmental permits and approvals that must be obtained before building the exploratory-studies facility. General plans for monitoring and mitigation are presented in the Environmental Monitoring and Mitigation Plan.[23]

We will carry out various environmental studies at the Yucca Mountain candidate site to collect the data required by the Environmental Monitoring and Mitigation Plan, to collect the data needed for obtaining various permits, and to collect any data that may be needed for the environmental impact statement. Plans and methods for the specific environmental studies to be undertaken are presented in environmental field activity plans. Plans for data collection will be made after scoping for the content of the environmental impact statement has been completed and an implementation plan has been issued.

If the Yucca Mountain candidate site is found to be unsuitable for a repository, we will decommission the facilities used for site characterization, including the exploratory-studies facility, and restore the site to its original condition, to the extent practicable. If no alternative use for the exploratory-studies facility is identified, we will remove the surface and underground facilities and stabilize and rehabilitate the land. We will also remove all equipment and backfill the underground excavations and ramps or shafts with the rock removed during excavation. In the case of trenches, we will backfill with the material that was originally excavated, and we will seal all boreholes. We have developed a reclamation feasibility plan[24] and a reclamation program plan.[25]

Protection of cultural, religious, and archaeological resources

To ensure compliance with the American Indian Religious Freedom Act, the National Historic Preservation Act, and related statutes, we are consulting with 16 Indian Tribes that have current or traditional religious or cultural ties to the Yucca Mountain area in an attempt to identify areas or resources having cultural or religious significance. We will avoid, minimize, or mitigate any potential adverse effects that are identified through this consultative process. In addition, we developed a programmatic agreement with the Nevada State Historic Preservation Office and the Advisory Council on Historic Preservation to ensure compliance with the National Historic Preservation Act. This agreement was signed on December 15, 1988.

The environmental impact statement

The environmental impact statement for the Yucca Mountain candidate site will address the environmental and socioeconomic effects of constructing, operating, closing, and decommissioning a geologic repository at Yucca Mountain and the potential effects that may occur over the long term, after closure.

Before beginning to prepare this statement, we will conduct a public scoping process to define the environmental issues and the alternatives to be examined in the document. As required by the National Environmental Policy Act of 1969, we will issue the document in draft form and will hold public hearings to receive comments on that document. The comments received at these hearings, as well as those submitted by Federal and State agencies and the general public, will be considered in preparing the final environmental impact statement, and the disposition of the comments will be addressed in a comment-response document. If the site is found to be suitable for a repository, the final statement will accompany the Secretary's recommendation to the President that Yucca Mountain be developed as a repository. As already noted, the environmental impact statement will also be submitted to the Nuclear Regulatory Commission as part of the license application.

Socioeconomics

Our program will solve a national problem—the problem of managing and permanently disposing of high-level radioactive waste and spent fuel. But the program will most directly touch people's lives through its effects on the local communities in which waste-management and disposal facilities are sited. The social and economic effects of the program may be both favorable and unfavorable. Generally, effects would result from employment created by site characterization and facility development and operation, the resulting direct and indirect population growth and related purchases and tax revenues, and expenditures for materials, equipment, and services.

The Congress recognized the potential for adverse socioeconomic effects and included in the Nuclear Waste Policy Act provisions that equip us and affected governments to address them. Together, these provisions and the requirements of the National Environmental Policy Act create a framework for managing such effects: (1) the law requires us to establish and implement a process that enables us to avoid, minimize, or mitigate potentially adverse effects, to the maximum extent practicable, throughout all phases of the waste-management program; and (2) the law gives affected governments the right to funding to develop requests for impact assistance and to mitigate adverse socioeconomic effects and the right to play an active role in assessing, monitoring, and managing effects.

The nature of socioeconomic effects

Favorable effects would result from the availability of more jobs, greater county or municipal revenues, and the inflow of money into local businesses. The specific effects associated with the construction and operation of waste-management facilities will depend on the characteristics of the facility and the characteristics of the site. Adverse effects could result when the demands on government and community facilities and services (e.g., schools, wastewater treatment, and medical care) exceed local resources; when the inflow of people increases the demand on scarce resources like water, land, and housing; and from the disturbance of local lifestyles and social structures.

While adverse effects can occur in any large development project, waste facilities may present special problems in terms of public perceptions. These special effects, often referred to as perception-based effects, may result from perceived risks associated with the storage, disposal, and transportation of hazardous materials. Residents may worry that land and property values will decrease, that fewer tourists will visit, and that industry or businesses that might have moved into the area will elect to locate elsewhere.

The State of Nevada believes that the transportation of spent fuel and high-level waste to, and its disposal in, a repository in that State would adversely affect the State's economy, including tourism. The State cites numerous studies it has sponsored concerning perception-based effects as evidence of the negative effect the repository will have on the State economy. At the county and local levels, concern has focused mainly on effects related to growth and waste transportation.

Our socioeconomic program

Our socioeconomic program ensures that host jurisdictions will benefit from our activities and potentially adverse effects will be managed to the satisfaction of the community. It is currently focused on the candidate repository site at Yucca Mountain, Nevada.

Section 175 of the Nuclear Waste Policy Act as amended directed us to report on the potential effects of a repository at the Yucca Mountain site and to recommend how these impacts might be mitigated. The areas to be examined were education, public health, law enforcement, fire protection, medical care, cultural and recreational needs, the distribution of public lands for the expansion or creation of new communities, vocational training and employment services, social services, transportation, equipment and training for State and local personnel, availability of energy, tourism and economic development, and other needs of the State and local governments.

Our "Section 175 Report" identified potential adverse impacts in at least 12 of these 14 categories in several communities within the study area.[26] We are now consulting with affected governments on the preparation of the Yucca Mountain Project Socioeconomic Plan. This document presents the socioeconomic requirements the repository program must meet, explains how we will meet those requirements, and presents a comprehensive socioeconomic program for the Yucca Mountain candidate site. This program will enable us to work cooperatively with affected governments to identify, assess, and monitor potential effects—including those identified in the Section 175 Report—and to select and implement appropriate mitigation strategies.

The comprehensive program will also include socioeconomic studies and analyses required by our guidelines for siting repositories (10 CFR Part 960), to support the evaluation of site suitability. These studies focus on potential impacts of site characterization on major sectors of local and regional economies, community facilities and services, social structures, and fiscal conditions in affected communities. In carrying out these studies, we will use the expertise of the affected governments to the extent practicable. If the Yucca Mountain site is found suitable for a repository, the environmental impact statement that will be prepared (see page 72) will assess the environmental and socioeconomic impacts of constructing, operating, closing, and decommissioning a geologic repository at that site. We will conduct a public scoping process before drafting the document so that the public can help us define the issues to be examined in the impact statement.

Meanwhile, we will continue our efforts to help communities realize the benefits that can result from increased employment and expenditures, for example, by providing for training for jobs that will be created and by holding workshops on procurement for local businesses. Other important initiatives in our socioeconomic program include work to establish, in cooperation with affected governments and interested parties, a policy, process, and procedures for the external review of socioeconomic materials and work to develop our capability to evaluate the theoretical and empirical bases for studies conducted by affected governments and interested parties, including studies of special effects.

International activities

We are involved in a number of international activities in the repository-development area. They include (1) those leading to the improvement of techniques, instruments, and expertise needed to characterize the natural barriers at the candidate repository site at Yucca Mountain; (2) participation in international natural-analog projects; (3) participation in international cooperative activities to obtain engineered-barrier information and develop and evaluate related data and models that will be applicable to the U.S. repository program; and (4) participation in efforts supporting the assessment of long-term performance and the verification and validation of modeling codes.

We currently have in place or are putting in place cooperative testing programs using unique facilities in Canada, Sweden, and Switzerland. These testing projects involve field and laboratory efforts to develop geophysical techniques for rock-mass characterization, hydrologic-measurement instrumentation and modeling capabilities, the testing of materials that may be used for seals, natural-analog studies, radionuclide-retardation studies, and the characterization and testing of materials for engineered barriers. Results from these testing programs are incorporated into corresponding efforts in our program for site-specific applications.

We also participate in cooperative projects in the area of performance assessment. These projects involve code development and intercomparison exercises; code verification; validation with laboratory, field, and natural-analog data; and consensus-developing activities in the scientific community on the application of numerical modeling to repository performance assessment and the concept of model validation. The latter concern is closely tied to regulatory requirements in this country.

Schedule

In November 1989, a revised program schedule was announced in the Secretary's report to the Congress.[27] The revised schedule was based on an assumed period of time for obtaining permits for the activities needed to characterize the Yucca Mountain candidate site; comments from the Nuclear Waste Technical Review Board, the Nuclear Regulatory Commission, and the State of Nevada; and the work scope described in the Site Characterization Plan and the associated study plans. The comments were directed at achieving a program that is not schedule driven and one in which an early search for indications of site unsuitability is a high priority. The program schedule may continue to be affected by factors not entirely within our control, including the processing of environmental permits, litigation, and funding levels.

The Secretary has decided that site characterization should be conducted in an orderly program that is not subject to pressures from unrealistic schedules.

The critical path for the start of waste acceptance at the repository currently goes through the following: the construction of the exploratory-studies facility and underground testing, completion of the license-application design, the preparation of the license application, the recommendation and selection of the site, the Commission's review of the license application, the construction of the repository, and the Commission's review of the updated license application.

According to our reference schedule (Figure 4-12), which has been adjusted to reflect program changes since 1989, new surface-based testing will start in early 1992 and the construction of the exploratory-studies facility will start late in 1992. If surface-based testing and the construction of the exploratory-studies facility can be started earlier, we will revise the schedule. The reference schedule in Figure 4-12 was based on the 1988 ESF configuration discussed in the Site Characterization Plan.[12] Should a different configuration from the ESF alternatives study be approved, the schedule may require modification and will be revised appropriately.

We will start the advanced conceptual design and the license-application designs for the repository and the waste package in 1992 and 1996, respectively, and will issue the draft environmental impact statement in 1999. In the year 2001, we plan to issue the final environmental impact statement and submit a site-recommendation report to the President if the site is determined to be suitable. If the President approves and Congressional action is favorable, we will submit the license application to the Nuclear Regulatory Commission and begin the final procurement-and-construction design. Assuming 3 years for the Commission's review of the license application, the construction of the repository will start in 2004, and the start of waste emplacement will begin in 2010.

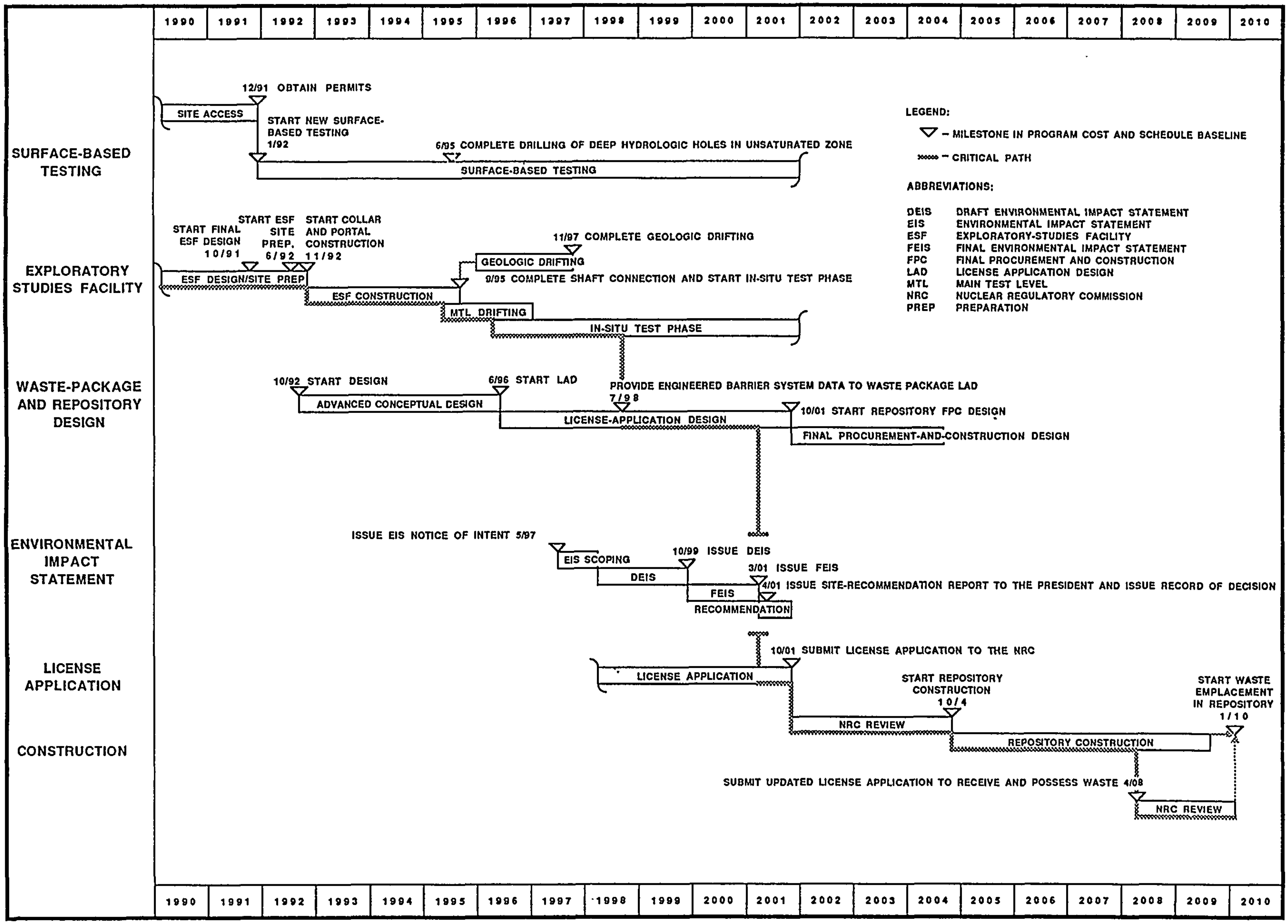


Figure 4-12. Reference schedule for the repository program.

5. THE MRS FACILITY

We plan to build an MRS facility as an integral part of the waste-management system. Such a facility will provide important benefits to the whole system by enhancing flexibility and reliability. We have developed a strategy that will allow the MRS facility to provide timely and adequate waste acceptance, beginning in 1998.

In the Amendments Act, the Congress authorized us to site, construct, and operate a facility for monitored retrievable storage (MRS) as an integral component of the Federal waste-management system, subject to specific conditions limiting storage capacity and linking the schedule of the MRS facility to the schedule of the repository. In this facility, a limited amount of spent fuel will be stored and monitored, with the spent fuel being easily retrievable for shipment to the repository.

The purpose and functions of the MRS facility

The MRS facility will provide benefits to the entire waste-management system. By allowing an orderly transfer of spent fuel to the Federal system, independent of the ability to emplace spent fuel in the repository, the MRS facility will increase the flexibility and reliability of the total system. And by providing both buffer storage and a central staging area for waste shipments to the repository, the MRS facility may increase the efficiency of waste transportation through the

> ***The MRS facility will provide closely monitored surface storage for a limited amount of spent fuel.***

use of large shipments by dedicated train. As an integral part of the waste-management system, the MRS facility is an important first step in moving spent fuel from reactors to permanent disposal and will reduce the need for additional at-reactor storage.

The MRS facility will include a building with special equipment for receiving, transferring, and inspecting spent fuel; a large storage yard; support facilities; and possibly a cask-maintenance facility. An artist's conception of such a facility is shown in Figure 5-1. It will accept shipments of spent fuel by truck and rail, inspect the spent fuel, and then transfer it to a storage yard, where it will be placed in storage modules. Additional functions related to safely packaging and preparing spent fuel for permanent disposal may be included in the basic design or could be added later if they are determined to be beneficial to the total waste-management system and if the volunteer host (see page 84) agrees. The storage units, which are described later, will be specially designed to protect both people and the environment and will allow us to closely monitor heat and radiation.

By law, the MRS facility can only store spent fuel temporarily; permanent disposal will be provided by the repository.

When the repository opens, the MRS facility will continue to receive spent fuel from reactor sites and will ship it to the repository. We plan that all shipments from the MRS facility will be made in large-capacity shipping casks carried on dedicated trains—trains carrying only spent fuel. The ability to use such trains is one of the advantages of the MRS facility.

By law, the MRS facility can only store spent fuel temporarily; permanent disposal will be provided by the repository. When the license issued by the Nuclear Regulatory Commission (NRC) for the MRS facility expires, the facility will be decommissioned, and the site will be restored, consistent with any terms negotiated by the host and the Federal Government.

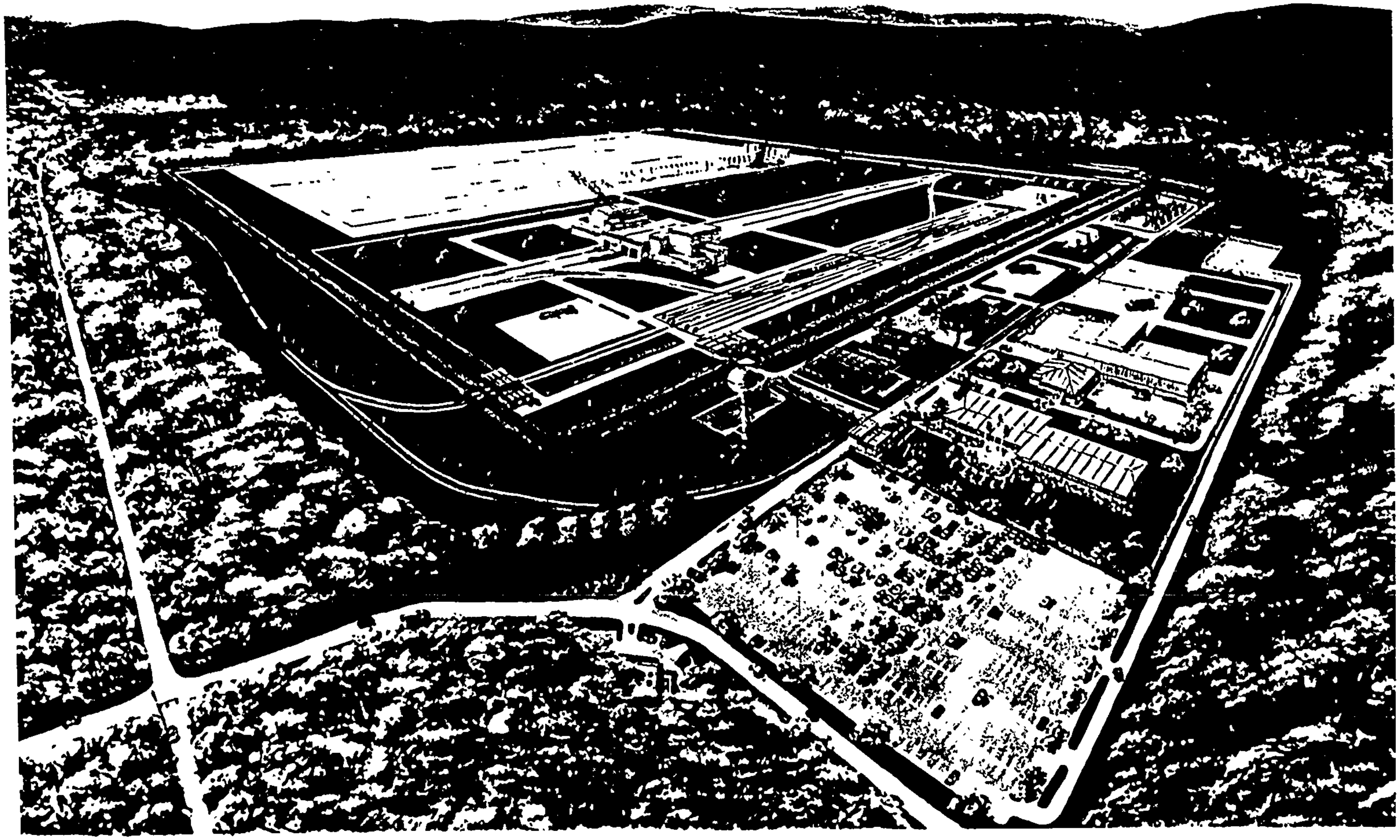


Figure 5-1. Artist's conception of an MRS facility with storage in concrete casks.

Strategy for developing the MRS facility

As discussed in Chapter 3, our strategy for developing the MRS facility is based on a design that meets the following requirements:

- It includes multiple barriers to protect the public, the workers in the MRS facility, and the environment.
- Its safety can be easily demonstrated.
- It allows the facility to be built in time to start receiving waste in 1998.
- It is cost effective.

The concept of monitored retrievable storage is well established. It is used successfully in several foreign countries and has been considered for use in the United States since the early 1970s. Furthermore, the technology needed to ensure the protection of health and safety has been demonstrated worldwide. Assessments by a number of professional and scientific organizations have concluded that an MRS facility would not pose any significant hazards to people or the environment. Nonetheless, safety remains the primary principle in all parts of our MRS program.

As specified in the legislation authorizing an MRS facility, the capacity of an MRS facility sited by the Department of Energy will be limited to 10,000 metric tons of uranium until a repository starts receiving waste and 15,000 metric tons at any time thereafter. There is another significant constraint in the Amendments Act: the construction of an MRS facility sited by the Department is not to start until the construction authorization for the repository is issued by the Nuclear Regulatory Commission. Since the passage of the Amendments Act, the schedule for the repository has been extended by several years, and thus an MRS facility linked to the repository schedule could not provide timely waste acceptance. The President's legislative proposal for the National Energy Strategy therefore includes a provision to repeal the schedule linkages. Alternatively, an agreement negotiated by the Nuclear Waste Negotiator with a volunteer host (below) could include terms differing from the current statutory schedule linkages.

The development of the MRS facility will be integrated with the development of the other components of the waste-management system, including the method by which utilities will transfer spent fuel to the system. We are analyzing the system implications of various transfer options, including safety, licensing, cost, and schedule considerations.

Siting an MRS facility

As mentioned above, the law provides for a dual approach to siting an MRS facility: (1) siting by the Department of Energy, through a process of surveying and evaluating potential sites, and (2) siting through the efforts of the Nuclear Waste Negotiator. The Negotiator, appointed by the President and confirmed by the Senate, is to seek a willing State or Indian Tribe with a technically qualified site and is to negotiate a proposed agreement on reasonable terms. The agreement must be approved by the Congress. The Negotiator's appointment was confirmed in August of 1990, and his efforts to locate a volunteer host are under way.

The Secretary of Energy signed a memorandum of understanding with the Negotiator in November 1990. The memorandum establishes a working relationship that ensures a timely flow of information between the parties; provides the Negotiator with the use of our services, facilities, and personnel as appropriate; and maintains the independence of both parties.

We believe that the efforts of the Negotiator offer the best opportunity to solicit interest in, and to negotiate, an agreement to site the MRS facility with a volunteer host. Our near-term role is to support the Negotiator as requested. However, we are developing a contingency plan for siting the MRS facility and will closely follow the progress of the Negotiator. Our decision on implementing the contingency plan will be based on the MRS schedule and the status of the Negotiator's efforts. As stated at the end of this chapter, our schedule for the MRS facility is based on the assumption that the Congress will enact a proposed agreement with a volunteer host State or Indian Tribe in 1992. If it is necessary to implement a contingency plan for siting the MRS facility, then our ability to start waste acceptance in 1998 will have to be reassessed.

The Secretary of Energy has announced the availability of grants to States, Indian Tribes, and affected units of local government that want to assess the feasibility of hosting an MRS facility.[28] The studies they conduct will help them determine whether they want to proceed to negotiations and to define the terms of the agreement they want to negotiate.

The Secretary of Energy has announced the availability of grants to States, Indian Tribes, and affected units of local government that want to assess the feasibility of hosting an MRS facility.

We expect that the site-negotiations process will be governed by the following conditions:

- The terms on which a site is obtained will be agreed on through negotiations between the Nuclear Waste Negotiator and a State or an Indian Tribe willing to host the facility.

- Only if a State or an Indian Tribe expresses interest in hosting the MRS facility will the Negotiator consider any sites under its jurisdiction.

- A State or an Indian Tribe that wants to explore the possibility of hosting an MRS facility is under no obligation to conclude an agreement. The discussions or negotiations will be entirely voluntary and may be terminated at will by the potential host.

- A State or an Indian Tribe will enter into an agreement in accordance with its laws.

If a State, Indian Tribe, or unit of local government wants to explore the possibilities for hosting an MRS facility, information on a variety of subjects will be made available, including the following:

- Technical requirements and considerations for evaluating a potential MRS site.

- MRS design and technology options under consideration.

- Mechanisms for a decisionmaking partnership between the Federal Government and the host during MRS design, construction, operation, and decommissioning.

- Mechanisms for the exercise of oversight by the host.

- The colocation at the MRS site of other facilities and activities that could provide economic benefits for the host, such as an operations center for the nationwide system necessary to transport spent fuel or facilities for scientific research and other technical activities supporting the Federal waste-management system.

- Additional incentives that may be desired by the potential host.

The design of the MRS facility

Resembling an industrial park, the MRS site will occupy about 450 acres of land, including a buffer zone between the facility itself and the boundary of the site. Access to the site will be controlled; the site will be enclosed by fences and monitored by a security force. The layout of the facility will be tailored to the physical features of the site and any particular requirements negotiated by the host.

Storage concepts considered for the MRS facility

There are several proven concepts for handling and storing spent fuel. Some of them have been licensed by the Nuclear Regulatory Commission and are in use at reactor sites. The storage concepts that are licensed or are in the process of being licensed include storage under water in spent-fuel pools, the method commonly used at reactor sites; concrete casks; metal casks; multiple-element sealed metal canisters in concrete modules; modular vaults; and metal dual-purpose casks for transportation and storage. Other relatively simple concepts could be derived from previously proven concepts or concepts being used in foreign countries. The choice of storage concept will depend on safety, licensing, cost, and schedule considerations and the preferences of the volunteer host.

Vertical concrete casks. These casks are made of heavily reinforced concrete, and their walls are thick enough to provide radiation shielding (Figure 5-2). Heat is removed by passive means. The cask has an inner liner of steel and a

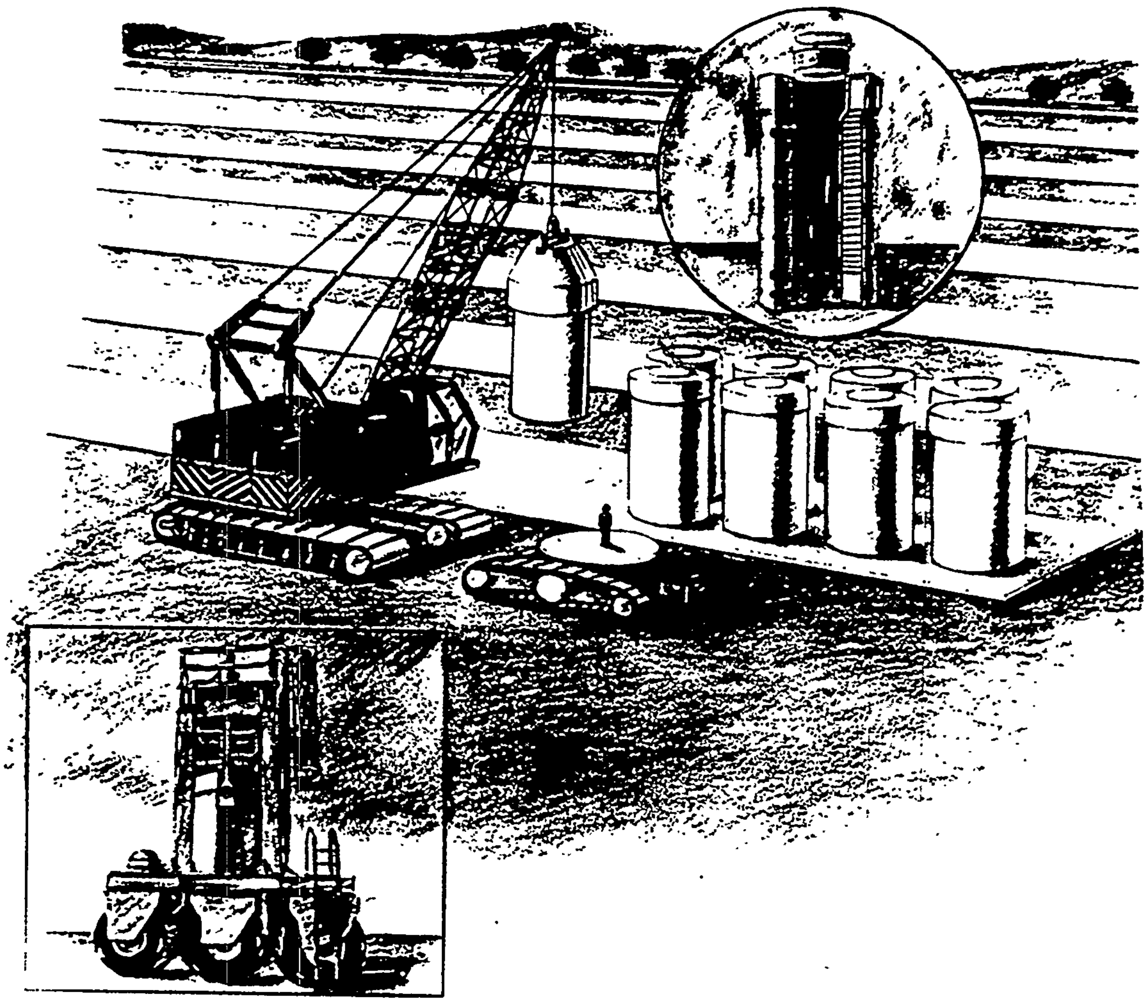


Figure 5-2. An artist's conception of concrete-cask storage, showing a cutaway view of a concrete cask (inset circle), part of the storage yard, and two kinds of transporters used to move the cask.

metal basket that holds the spent-fuel assemblies. After being loaded with spent fuel, the cask is sealed by a cylindrical concrete shield plug with a mechanical seal fit into the top of the cask cavity and a coverplate welded over the plug.

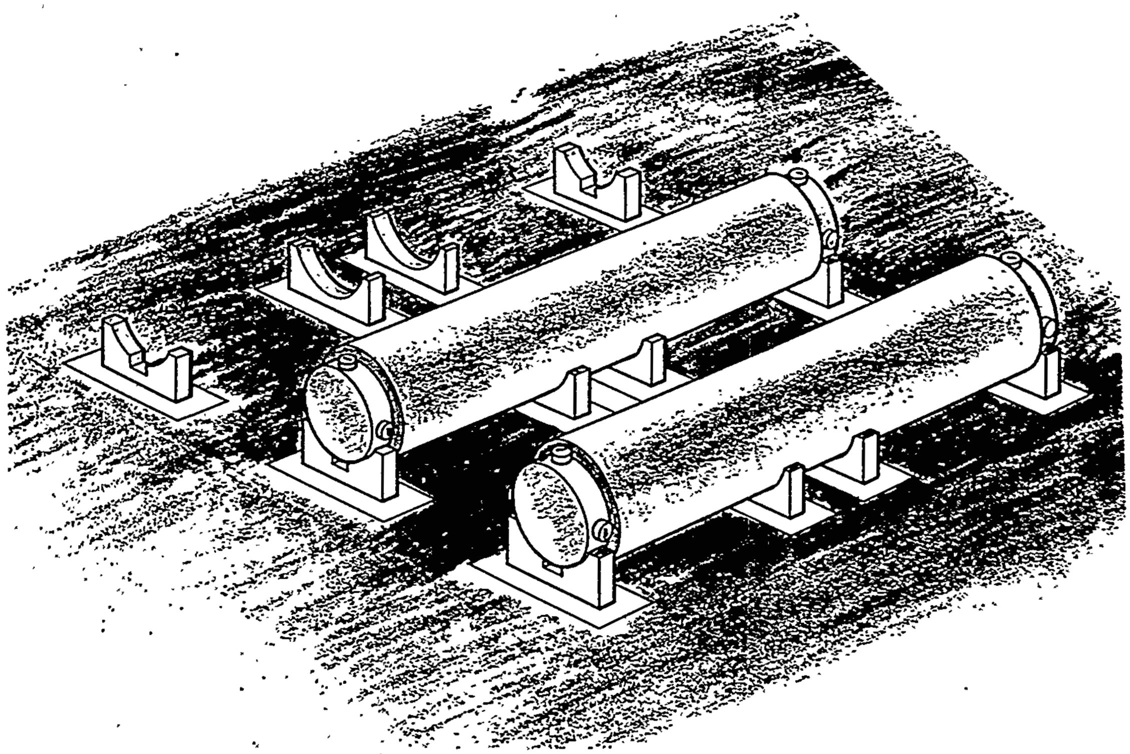


Figure 5-3. An artist's conception of spent-fuel storage in metal casks.

Metal casks. Metal casks, illustrated in Figure 5-3, are large and heavy vessels equipped with internal baskets for holding spent-fuel assemblies. The body of the cask is usually made from forged steel, cast iron, or lead and stainless steel. The walls of the cask are sufficiently thick to provide shielding against gamma radiation. In addition, the body of the cask contains a shield of neutron-absorbing material. Heat is removed by passive means. The external surface may be smooth or finned to enhance cooling.

Horizontal multiple-element sealed canister. In this concept, illustrated in Figure 5-4, the spent fuel is kept inside a sealed stainless-steel canister that is protected and shielded by a concrete module. Air channels are provided in the concrete module to remove the heat passively from the fuel.

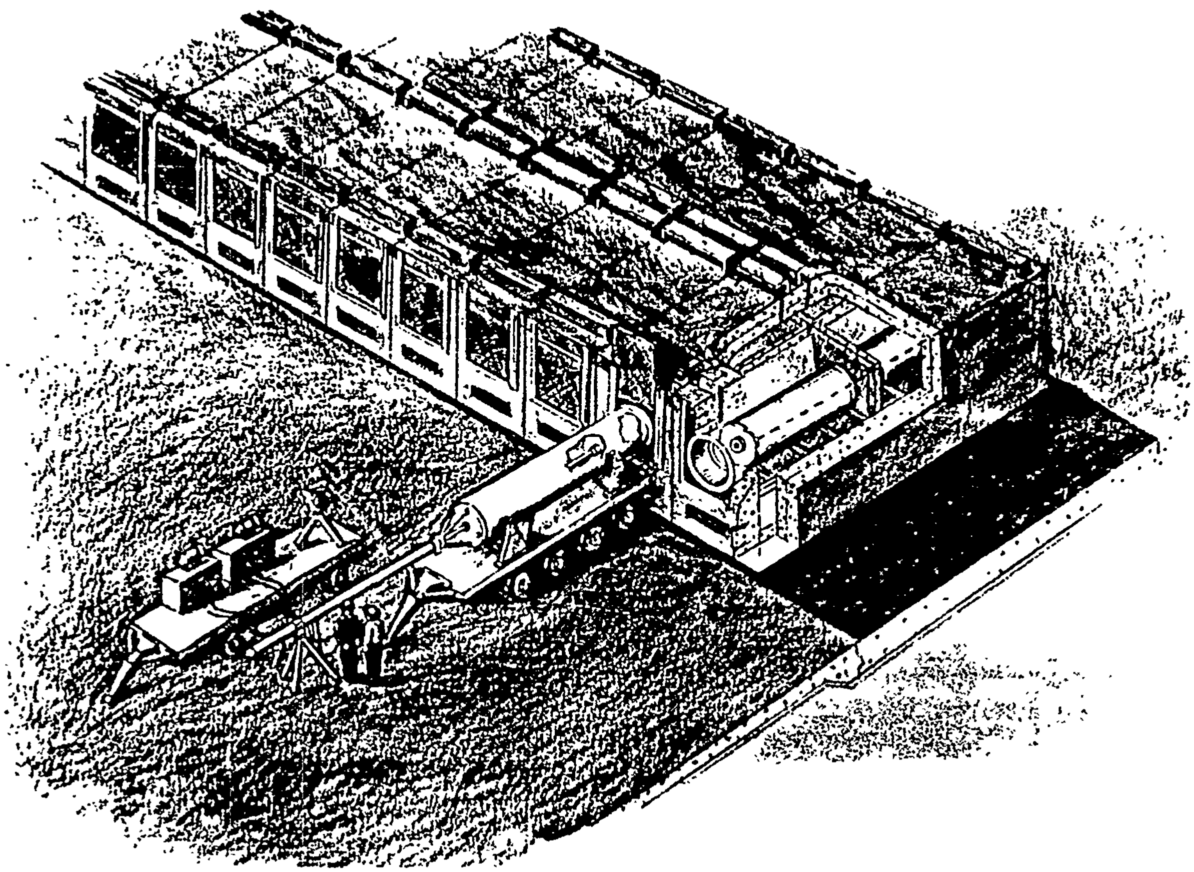


Figure 5-4. An artist's conception of spent-fuel storage in multiple-element sealed canisters inside a concrete module.

Modular vaults. Modular vaults consist of metal tubes arrayed vertically and housed in a concrete structure; an artist's conception of a modular vault is shown in Figure 5-5. The concrete provides shielding and protection on all sides. Heat is removed by passive means. Each tube stores a single spent-fuel assembly and is made of carbon steel. A shielded device would be used to transfer the spent-fuel assemblies from the shipping casks into the vertical steel storage tubes. The modules would provide ready access to the fuel assemblies, and additional modules could be easily added to expand storage capacity.

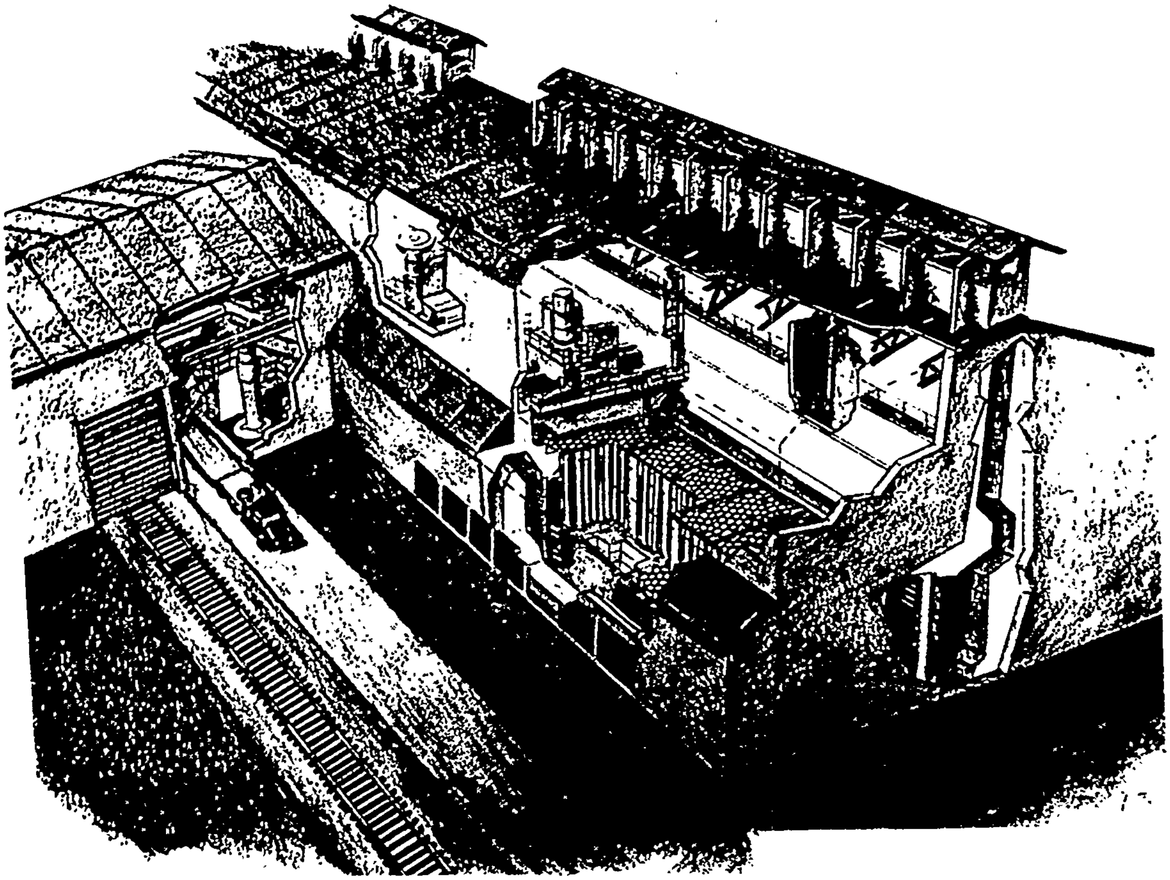


Figure 5-5. An artist's conception of modular vaults for spent-fuel storage.

Dual-purpose transportable storage casks. The dual-purpose transportable storage cask could be used to both ship and store spent fuel. The design (see Figure 5-6) is based on metal casks currently in operation as storage or shipping casks. Current designs of dual-purpose casks provide for large capacity and a

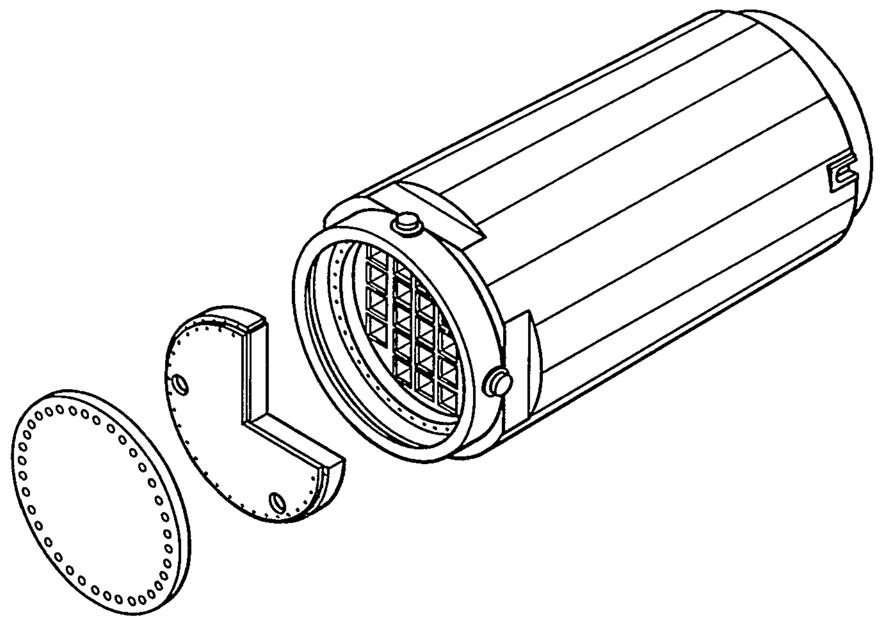


Figure 5-6. Diagram of a dual-purpose transportable storage cask.

weight of more than 100 tons when loaded with fuel. Such casks could be handled only at reactor sites with heavy cranes and access to rail transport. The cask would be loaded at a reactor site and would be shipped to the MRS facility, where it would be inspected and stored unopened. The casks will be manufactured in accordance with designs approved by the Nuclear Regulatory Commission, and they must withstand the same stringent tests that are applied to a shipping cask (Chapter 6).

Design concepts for other parts of the MRS facility

In addition to a method for storage, an MRS facility must have facilities for handling spent fuel. We had planned to provide for this purpose a large building with shielded cells for handling the spent fuel. Since such a building would require up to 36 months for construction, we had planned to develop the MRS facility in two phases. The first phase was to have used transportable storage casks or other dry-storage technologies that would minimize the need for spent-fuel handling. The spent-fuel-handling building was to have been completed in the second phase; it was to have provided additional storage capacity, additional capabilities for spent-fuel handling, and the ability to accept spent fuel at greater rates.

We subsequently identified simpler concepts for spent-fuel handling and storage. An MRS facility based on these concepts could be constructed quickly and meet our requirements. We have identified more than 20 combinations of possible storage-and-handling concepts that could be used. They vary in development time and costs. Some are modular; a facility based on these concepts could be constructed and ready to accept spent fuel in a year or less, and it could be expanded to increase the capability for spent-fuel acceptance as it becomes fully functional. An artist's conception of a simple spent-fuel-handling building is shown in Figure 5-7.

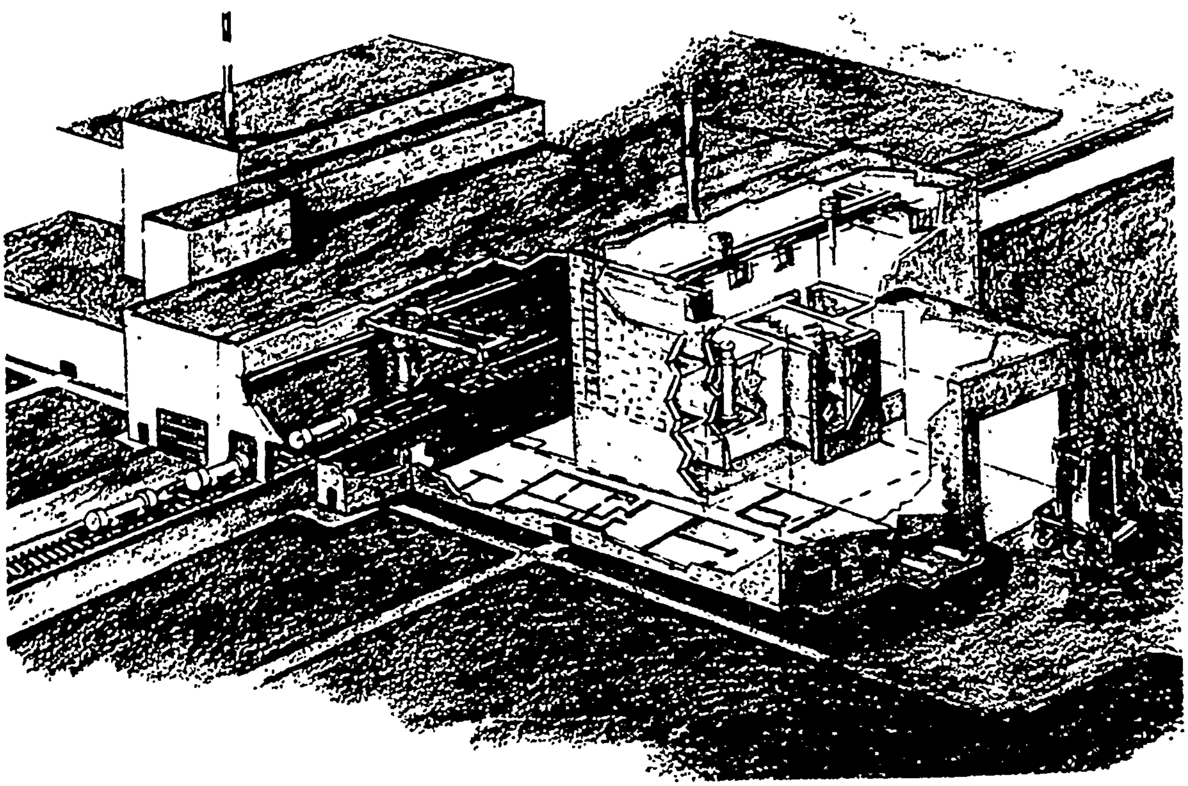


Figure 5-7. An artist's conception of a simple spent-fuel-handling building at the MRS facility, showing a hot cell on the right.

Other buildings at the MRS site will house laboratories for environmental monitoring and offices for administration and security personnel. If concrete casks are used for storage, a plant for fabricating these casks will be built at the MRS site. Furthermore, we may decide to add to the MRS site a maintenance facility for shipping casks and their components. In conjunction with a volunteer host, we may decide to locate other transportation-support facilities at the MRS site (Chapter 6).

The design of the MRS facility will include facilities for the treatment of the low-level radioactive waste that will be generated at the MRS site. These wastes will be collected and prepared for disposal away from the MRS site. We will prepare a plan for the management of these wastes.

The chosen MRS configuration will allow the facility to be constructed quickly and use proven technologies to the greatest extent practicable. We are evaluating available and reasonably achievable technology and configuration alternatives that can provide safe, timely, and cost-effective waste management.

In addition, the design could include equipment and facilities needed for preparing spent fuel for permanent disposal if such preparation is found to be beneficial to the total waste-management system. These functions could be included in the basic design or added later. However, once the Congress has approved the original proposed agreement between the Federal Government and an MRS host, the addition of any new functions would have to be consistent with the agreement. Furthermore, the addition of new functions could require an amendment to the MRS license and hence a review by the Nuclear Regulatory Commission.

Safety

The radiation-related risks of the MRS facility are predicted to be very small. These predictions are based on the technologies considered for the facility, experience with nuclear operations, and the evaluations performed by the

Nuclear Regulatory Commission for several dry-storage facilities, operated by utilities, that use storage methods similar to those that will be used at the MRS facility (see, for example, references 29 and 30).

To help ensure that risks are kept very small, concern for safety will be the underlying principle in siting, designing, building, operating, and decommissioning the MRS facility. The facility will employ multiple physical barriers to protect the health and safety of the public and workers and the quality of the environment. It will have backup safety systems and fail-safe designs as appropriate. Similarly, multiple procedural protections (see below) are built into the process by which the MRS facility will be developed and operated. Adding to this comprehensive safety network will be the scrutiny of oversight bodies and public review.

We are committed to siting, designing, constructing, operating, and decommissioning the MRS facility in a manner that protects health and safety and the quality of the environment.

Safety features

The safety features of the MRS facility will include physical barriers, the training of personnel, and operating procedures. The physical features may include massive concrete or metal shielding of equipment used during handling and storage operations, extensive shielding of the spent fuel itself and of the areas in which the fuel is handled, the use of remotely controlled manipulators or robots, airtight sealed transfer areas and devices, the confinement and filtration of air from areas in which spent fuel is handled, a buffer zone between MRS facilities and the boundary of the site, and equipment for monitoring the facilities in which spent fuel is handled and stored. Personnel will be extensively trained in the proper procedures for normal operations and procedures for responses to emergencies.

All of these precautions are designed to meet the licensing requirements of the Nuclear Regulatory Commission—requirements that protect the health and safety of the public and workers and the environment in the event of an accident due to natural events or human error.

Procedural protection

Among the key procedural protections are an early review of whether a site is technically suitable, reviews of the potential environmental and socioeconomic effects of an MRS facility, Congressional review of a proposed agreement, reviews of our plans by the Nuclear Waste Technical Review Board, licensing by the Nuclear Regulatory Commission, and continued monitoring of MRS operations by the Commission.

The host can assure itself that the MRS facility performs to its satisfaction, meets community standards, and serves community goals.

Equally important, the MRS facility will be sited with the consent of the volunteer host, and the host can negotiate for itself an active role in MRS development and operations. By participating in decisionmaking and by exercising rigorous oversight of MRS activities, the host can assure itself that the MRS facility performs to its satisfaction, meets community standards, and serves community goals.

Licensing

Before we can build and operate the MRS facility, we will have to apply to the Nuclear Regulatory Commission for a license. The Commission will issue this license only if it is satisfied that its requirements for the protecting the public, the workers, and the environment are fully met.

We plan to submit a single application for a license under the applicable regulations[31] (10 CFR Part 72) to construct and operate the MRS facility. The license application will describe the proposed facility, describe the conditions under which it will be constructed and operated, and explain how and where activities will be performed. It will contain an assessment of the proposed design and operations to determine whether they are in compliance with the regulatory criteria of the Commission and will include an environmental impact statement.

To facilitate licensing, we will base the design, to the extent practicable, on technologies that have already been licensed and that have proved reliable through actual operating experience. Simplicity of design and maintenance and reliance on well-established operating procedures will add to confidence in the technology. We also plan to select, to the extent practicable, a design whose licensability and certification are relatively independent of site-specific conditions. We will meet with the staff of the Commission before licensing to identify issues and begin working to resolve them.

Protection of the environment

It is our policy to conduct our operations in a manner that is environmentally safe and sound, and we intend to comply with all applicable Federal, State, Tribal, and local regulations; executive orders; and the requirements of the Department of Energy in the siting, construction, operation, and decommissioning of the MRS facility.

We will comply with all applicable Federal, State, Tribal, and local regulations in the siting, construction, and operation of the MRS facility.

Our first major activity in this area will be the preparation, when requested by the Negotiator, of an environmental assessment for a proposed MRS site. The assessment is to include a detailed statement of the probable impacts of constructing and operating an MRS facility at the site. (An environmental assessment is also required if the MRS facility is sited through a survey-and-evaluation process directed by the Department of Energy.) During the preparation of the assessment, we will hold public hearings to present information about the MRS facility to the public and to receive comments and recommendations as to what issues and concerns the public wants the document to address. We will consult closely with the potential host in preparing the document, and the host may wish to negotiate for itself an even more active role in developing the environmental assessment.

Once the selection of an MRS facility site is effective, the requirements of the National Environmental Policy Act of 1969 will apply, including the requirements for the preparation of an environmental impact statement. The final environmental impact statement will accompany the license application to the Nuclear Regulatory Commission.

We will have additional environmental-compliance and mitigation responsibilities at the MRS facility. To meet our responsibilities, we plan to develop an environmental program for the MRS facility and to prepare a programmatic planning document that will identify applicable environmental requirements and describe the actions necessary to ensure compliance with these requirements.

The construction of the MRS facility will be similar in scale to the construction of an industrial park, and its operation is not expected to have significant effects on the environment. At the end of its operating life, the facility will be decommissioned and the site will be restored, consistent with any terms negotiated by the host and the Federal Government.

Socioeconomics

The social and economic impacts of the MRS facility may be both favorable and unfavorable. The specific types and degrees of impacts of the MRS facility will depend on the specific design characteristics of the facility itself and the particular socioeconomic conditions of the host community.

Favorable impacts will include more jobs, greater tax revenues, and the influx of money into local businesses. The kind of technology selected to perform the basic functions of the MRS facility will dictate the size of the work force and the types of workers needed for the facility. Depending on work-force requirements and the local availability of labor, the negotiated agreement might provide for training to help and encourage local residents to obtain employment at the MRS facility.

Adverse impacts should be minimal. They could result if increased demands on government and community facilities, housing, and services (e.g., schools, wastewater treatment, and medical care) exceed local resources; if increased demand for water and land places a burden on scarce resources; and if the quality of life desired by the community is adversely affected. If so, these impacts will be mitigated or compensation will be provided.

While potential adverse impacts can result from any large development project, the public may perceive special risks associated with facilities handling radioactive materials. People who live near a site at which such a facility may be located may be concerned that their property values will decrease, that fewer tourists will visit, or that industries or businesses that might have moved to the area will be driven away.

To adequately address these potential socioeconomic impacts, assessments will have to be performed at various stages of MRS siting and development. The Nuclear Waste Policy Act provides funding for potential hosts to conduct their own studies to assess the feasibility of hosting an MRS facility. And socioeconomic impacts will be included in the environmental assessment and the environmental impact statement described in the preceding section.

International activities

The technologies being used for spent-fuel handling and storage in other countries may provide information useful to our efforts to plan, site, and design an MRS facility. We monitor and participate as appropriate in relevant activities of the International Atomic Energy Agency, including a research project on the behavior of spent fuel in storage. We also monitor technology developments and progress in other countries so that any useful approaches and technology can be adapted for use in our waste-handling and storage activities, expertise from other countries can be acquired to support our activities, and a broader experience base can be used to formulate program policy and direction.

Schedule

The reference schedule for the MRS facility is presented in Figure 5-8. This schedule has been revised to reflect program changes that have occurred since the schedule published in the Secretary's 1989 report.[27] As was stated in the case of the repository, the MRS schedule may be affected by factors beyond our control, including funding levels and litigation. In addition, it is based on the assumption that the Congress will enact a proposed agreement with a volunteer host State or Indian Tribe in 1992 and that this agreement will not include provisions linking the construction and operation of the MRS facility to the construction of the repository. Once the agreement has been enacted, we will start the process of scoping the content of the environmental impact statement and will issue the statement in draft for public comment in 1994. The final environmental impact statement will be issued in 1995 and submitted along with the license application to the Nuclear Regulatory Commission. In order to provide the staff of the Commission additional time for their safety review, we plan to submit the safety analysis report for the MRS facility in 1994, some 12 months ahead of the license application. The period allowed for license review by the Commission includes completion of the adjudicatory process. Construction will begin in 1996. Waste acceptance at the MRS facility will begin in 1998.

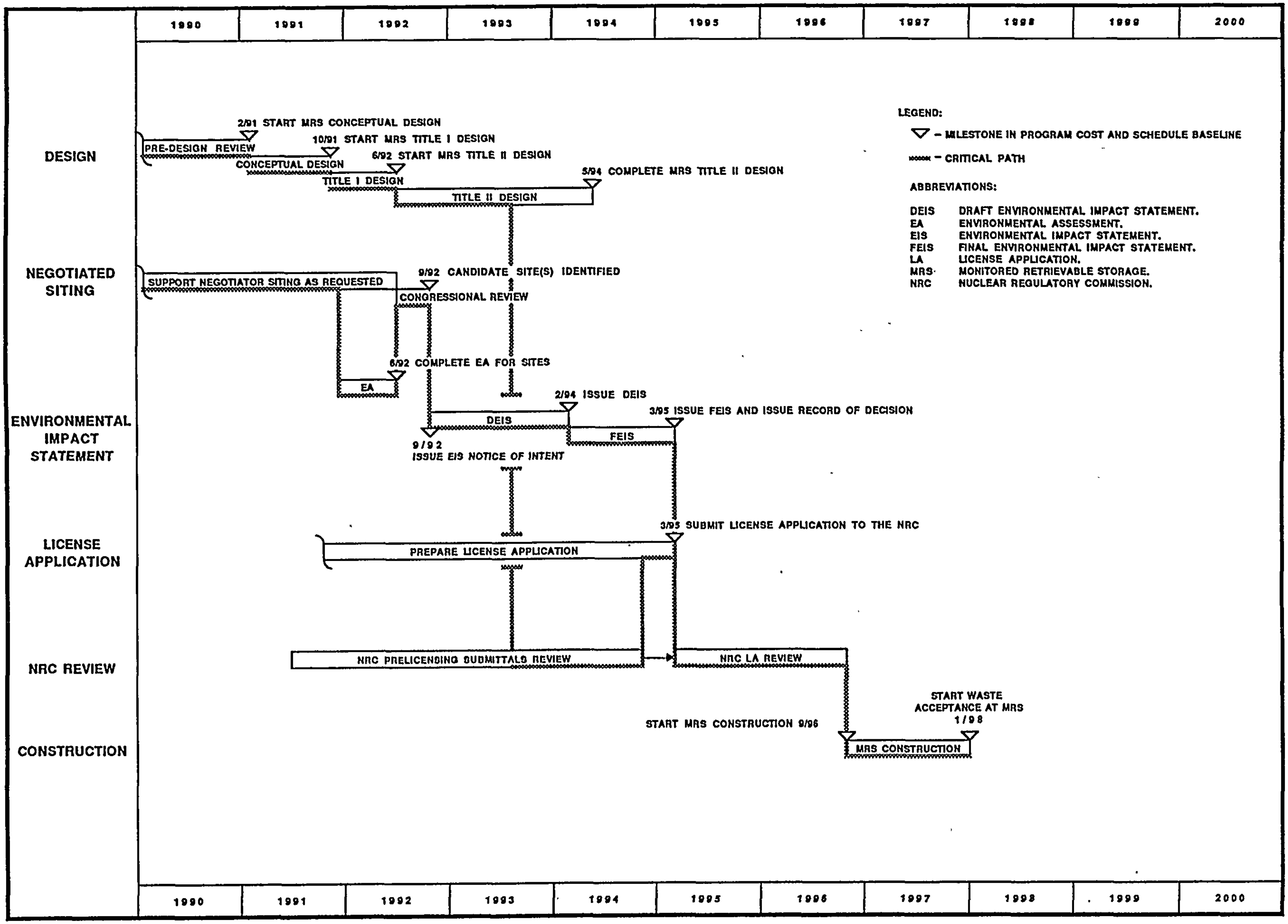
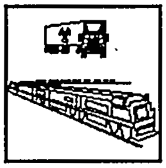


Figure 5-8. Reference schedule for the MRS facility.

6. TRANSPORTATION



The transportation of radioactive waste may do more to bring radioactive-waste disposal to widespread public attention than any other aspect of the Federal waste-management program. We will therefore emphasize demonstrating the safety of transportation to the public as well as the technical community.

A key element of the waste-management program is the development and operation of a safe, publicly acceptable, and economical waste-transportation system that is available when needed. We will accept spent fuel at reactor sites and ship it to the MRS facility or directly to the repository, depending on the location of the reactor site and the MRS facility. The shipments will be made by truck, rail, or barge or a combination of these modes. From the MRS facility, the spent fuel will be shipped in dedicated trains to the repository. High-level waste will be shipped by rail directly from the sites where it is stored to the repository. The locations at which we will accept waste for shipment are shown in Figure 6-1.

Approach to development and operation

Safety. The primary policy governing the development and operation of the transportation system is the protection of health and safety, for both the public and the workers at the MRS facility. We will carefully manage our contractor activities to ensure compliance with applicable Federal, State, Tribal, and local regulations pertaining to the transportation of spent fuel and high-level radioactive waste.

Public participation. We recognize that the participation of interested parties is essential to promote better understanding and to foster public confidence in the safety of waste transportation. As discussed in Chapter 7, we will continue to work with interested parties to ensure that their concerns are identified, evaluated, and appropriately addressed. We use a variety of mechanisms and forums to provide opportunities for participation.

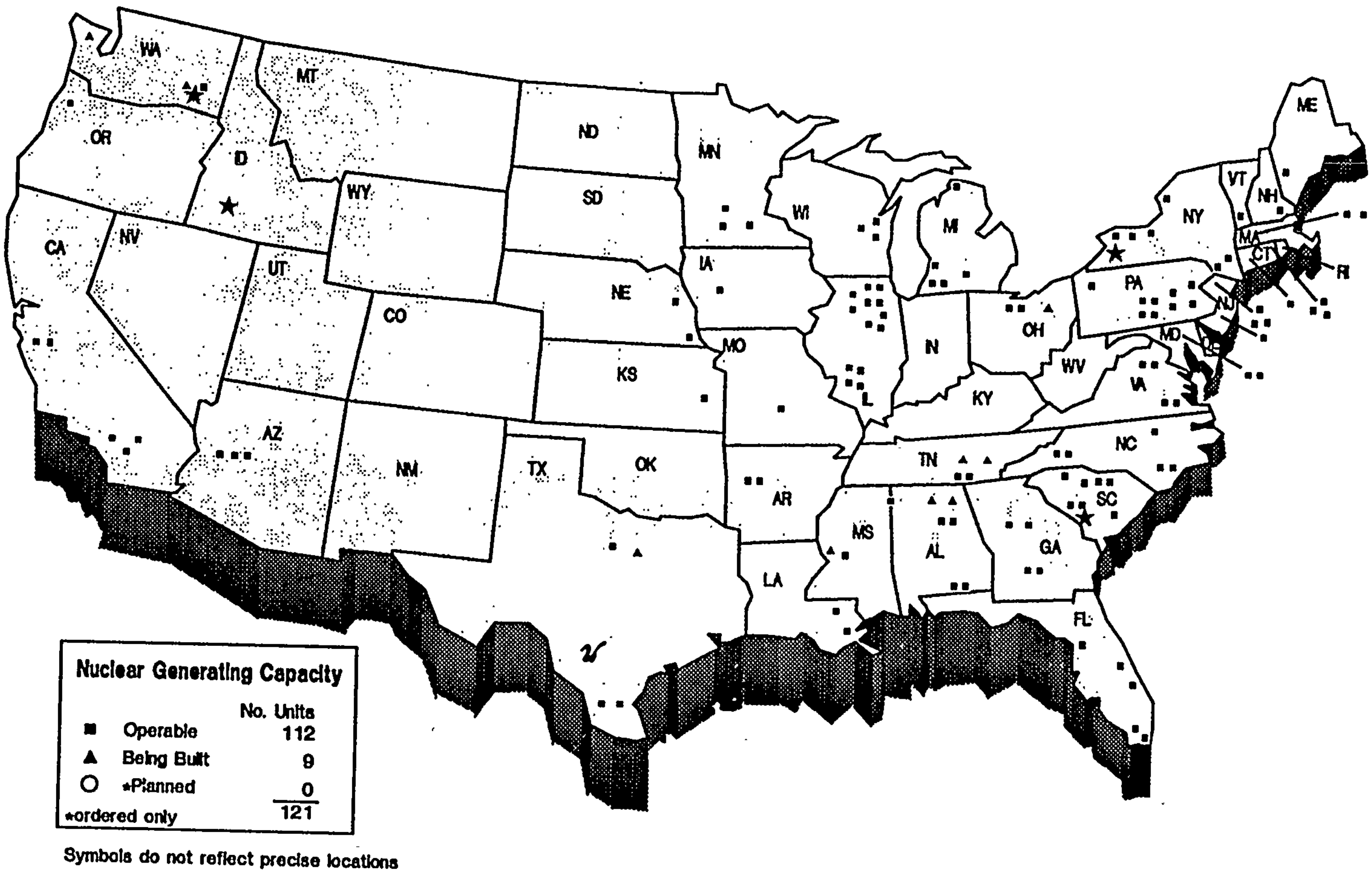


Figure 6-1. Locations at which we will accept waste. (The stars indicate sites at which high-level waste is stored.)

Use of private industry. As directed by the Congress, we will use private industry to the fullest extent possible in each aspect of transportation, including the development and procurement of shipping casks, the transportation support system, and associated services.

Efficiency and cost effectiveness. The transportation program must be efficient and cost effective. All major decisions are based on the results of both system studies and economic analyses, and we have developed technical models and data bases to support these studies. In addition, in evaluating cost effectiveness, we intend to consider institutional implications where appropriate. We will also consider activities funded by other Federal, State, Tribal, or local agencies, such as the emergency-response training funded by the Federal Emergency Management Agency, in order to avoid duplication of effort.

Basic strategy for acquisition

For shipping spent fuel from reactor sites to the MRS facility, we are developing new-generation casks, with capacities greater than those of existing casks, for shipments by truck and by rail or barge. We are also planning for the acquisition of existing casks as a complement to the casks being developed. We will also establish the capability for transportation operations. Besides the shipping casks and other equipment, this will require the procurement of the services of contractors who will arrange carriage, maintain equipment, inspect equipment, plan and schedule operations, and train personnel. In addition, we will provide technical assistance and funds to States for training the public-safety officials of local governments and Indian Tribes through whose jurisdictions wastes will be shipped. A decision to be made is in regard to operation: What is the most efficient way to operate the transportation system, using private industry to the fullest extent possible?

For later phases of the program, when waste is to be shipped from the MRS facility to the repository, we will consider developing casks with larger capacities. We are also planning to develop casks for high-level waste and for nonstandard spent fuel.

Detailed plans for the transportation program will be given in the Transportation Plan, which will be issued after this Mission Plan Amendment. That document will supersede the Transportation Institutional Plan[32] and the Transportation Business Plan.[33] The plan will be available to all parties who may be affected by, or are interested in, our transportation activities.

How a typical shipment will be made

A typical truck shipment of spent fuel from a reactor site will begin with directions from our transportation operations center to the motor carrier. The carrier will be instructed to send a tractor-trailer to pick up an empty shipping cask and proceed to a particular reactor site. After arriving at the reactor site, the cask will be lifted by crane from the transporter, and both the cask and the tractor-trailer will be inspected. At this point, utility personnel will move the cask into the spent-fuel storage pool (or another facility suitable for loading spent fuel), load it, and move the loaded cask onto the tractor-trailer. Our representative will then verify the classification and description of the waste and accept title to it. Before the cask is allowed to leave the reactor site, the tractor-trailer and the cask will again be inspected to verify that all safety requirements are met, and the qualifications of the driver will be checked; this step may involve our personnel, utility personnel, and State inspectors.

Every shipment will have to pass multiple inspections to ensure safety.

Strict rules will be followed while the shipment is in transit (see "Operating procedures," page 113). On arrival at the MRS site or the repository, the tractor-trailer and the cask will be inspected again. Once the inspection has been completed, the cask can be lifted from the tractor-trailer for unloading the spent fuel.

A similar series of events involving multiple inspections will be followed when waste is shipped by rail.

The design and development of shipping casks and related equipment

Waste transportation will require shipping casks, which are rugged containers designed to protect the public, the transportation workers, and the environment and to contain their contents under both normal and accident conditions. The cask will be carried by a transporter, which will be a tractor-trailer for shipments by truck (Figure 6-2) and a railcar for shipments by rail (Figure 6-3). Ancillary equipment includes (1) tiedowns and other equipment needed for handling the cask and securing it to the transporter and (2) equipment used for maintenance. The casks and other equipment must be compatible not only with the facilities from which waste will be accepted but also with those to which the waste will be shipped—the MRS facility and the repository.

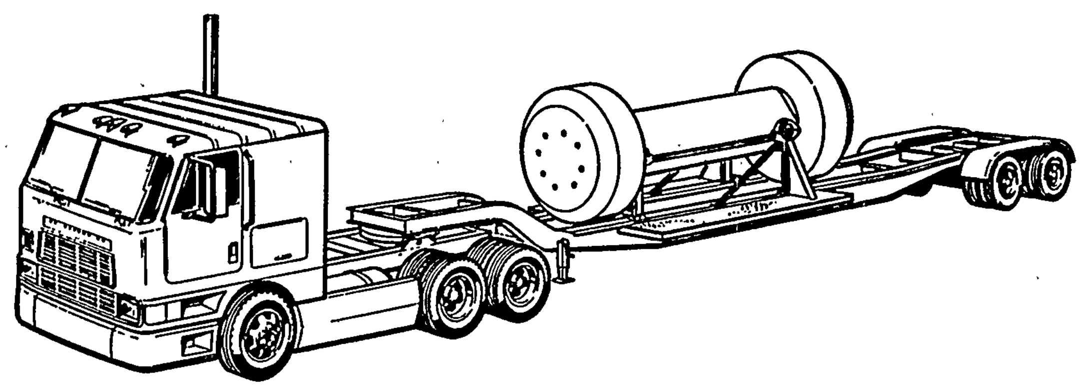


Figure 6-2. Tractor-trailer and cask used for shipment by truck. During an actual shipment, the cask would be enclosed in a personnel barrier and carry placards warning that the cargo is radioactive, and the tractor would be equipped with a device allowing the shipment to be tracked by satellite.

The development of casks for shipments from reactors

We have undertaken a major effort in developing a new generation of casks. The designs of these casks, like those of the existing casks, are to be certified by the Nuclear Regulatory Commission. At present we are concentrating on developing "from-reactor" casks suitable for shipping most of the spent fuel to either an MRS facility or a repository. We are currently developing one truck cask and another cask suitable to be transported by rail or barge. The designs of these casks are nearing completion. The next step will be an application to receive from the Nuclear Regulatory Commission a certificate of compliance in accordance with the Commission's regulations[34] for the packaging and transportation of radioactive material (10 CFR Part 71). We are also developing, at a reduced level of effort, a second design for a truck cask and a second design for a rail-or-barge cask.

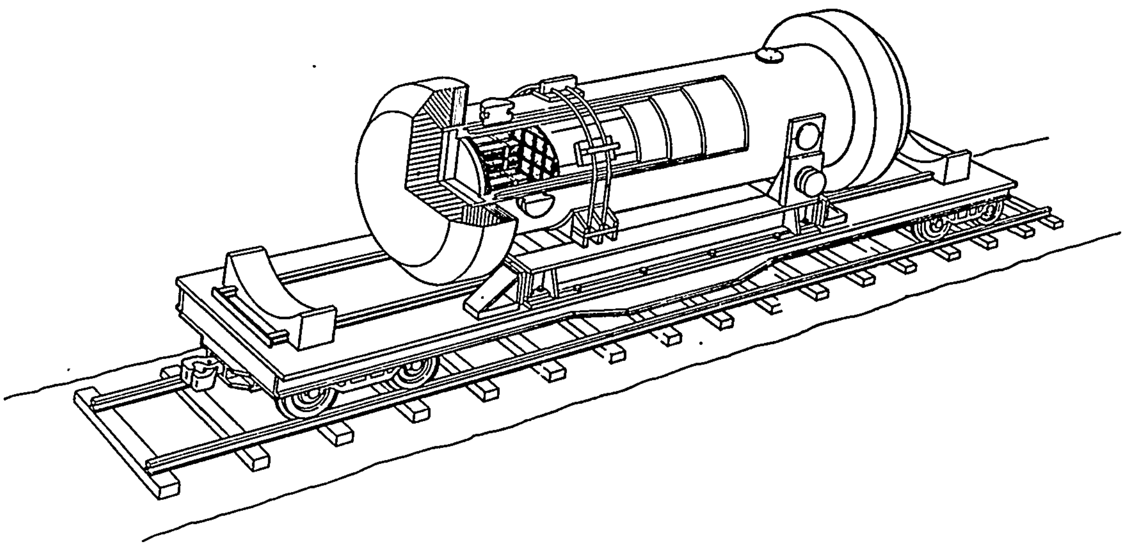


Figure 6-3. Railcar and cask used for shipment by rail. The cask is shown in a cutaway view. During an actual shipment, it would be enclosed in a personnel barrier and carry placards warning that the cargo is radioactive, and the railcar would be equipped with a device allowing the shipment to be tracked by satellite.

The major parts of the cask are a high-strength body; a fuel-support basket, which holds the spent-fuel assemblies; shielding against gamma radiation and shielding against neutrons; removable impact limiters at each end of the cask; closure heads; and pins for lifting the cask and securing it to the bed of the tractor-trailer. With the impact limiters attached, the truck cask is 18 to 20 feet long and 6 feet in diameter (Figure 6-4). The nominal weight for a loaded legal-weight truck cask is expected to be 26 to 28 tons. A "legal-weight truck" is a tractor-trailer whose gross weight when loaded is properly distributed and does not exceed 40 tons and whose dimensions meet limits set by the States.

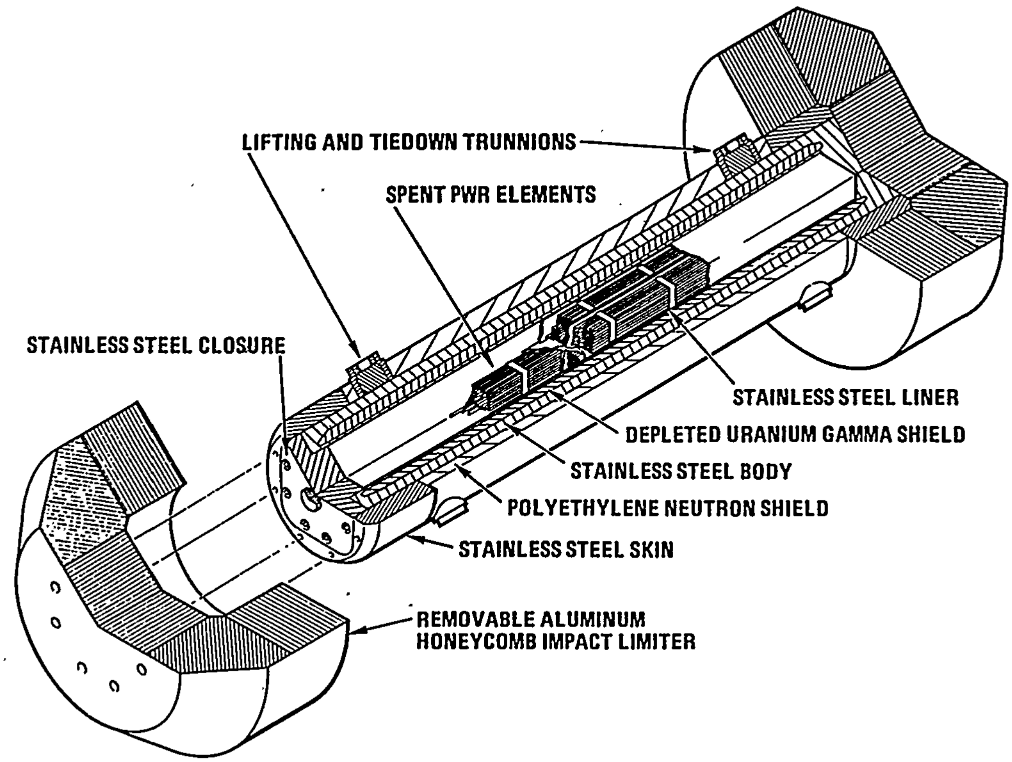


Figure 6-4. Diagram of a truck cask.

The rail-or-barge cask (Figure 6-5) is larger than a truck cask and can carry more spent fuel. When loaded, it will weigh 100 tons. With the impact limiters attached, it will be 21 feet long and 10 feet in diameter. This type of cask is usually mounted on a skid suitable for a railcar or a barge.

We are also considering the advantages and disadvantages of developing and using an overweight-truck cask, which would reduce the number of shipments. Such a cask may be of use at reactor sites that can load casks that are heavier than the legal-weight truck cask but cannot accommodate rail-or-barge casks. An "overweight truck" is a tractor-trailer unit designed to transport heavy loads, with the gross vehicle weight exceeding 40 tons. To use such trucks we would have to obtain overweight permits from the States that would be traversed, and the hours of operation could be limited. We will base our decision on the use of such casks on operational considerations, such as the difficulty of scheduling shipments, and potential benefits to the efficiency of the waste-management system.

Advantages of developing new casks

Two major advantages are expected from the new designs: (1) increases in payload and (2) standardization of equipment and procedures for handling.

Increases in payload. Increases in payload will reduce the number of shipments, which in turn will decrease costs. The increases will be possible because the spent fuel we ship will be older than the spent fuel for which the current generation of casks was designed. For certification by the Nuclear Regulatory Commission, the age of the fuel at shipment is a key factor. The spent fuel we will ship will be at least 10 years old, whereas the existing casks were designed for fuel aged much less (e.g., 6 months or 2 years, depending on the cask).

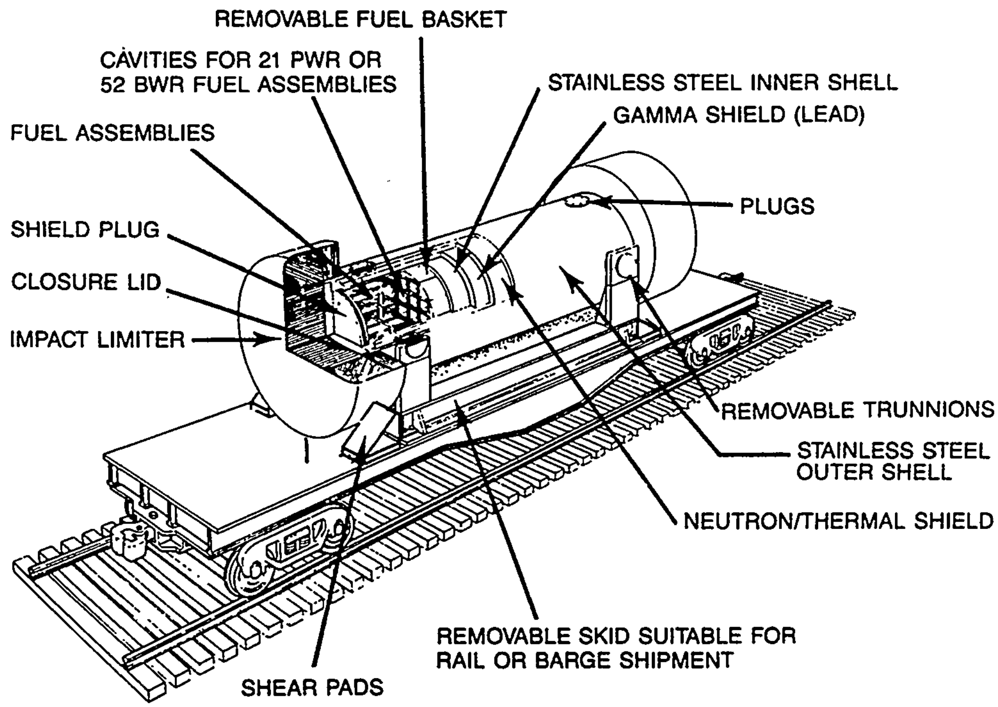


Figure 6-5. Diagram of a rail cask.

Because spent fuel is less radioactive as it ages, older fuel requires less shielding and generates less heat, and therefore more spent fuel can be shipped in a cask. The legal-weight truck cask we are developing for shipments from reactor sites (Figure 6-4) can carry three to four spent-fuel assemblies from a pressurized-water reactor (PWR) or seven to nine assemblies from a boiling-water reactor (BWR); the existing casks can accept no more than one PWR assembly or two BWR assemblies. The cask we are developing for shipment by rail or barge (Figure 6-5) will be able to carry 21 to 26 PWR assemblies and 48 to 52 BWR assemblies; the capacity of existing railcasks is 7 PWR assemblies or 18 BWR assemblies.

Standardization of equipment and procedures for handling. The development of new cask designs will permit the standardization of cask-handling equipment. The standardization of cask interfaces could not only increase the efficiency of handling but also simplify procedures for a variety of organizations that are likely to be involved in waste shipments.

To ensure compatibility with reactor sites, we are conducting studies to determine the interface characteristics of each reactor site; we are also determining the existing transportation infrastructure in the area of each site. The facility interface study will evaluate the handling and shipping capabilities of the facilities where we will accept waste and determine the physical and administrative constraints that will affect transportation operations at that site. The infrastructure study will cover potential rail, road, and barge access corridors to and from each site. Taken together, these studies will serve as a basis for determining site-specific transportation requirements, which will be periodically updated as conditions change. The results of these studies are being factored into the cask-design activities and into our planning for the acquisition of existing casks.

The development of other casks

We are considering two approaches to the development of casks for shipping spent fuel from the MRS facility to the repository, for shipping spent fuel and irradiated hardware that cannot be accommodated in the casks we are now developing, and for shipping high-level waste. One approach would be to develop new cask designs; the other would be to modify the design of casks developed for shipments from reactor sites. The choice of approach will depend on the results of tradeoff studies comparing the advantages and disadvantages of each approach.

The process of development and procurement

In developing the casks we are using private industry to the fullest extent possible. Where appropriate, however, we will provide technical and testing assistance to industry. We will make available for review the results of work we support, such as topical reports and the results of engineering and design-verification tests.

The application for cask certification will be prepared and filed with the Nuclear Regulatory Commission by the development contractors. The application for certification will be accompanied by a safety analysis report, which must include evidence that the cask can survive specific test conditions, as discussed later under "Safety." Analyses, supported by appropriate design-verification tests, will be used to demonstrate compliance with the Commission's regulations. Scale models replicating the cask designs will be used for these design-verification tests.

Our contracts call for the contractors to fabricate full-scale prototypes of each cask, which is expected to take about 2 years. When the prototypes are ready, acceptance and operational testing will be conducted. In these tests, we will evaluate the casks as part of the integrated transportation system. Some of the tests will be done for the purpose of establishing detailed handling procedures for the casks, cask components, and special handling equipment; others will be done to provide experience in the handling of casks and equipment. This operational testing program is expected to include exercises in handling the prototype casks at reactor sites and at facilities operated by the Department of Energy, such as the Idaho National Engineering Laboratory. In defining the testing program, we will draw on the operational experience of the transportation program for the Waste Isolation Pilot Plant, which has been constructed in southeastern New Mexico for the disposal of transuranic radioactive waste from defense activities.

To assist the cask designers in the cask-certification process, we are sponsoring studies of technical issues that may arise. The issues being examined include credit for "burnup" in the reactor, which is related to cask capacity; the method used to evaluate the amount of dispersible radioactive material, or "source term," in the cask; and methods for controlling any contamination of the outside surfaces of the cask. We will address other issues as they are identified.

The development of equipment needed for handling shipping casks

Included in the transportation program is the development of equipment for handling the shipping casks. We have identified the cask-handling equipment (e.g., yokes, special tools) that will be needed. Our general objective is to standardize wherever possible and to avoid designs requiring special tools.

We are also interested in using remotely controlled and automated equipment for cask handling. One benefit of using such equipment is precision. More important, it decreases the exposure of workers to radiation, and we are therefore encouraging the cask contractors to design casks to accommodate automated equipment.

Transportation support system

The transportation support system will consist of a cask-maintenance facility, which may be constructed at the site of the MRS facility, and other transportation support systems, such as facilities for operations, the training of personnel, and the maintenance of equipment. The required support systems will be identified as the need for them becomes evident, when more information about the remainder of the waste-management program is available, and when future decisions about cask development are made. Like the cask-maintenance facility, they may be colocated with other waste-management facilities. Some functions may be provided by existing Federal or private facilities.

We are currently determining the requirements for the cask-maintenance facility. We have used the preliminary designs of the "from-reactor" shipping casks being developed to perform a functional analysis for this facility and to develop a preliminary conceptual design. The development of other transportation support equipment and facilities will proceed as functional requirements are defined.

Transportation modes

As already mentioned, the waste may be shipped by truck, rail, or barge or a combination of these modes. Although the modes of transportation for specific shipments have not been determined, we prefer to ship by rail where possible because fewer shipments would be needed. The decisions on transportation modes will depend on the type of cask preferred by the waste generators and will be made during planning for operations.

In the case of shipments from reactor sites, operational factors contributing to the ability to ship by rail will depend mainly on two conditions: the availability of rail access to a particular site and the ability of the facility to handle the much heavier rail cask. Our understanding of the situation will be greatly helped by the study we are conducting to evaluate the handling and shipping capabilities of reactor sites. Since it is already clear that it will not be possible to use trains or barges for shipments from all reactor sites, we plan to maintain the capability to transport waste by truck.

For moving spent fuel from the MRS facility to the repository, we plan to use rail shipments by dedicated train. We also plan to rely mainly on rail transport for shipping high-level waste, which will go directly to the repository, without first being routed to the MRS facility.

Identification of routes

Highway shipments

Because highway shipments travel on public roads, highway routing of radioactive materials is subject to Federal law in the form of regulations[35] issued by the Department of Transportation (DOT). These regulations specify that spent fuel and other highly radioactive materials must be transported on "preferred routes." Preferred routes consist of the Interstate highway system or alternative routes designated by State routing agencies. These agencies are defined to include both State agencies and Indian Tribal authorities that have police powers to regulate and enforce highway-routing requirements. These agencies must use DOT guidelines or equivalent criteria in designating alternative routes that may be used. The guidelines identify the important factors to be considered in selecting routes that will minimize any risks to the public. If requested, we will provide technical assistance to States and Indian Tribes for evaluating and designating alternative routes.

Our contracts with the transportation-service contractors who will carry the shipments will specify the requirements of DOT routing regulations and formally direct that all shipments be conducted on Interstate highways or on alternative routes designated by States and Indian Tribal governments. Carriers will select their routes on the basis of these specifications.

We will identify potential alternative routes in order to identify the jurisdictions that may be eligible for training assistance.

Rail shipments

Rail routing of radioactive materials differs from highway routing: because rail shipments travel on private railways owned and maintained by rail carriers, rail routing of radioactive materials is not currently regulated. Unless the Department of Transportation issues rail-routing regulations in the future, we, in consultation with the rail carriers and interested parties, will develop rail-route planning criteria for the waste-management system.

Operating procedures

To facilitate compliance with transportation regulations and to guide and control transportation activities, we will develop a detailed set of operating procedures. These procedures will specify how the casks are to be loaded and handled, how they are to be inspected, and how they are to be maintained. In developing these procedures we will work closely with the waste generators to resolve any technical issues well in advance of shipments.

Already drafted are procedures for the State inspection of highway shipments. These procedures were developed by a task force convened in 1986 by the Commercial Vehicle Safety Alliance in a cooperative agreement with us. The procedures are being reviewed for adoption by members of the Alliance. They are intended for use by State inspectors to inspect shipments at points of origin and destination; they include inspection of drivers, shipping papers, vehicles, and casks. In August 1989, we renewed our cooperative agreement with the Alliance and will conduct a 5-year pilot program to test the State-inspection procedures during shipments of transuranic waste from the Idaho National Energy Laboratory to the Waste Isolation Pilot Plant in New Mexico. The adoption of these procedures would create uniform inspection-and-enforcement standards, which would be beneficial to our transportation program.

Safety

Our planning for transportation operations will draw on the significant experience gained in many years of shipping radioactive waste and other hazardous materials. Approximately 100 million shipments of hazardous materials are made each year in the United States, and approximately 3 million of these shipments carry radioactive material.[36] (Included in the shipments of radioactive material are shipments of spent fuel, with the equivalent of about 2000 metric tons of uranium having been shipped to date in the United States.) For comparison, the maximum annual number of shipments under our program is estimated at 850 to 900 shipments by rail and truck when full-scale operations begin.

While accidents have occurred in the transportation of spent fuel and high-level waste over 40 years of shipping, none of them has caused death or environmental damage due to the radioactivity of the cargo.

While accidents have occurred in the transportation of spent fuel and high-level waste over 40 years of shipping, none of them has caused death or environmental damage due to the radioactivity of the cargo. The factors responsible for this remarkable safety record include comprehensive regulations, detailed operating procedures, strict requirements for driver qualifications, and thorough training. However, the most important contributors to safety are the shipping casks, which are designed to provide radiation protection under normal and accident conditions.

To provide specific guidance for all phases of the program, we are preparing a system safety plan. Its purpose is to ensure that the system is designed, constructed, and operated in a safe manner.

Compliance with regulations

In developing our system and transporting waste to or from our facilities, we will comply with all applicable Federal, State, Tribal, and local regulations, including those issued by the Department of Transportation and the Nuclear Regulatory Commission. As required by the Amendments Act, we will comply with the Commission's regulations regarding advance notification of State and local governments before shipping spent fuel or high-level waste. To ensure the early identification and resolution of issues that could impede the transportation mission, we maintain formal coordination and have signed a memorandum-of-understanding with each agency. These memorandums delineate the respective responsibilities of each agency and establish common planning assumptions.

Our transportation program will be subject to the requirements of the Hazardous Materials Transportation Uniform Safety Act of 1990, which amended the Hazardous Materials Transportation Act of 1974. The requirements that are applicable to our program include (1) the need to obtain motor-carrier safety permits and to register carriers, (2) the inspection of motor vehicles before shipping any waste, and (3) requirements for training all personnel involved in waste transportation.

The most important contributors to safety are the shipping casks, which are designed to provide radiological protection under normal and accident conditions.

Another element in our transportation planning is the physical security of spent-fuel shipments. In 10 CFR Part 73, "Physical Protection of Plants and Materials," the Nuclear Regulatory Commission has established specific regulatory requirements for the protection and safeguarding of these shipments.[37] Our shipments will be in full compliance with the requirements of the Commission.

We will ensure radiation safety by having cask designs certified by the Nuclear Regulatory Commission, controlling access, monitoring and controlling contamination, and training personnel in both normal and emergency operating procedures. Administrative controls and records will be maintained in order to ensure that the radiation exposure of workers is within regulatory boundaries.

We will emphasize industrial safety through such measures as training, safety-system surveillance, monitoring, and recertification. Personnel will be monitored for fitness for duty in accordance with standard industrial practices. And we will be prepared to respond to unusual events when they do occur, thus minimizing their effects.

Safety of casks

The design and integrity of the cask are the most important factors in ensuring safety during shipment. As required by law, we will use only shipping casks whose designs have received a certificate of compliance from the Nuclear Regulatory Commission. To receive a certificate, the applicant must submit a safety analysis report showing that the cask can meet regulations designed to ensure adequate containment of radioactive material, the control of external radiation exposure, and the control of nuclear "criticality." This includes a demonstration that the cask will perform satisfactorily both in normal operations and under accident conditions.[34] The applicant must demonstrate to the satisfaction of the Commission that the cask would survive intact the sequence of accident conditions shown in Figure 6-6: impact (a 30-foot drop onto an unyielding surface), puncture (a drop onto a metal spike), thermal exposure (1475°F for 30 minutes), and submersion under water (3 feet for 8 hours).

Training of operating personnel

Training is an integral element of transportation support functions. Its objective is ensuring that transportation operations are conducted safely and efficiently and in compliance with the applicable statutes and regulations.

We will therefore develop programs for training transportation-operations staff, field-service personnel, and interface personnel at waste-generator sites. The initial training of staff for support facilities will be designed to produce competent trained personnel at all levels of the organization, with training based on the education, experience, and assignment of the staff member. For field-service personnel and other transportation-operations personnel, training will be

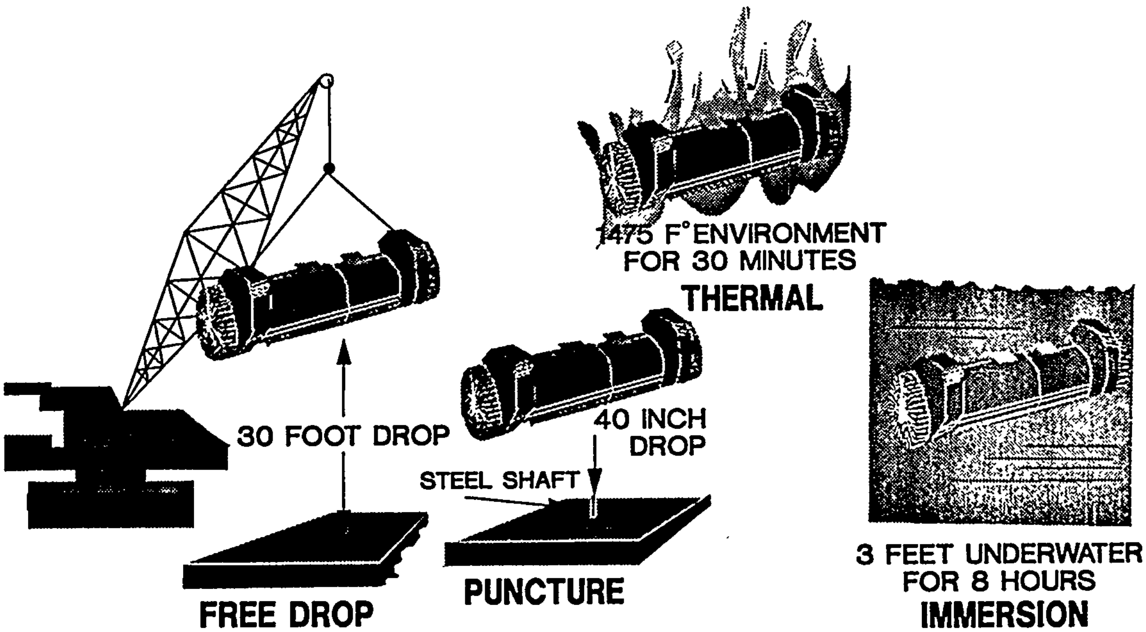


Figure 6-6. Severe tests that shipping casks must be designed to withstand.

required for such things as cask-handling operations, road-worthiness inspections, physical-protection tasks, emergency response, and the operation, servicing, maintenance, and performance testing of equipment. In the case of interfacing personnel at waste-generator sites, the training will cover mainly cask-handling and cask-loading operations.

Training of public-safety officials

In accordance with the Amendments Act, we will provide technical assistance and funds to States for training the public-safety officials of local governments and Indian Tribes through whose jurisdictions wastes will be shipped. Training is to cover procedures for transportation under normal conditions and emergency situations (page 118). We are developing a draft strategy for implementing these requirements for shipments to an MRS facility in 1998. In developing that draft strategy and in achieving its goals, we are working with regional and national groups of States and Indian Tribes, technical organizations, and other interested parties. The availability of the draft strategy for public comment will be announced in the *Federal Register*.

We will define workable mechanisms for administering technical assistance and funds by 1993 if an MRS site has been identified. After determining the preliminary mix of transportation modes and potential routes to the identified MRS site, we will begin providing training assistance between 1993 and 1995. In continuing assistance after 1995, we expect to make adjustments and support retraining as needed.

Assessment and management of transportation risks

We are developing a comprehensive program for the assessment and management of transportation risks. This program will include the development, enhancement, or evaluation of various computer models based on well-established techniques of risk assessment. To support the models, we have developed transportation data bases, which are continually updated and include data on the rates of accidents in rail and road transport. These data bases are used in defining assumptions used in assessing transportation risks and developing risk factors for national transportation-network analyses.

We have kept the Nuclear Waste Technical Review Board informed of our work on computer models and codes, and the Board has responded with comments and recommendations. We expect a similar working relationship with the Board regarding the application of the models and codes. One of these applications will be using risk assessment as a tool in supporting decisions on transportation modes and routes.

Emergency response

In the event of an emergency, we will have certain responsibilities as the owner and shipper of the waste. In addition, the Department of Energy is the Federal agency to which the Federal Radiological Emergency Response Plan[38] assigns responsibility for providing Federal assistance for radiation monitoring and accident assessment. During normal operations of the system, we expect to maintain and supply information to the Department's emergency-management system on a continuous basis and respond to any request for support as soon as it is received from the emergency-management system. Our emergency-response actions are expected to be initiated through the cognizant Federal agencies and will follow the procedures outlined in the Federal Radiological Emergency Response Plan.

In response to an emergency situation, we will be prepared to provide technical assistance and equipment when requested through the State cognizant authority. (State, Tribal, and local governments are generally responsible for providing the first response to a transportation accident.) We will also provide any technical assistance that may be needed in later stages of the response. Finally, we will participate in activities needed for the recovery of the transportation system and assist in the mitigation of consequences.

Schedule

The reference schedule for the development of the transportation system is shown in Figure 6-7. This schedule is consistent with that of the overall waste-management system. The transportation schedule must be able to support both the MRS facility and the repository.

Applications for certification for the from-reactor casks that we are developing are expected to be submitted to the Nuclear Regulatory Commission in 1992. We expect that the Commission's review of the applications, including comment resolution, will take approximately 2 years. This should result in certificates of compliance being issued by the Commission in 1994. Acceptance and operational testing should be completed by the end of 1995. We expect to issue the cask-fabrication contracts in 1995 or 1996. The fabrication of casks should start in 1996, with the casks ready for shipments to the MRS facility by 1998. To ensure adequate transport capability in 1998, we are developing a plan to use existing casks to complement the casks being developed. After the routes for the initial shipments to the MRS facility have been identified, we will provide technical assistance and funds for training the public-safety officials of Indian Tribes and local governments whose jurisdictions are traversed by these routes.

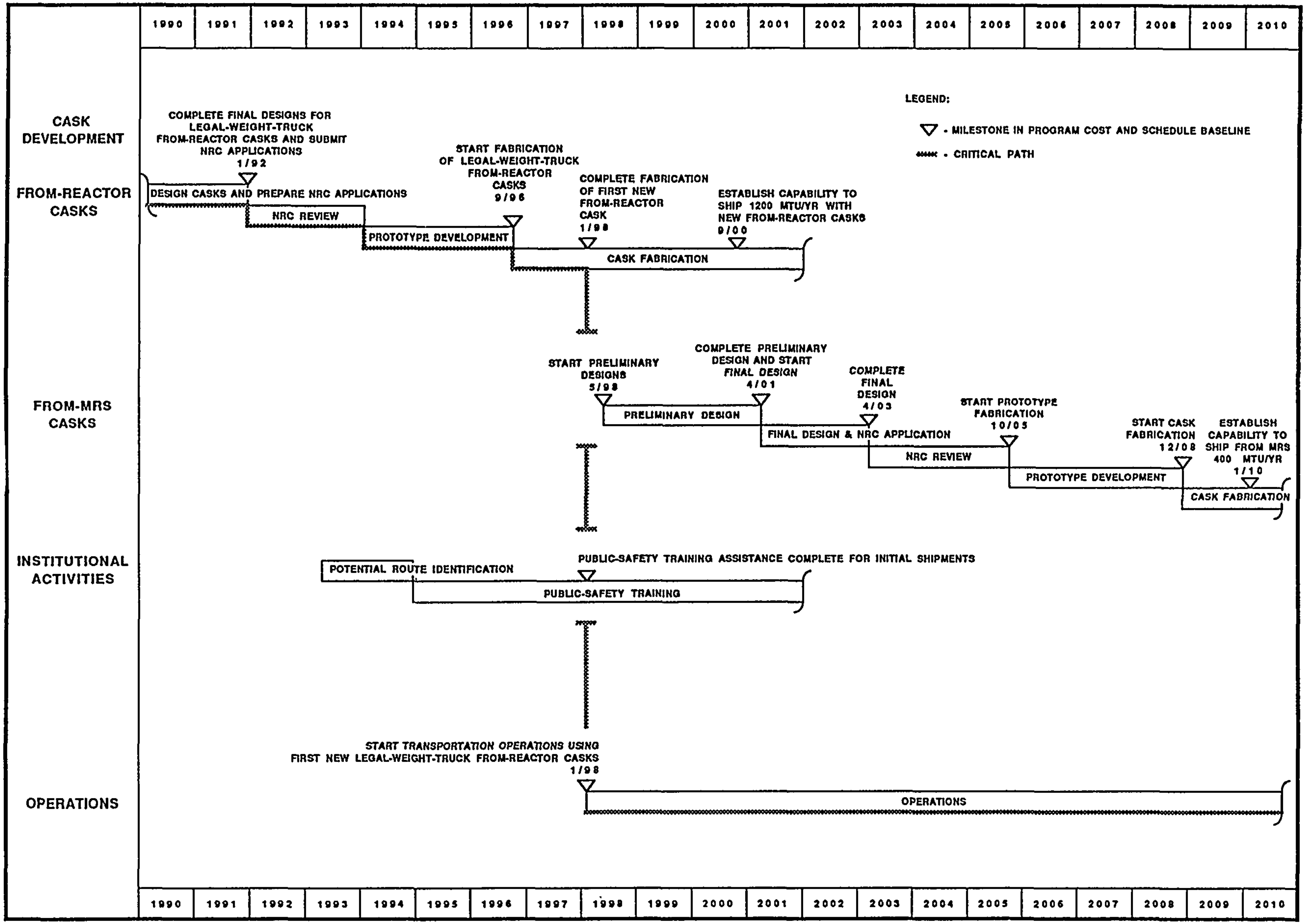


Figure 6-7. Reference schedule for the transportation program.

7. BUILDING TRUST AND CONFIDENCE

The promise of meaningful participation in the program remains in doubt to many affected governments and interested parties. Guided by the principles of openness and responsiveness, we will work to improve relationships with those affected governments and interested parties.

To build the public trust and confidence in our program that is vital to our success, we must interact and communicate effectively with the various parties concerned with the program. This need is rooted in our dual obligations as part of the government of the United States to clearly explain our mission, plans, and activities and the issues attendant upon them—and to actively solicit the views of other parties and consider them in formulating policies and making decisions. The many parties with whom we interact are shown in Figure 7-1.

In meeting these obligations, we provide other parties with the information they need to participate knowledgeably in the program, to contribute to our decisionmaking, and to oversee our work; and we enable the general public to understand our program and to form its own conclusions about it. The interaction and communication that enable us to understand and be understood in turn promote the integration of technical, institutional, and management concerns in our planning and decisionmaking.

For affected governments, financial assistance is as vital to participation and oversight as information. The Nuclear Waste Policy Act (the Act) as amended guarantees such assistance, which has enabled States, units of local government, and Indian Tribes affected by the program to establish their own mechanisms for interacting with us and monitoring our activities.

If our own institutional efforts are to be effective, they must be adequately staffed and supported. We will commit appropriate resources to them, increasing upper-management involvement and augmenting staff and training.

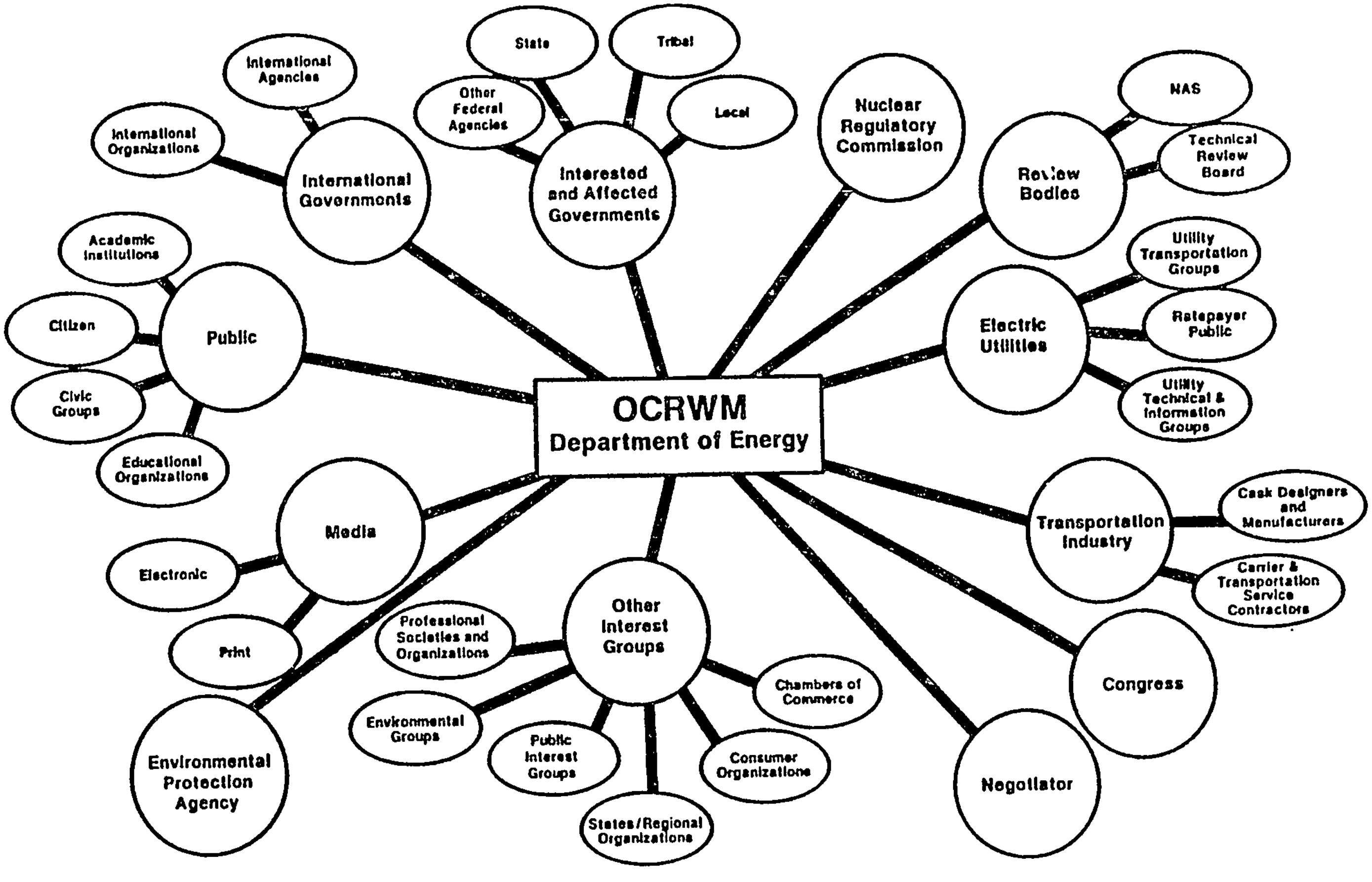


Figure 7-1. Interaction with interested parties.

We will increase integration among our technical, institutional, and managerial staff, providing more opportunities for joint action on program issues, and we will provide staff with training in the communication skills they need to clearly explain their activities to the public.

To determine how effective our institutional efforts are, we will employ both formal and informal evaluation mechanisms and will modify our activities on the basis of these evaluations, as appropriate.

The Congressional mandate

Recognizing that we would face significant institutional challenges in developing the waste-management system, the Congress structured a major role in program development for States, units of local government, and Indian Tribes affected by the program and for the general public. The Act as amended goes to unusual lengths in specifying for affected governments extensive rights to oversee and participate in the program.

The Act as amended provides a variety of mechanisms to ensure that affected governments have the funding they need to exercise those rights, to mitigate socioeconomic effects, to compensate jurisdictions for the absence of tax revenues that might otherwise be realized if non-Federal activities were undertaken at the site (payments-equal-to-taxes), and to provide benefits for hosting waste-management facilities. It also specifies that in siting Federal research projects the Secretary is to give special consideration to proposals from States where a repository is located.

To enable affected governments to exercise their rights to participation and oversight, the Act as amended requires us to provide not only financial assistance but also timely information about major program decisions and actions. It specifies reporting mechanisms to be employed and documents to be issued and provides opportunities for public participation through formal hearings and comment processes. It directs us to consult and cooperate with affected governments, to attempt to develop formal agreements with them for this consultation and cooperation, and to assess the effects of planned activities and avoid or mitigate significant adverse socioeconomic impacts.

The current institutional environment

While our extensive interactions with States, units of local government, Indian Tribes, and interested parties have often been productive, the program has engendered heated controversy, political reaction, and extensive litigation. Eight years after its statutory creation, nontechnical factors continue to have a major effect on its progress.

Clearly, we must develop ways to function more effectively in a difficult institutional environment. Our actions must be open to scrutiny. We must provide a forum in which differing interests can be expressed so that all parties can better understand each other. And we must be responsive to the concerns those parties express.

We believe that the Act as amended provides a sound and resilient framework for implementing such a program. The challenge for us is to employ those provisions more effectively. Our plans for accomplishing this are set forth in the sections that follow.

Substantive and early involvement in our decisionmaking process by affected governments, interested parties, and the public is important.

Broadening participation in decisionmaking: the role of affected governments, interested parties, and the public

Substantive and early involvement in our decisionmaking process by affected governments, interested parties, and the public is important for several reasons: (1) affected governments have statutory rights to participate in shaping the program; (2) in contributing their knowledge and viewpoints, all parties can help us identify emerging issues and can help us make better decisions; (3) their participation enables them to better understand the program and each other—and thus participate still more effectively; and (4) broad-based participation can help build public trust and confidence in the national program for radioactive-waste management and disposal.

We are committed to the early involvement of affected governments, interested parties, and the public in helping us formulate and evaluate policy alternatives before we make our decisions. Building on our successful experience with the strategic-principles workshops (see Chapter 2), we are establishing an ongoing process of interactions that will enable these parties to provide their viewpoints directly to the Director of the Office of Civilian Radioactive Waste Management (OCRWM). The principal elements of this process are summarized below.

Establish a Director's forum for predecisional participation. We will establish a Director's forum for representatives of affected governments, interested parties, and members of the public. The forum will meet on a regular basis to exchange information and individual views on upcoming program decisions, policy alternatives, and the effectiveness of our institutional efforts.

The forum's efforts will be coordinated with our existing interactions with parties in our site-characterization program at the Yucca Mountain candidate site in Nevada, in the development of an MRS facility, and in the transportation program. The involvement of the forum in predecisional efforts will strengthen our ability to integrate technical, institutional, and managerial concerns about major program issues. The forum will be especially useful in helping us determine actions that can help build public trust and confidence. In working with the forum, we will draw on the recommendations of such groups as the Secretary of Energy Advisory Board Task Force on Civilian Radioactive Waste Management, which will be assessing measures that can build public trust and confidence in our program. The Task Force's analysis of lessons learned from the past will be especially helpful.

Build an issue-identification and analysis system to support the Director's forum. To support the work of the forum, we are establishing a process for (1) identifying upcoming technical, institutional, and management issues of potential concern to affected governments and interested parties; (2) working with forum representatives to select issues for consideration by the forum; and (3) producing background information and analyses to help the forum consider issues. Some elements of the issue-identification and analysis system are already in place; the next step will be coordinating them in a manner that will support the forum's meeting schedule.

Ensure timely and informative responses to comments and recommendations. The task of making a key decision cannot be considered complete until all participants in the decisionmaking process understand the basis for the decision and how their views were considered. This means not only employing comment-response documents; it means making sure that all parties are fully informed as to the actions taken pursuant to decisions and what the consequences of those actions are. It also means responding to comments in a timely manner. We will place special emphasis on ensuring that members of the forum—and all other parties who participate in our program—are afforded full and timely responses.

Strengthening two-way communication with the general public

Effective, two-way communication with the public is essential to the success of our mission. If we fail to listen carefully and respond clearly, promptly, and openly to public concerns, no locality is likely to accept the facilities needed to solve the problem of radioactive waste.

Our communication challenge includes multiple audiences, highly technical subject matter, and controversial issues. We must build credibility in a climate of distrust of public institutions and widespread uncertainties about capabilities to safely manage radioactive waste and other hazardous materials. We must also be open to new approaches to improve our performance. With this in mind, we intend to proceed with the following activities, which include both new initiatives and renewed emphasis on some current efforts:

Respond promptly and effectively to public comments and inquiries. Just as we will work to shorten our response time to comments from affected governments and interested parties, we will work to shorten our response time to formal comments from the general public. We will assess our procedures for responding to comments and inquiries from the general public to determine how we can streamline them, and we will explore the use of discussion groups and workshops as a means to better understand public comments and inquiries.

Issue a five-year communication plan. The plan will detail the specific initiatives we will pursue to improve our communication products and processes and the criteria we will use to evaluate our progress toward earning public confidence. We will seek external comment on the plan before we issue it in final form.

Effective, two-way communication with the public is essential to the success of our mission.

Support the news media. The news media are a vital route to the various parties directly concerned with our program and to the larger public. In working with the media, we will follow several approaches. We will make a high-priority, systematic effort to increase the availability of senior staff for interviews and informal discussion sessions with the media. We will also increase the availability of staff with technical expertise to talk with the media about developments in their areas.

We will actively reach out to national and local print and electronic news media, trade publications, science writers, and general-interest publications to help journalists understand our program as it evolves, so that they can provide current information of interest to their audiences. Our outreach efforts will take several forms, including periodic media briefings to report on overall program progress and written background information and video footage for key program events, as well as briefings for the media on topics of particular interest.

Help staff acquire more-effective communication skills. Our staff have a difficult communication challenge: to exchange information about a technical and controversial program with a variety of publics. If our staff lacks effective communication techniques for providing information to, and receiving information from, the public, all parties suffer. We will continue to use nationally recognized communication experts to train our staff to communicate in ways that foster better understanding. This training will be extended to a broader range of our personnel, and more intensive training will be provided for personnel who interact directly with interested parties and the public.

Make better use of public-speaking engagements. Speaking engagements and conference participation are important forms of communication, not only as opportunities for providing information but as a means of obtaining information and a better understanding of others' views. Our staff members undertake numerous speaking engagements with interest groups, education associations, civic groups, universities, colleges, schools, and international organizations.

We are establishing a formal, program-wide speakers' bureau, including mechanisms for obtaining systematic feedback from our speaking engagements and participation in conferences, on the subjects our audiences are most interested in and on the views expressed by the public. We are also seeking to expand the range of organizations with which we can exchange information and interact.

Improve our public-information materials and techniques. We produce and disseminate a variety of publications, brochures, fact sheets, and videos, as well as the *OCRWM Bulletin.* For many of these materials, external focus groups and reviewers have been used to help gear the text and visuals to particular audiences and levels of understanding. We plan to increase the use of external reviewers for this purpose.

We also conduct an active exhibits program. Program exhibits have been displayed in 30 States in the United States and abroad. In addition, we disseminate information to the larger public through national and regional professional, scientific, educational, and utility organizations. Other organizations convey information about our program and provide feedback to us on public concerns. The "open houses" we periodically hold at Yucca Mountain complement these activities.

In continuing these activities, we are placing a special emphasis on clarity in our communication efforts by (1) developing clearly understandable texts for the general public; (2) taking care to explain the significance of reports, decisions, and actions; (3) developing clear supporting graphics, videos, and other materials to augment text, exhibits, and presentations; and (4) determining how well our information materials are serving the parties who use them.

The *OCRWM Bulletin* is a monthly publication that reports on significant program developments. It is currently distributed to some 7000 readers. To reach a larger public, we will expand its use and will include response sheets in each issue to solicit comments from readers on issues discussed or on any other subject related to our efforts that readers may wish to raise. We will also expand our use of the *Federal Register*, a daily publication used by Federal agencies to document their predecisional and decisionmaking processes. And we are examining other ways in which we can both provide and solicit information in order to identify emerging issues, shape predecisional alternatives, and document decisions.

We also plan to expand the use of our Infolink, a publicly accessible, interactive information data base, and to explore the use of a toll-free 800 telephone number for callers with questions about the program. We currently use recorded messages to provide the public with detailed information about our meetings with the Nuclear Regulatory Commission.

Maintaining the support of the scientific community

Because the repository program is a first-of-its-kind undertaking, earning the confidence of the scientific community in our technical work is fundamental to earning the confidence of the larger public. From the inception of our program, we have worked hard to interact with this community. Our staff participates extensively in both national and international conferences sponsored by scientific, technical, and professional organizations; we present papers that report on the latest program developments and plans and engage in discussions of program issues. Our participation serves not only to keep those communities informed; it exposes our work to their scrutiny and encourages independent technical comment that can supplement the formal peer review we employ on selected technical tasks.

> ***Earning the confidence of the scientific community in our technical work is fundamental to earning the confidence of the larger public.***

To help create an international forum for information exchange and peer review of program issues, we joined a number of cooperating organizations in support of the International High Level Radioactive Waste Management Conference and Exposition. Sponsored by the American Society of Civil Engineers and the

American Nuclear Society, this annual conference is hosted by the Howard R. Hughes College of Engineering of the University of Nevada, Las Vegas. It draws many hundreds of participants to plenary and technical sessions that range over every aspect of waste management. We will continue our active participation in this and other forums, adhering to the highest professional standards in presenting our technical work.

We also participate in international meetings to exchange information on technical, public-information, and communication programs; to assess public concerns and exchange lessons learned; and to enter into joint projects to build communication links and understanding of the international aspects of radioactive-waste management. These meetings and information exchanges include those with the Nuclear Energy Agency of the Organization for Economic Cooperation and Development and informal discussions with information and communication managers from Belgium, Canada, Finland, France, Germany, Japan, the Netherlands, Spain, Sweden, Switzerland, and the United Kingdom.

Engaging the education community

Building broader public understanding of radioactive-waste management is a continuing and long-term endeavor. This understanding must be developed within the broader context of energy use and environmental concerns so that the public can make informed decisions about energy sources and the by-products associated with them.

Toward this end, we have developed a variety of education programs. We have joined the general effort of the Department of Energy to improve the scientific literacy of students at the secondary education, college, and postgraduate levels; enhance the skills of teachers; encourage careers in science and engineering; foster a keener awareness of science issues among the general public; provide student opportunities; develop curricula materials; conduct an active education outreach program; and conduct international education activities.

Through our education program, we work with students, educators, curricula developers, universities, industry, State and local governments, and the general public. We also work with representatives of other countries to develop education programs that will help to build the skills and knowledge of present and future generations so they are equipped to manage radioactive waste. Our education program encompasses the following activities:

Enhance teacher skills. We participate in and support in-service workshops throughout the country for teachers of kindergarten through grade 12. We also participate in school science projects and in teacher workshops held at the education centers of utilities. Another area of involvement has been the development of a reference guide to teaching resources and materials.

Provide student and faculty opportunities. We provide three kinds of opportunities for students and faculty. One is the OCRWM Fellowship Program, which encourages talented students to enter graduate programs in study and research directly related to the management of radioactive waste. Another opportunity is available through cooperative agreements and projects with universities. This includes support for the University of Nevada-Las Vegas for independent research and analysis and a supercomputer and support for the University of Nevada-Reno for independent research related to waste management at the Mackay School of Mines. We have an agreement with these universities for infrastructure studies and other research and development work, as well. We also provide support for Historically Black Colleges and Universities to strengthen academic programs and student or faculty research related to waste management and disposal, and to increase their interactions and linkage with us.

Develop curricular material. We have supported the development of curricular material, including a modular four-unit, 30-lesson-plan curriculum for grades 8 through 12 for science and social-studies classes. The material includes a teacher's guide, a reader for the students, video tapes, computer software, and hands-on activities and experiments in basic science and social studies. These materials have been developed and are being reviewed and tested by professional curricula developers and science and social-studies teachers around the country. We plan to seek a review of these materials by nonprofessionals as well.

Conduct education outreach activities. Our education outreach activities include participation in educator conferences and science fairs; presentations to school

Building broader public understanding of radioactive-waste management is a continuing and long-term endeavor.

classes and, in the case of schools in Nevada, tours of the Yucca Mountain candidate site and student visits to our Yucca Mountain Information Offices in Las Vegas or Beatty, Nevada; and the provision of speakers and educational materials to schools. We hope to expand these efforts, both to make more schools aware of the information we can provide and to learn from schools how we can best provide information to them.

Conduct international education activities. Our work with the Nuclear Energy Agency of the Organization for Economic Cooperation and Development, mentioned above, includes efforts to develop multinational education workshops on science, technology, and the environment as they relate to radioactive-waste management. We are also working with other countries to develop education programs that will build skills and knowledge in the area of radioactive-waste management.

Develop a multiyear education strategy. We are building on our current education activities in concert with the education community to develop a multiyear educational strategy that will meet our statutory responsibilities and support national, Departmental, and program education goals. This strategy will involve us in cooperative efforts with the education community to assess educational needs, to coordinate our programs with other Federal agencies, and to evaluate these activities in a process that involves the public. To carry out this strategy, we will be committing more resources to expanding these activities.

Working cooperatively with parties involved in the program

Closely related to our efforts to foster predecisional involvement by affected governments and interested parties will be efforts to work cooperatively with them. For example, we plan to seek the involvement of affected governments and interested parties in the early evaluation of site suitability. Our plans for working with State and local governments; Indian Tribes; parties interested in other public and private organizations; the Nuclear Waste Negotiator; electric utilities; and regulatory, oversight, and review bodies are presented below.

Affected governments

Affected State and local governments. By law, the State of Nevada and Nye County, in which the candidate repository site is located, have status as affected governments. The Secretary may at his discretion designate as "affected" those units of local government contiguous to the unit in which a site is located, thus making them eligible for funding if they so request, and for oversight and participation rights. Currently, the units of local government in Nevada designated as affected are Nye County, the county in which the Yucca Mountain candidate site is located, and Clark, Lincoln, Esmeralda, Eureka, White Pine, and Mineral Counties. Inyo County in California has also been designated as affected. In addition, we have notified Churchill and Lander Counties in Nevada that they may wish to request that the Secretary designate them as affected units of local government in the future (Figure 7-2).

The Act as amended requires the Secretary to seek to enter into a binding written agreement with the State—an agreement specifying procedures to govern their interactions. It also authorizes the Secretary to enter into a benefits agreement with the State. Up to this time, the State of Nevada has declined the Secretary's offers to enter into discussions to develop these formal agreements. We continue to interact informally in a variety of ways with the State and with units of local government.

Under the provisions of the Act as amended, the State and affected units of local government are eligible for oversight grants, impact assistance or payments through a formal benefits agreement, and annual payments-equal-to-taxes. To date, we have provided approximately $45 million in oversight grants to the State and an additional $13 million in oversight grants to the affected units of local government. To date, no requests for impact assistance have been submitted to the Secretary.

In March 1990, we published for public comment a proposed notice[39] of interpretation and procedures implementing the payments-equal-to-taxes provisions of the Act as amended. We have reviewed the comments and will publish a final notice in the near future.

provisions of the Act as amended. We have reviewed the comments and will publish a final notice in the near future.

In accordance with the provisions of the Act as amended, the State or Indian Tribe and unit of local government within whose jurisdiction a candidate repository or MRS site is located may designate onsite representatives. The Secretary has invited both the State and Nye County to appoint representatives. The Governor of Nevada assigned the oversight function to the Nevada Agency for Nuclear Projects/Nuclear Waste Project Office. We are working with Nye

Figure 7-2. Nye and contiguous counties.

County, at its request, to develop a written understanding with respect to the role that the county's onsite representative will have in the repository program.

The State's Nuclear Waste Project Office and affected units of local government continue to play a valuable role in the technical repository program. Interactions occur through frequent staff contacts, information exchanges, and joint attendance at meetings, workshops, and hearings sponsored by us or by Nevada organizations, including our semiannual public project-update meetings. State and local-government representatives attend our meetings with the Nuclear Regulatory Commission and the Nuclear Waste Technical Review Board as well as our technical meetings. They observe our quality-assurance audits, review site data, and review and comment on technical documents. The State has applied for and received general-access permits allowing representatives to enter the site to observe site-characterization activities.

We are committed to meeting our statutory obligations to the State, Indian Tribes, affected units of local government, and the public and to going beyond these obligations to make a good-faith effort to build constructive working relationships and to strengthen their ability to review and oversee our activities.

In addition to the efforts described above, we intend to continue or initiate the following activities:

Work with affected units of local government. A framework for formal interactions between the Department of Energy and Nye County, Nevada, was signed on April 2, 1991. The framework establishes a process for structuring interactions between the two parties that could result in the execution of protocols, letters, or memorandums of understanding on such subjects as interactions, socioeconomic-impact monitoring and assessment, impact-mitigation procedures, Department of Energy procurement within the county, onsite representation, and transportation. We are currently negotiating protocols with Nye County pursuant to this framework. We will seek similar agreements with other affected governments, as appropriate.

We will continue to involve affected units of local government in our technical program by soliciting their comments on technical documents, by interacting with them on socioeconomic studies, and by inviting them to participate in other predecisional activities. We will continue to provide economic-development information and assistance and to hold government procurement workshops, so that they can realize economic benefits from our program.

Provide direct payments. The President's budget request for fiscal year 1992 includes a request for the authority to make direct payments to affected governments, as opposed to grants, to fund their oversight of the waste-management program. If authorized, this approach will afford recipients much greater flexibility and substantially reduce administrative burdens while expediting their receipt of funds.

Work cooperatively with Indian Tribes. Indian Tribes have a unique legal and political relationship with the government of the United States, defined by the U.S. Constitution, treaties, statutes, and court decisions. This relationship establishes parameters for our interactions and commits the Department to deal directly with Tribes on matters of concern to them and to protect and preserve Tribal lands and resources.

Several laws guide our interactions, including the Nuclear Waste Policy Act as amended, the National Environmental Policy Act, the American Indian Religious Freedom Act, the National Historic Preservation Act, and the Archeological Resources Protection Act.

We are committed to making a good-faith effort to build constructive working relationships with affected governments and interested parties and to strengthen their ability to review and oversee our activities.

Under the Nuclear Waste Policy Act as amended, an Indian Tribe on whose reservation a candidate repository site or an MRS site is located has affected status. Other Indian Tribes who meet certain conditions may also be designated as affected, and this designation is to be made by the Department of the Interior. Affected status enables them to receive financial and technical assistance from us and to exercise rights to participation and oversight. Three tribes in the Northwest were at one time designated as affected in connection with a former candidate site. No Indian Tribes are currently designated as affected.

To build constructive working relationships with Indian Tribes, at the national level, we provide funding to the National Congress of American Indians through a cooperative agreement, and we will continue to interact with it on a range of program issues. At Yucca Mountain, we plan to implement a cultural-resources program. Guided by the National Historic Preservation Act and the American Indian Religious Freedom Act, we are consulting with 16 Indian Tribes to develop and implement a cultural-resources program at Yucca Mountain. In cooperation with representatives from the various Indian Tribes, we are identifying sites and resources of cultural importance to them in order to avoid or minimize the possible effects of site-characterization activities at Yucca Mountain.

Parties interested in transportation issues

States, Indian Tribes, local governments, other interested parties, and the public have various roles in the development of the transportation program. Further, in the transportation program, technical and institutional issues are closely interwoven. To satisfy legislative directives and to integrate technical and institutional concerns, we interact extensively with these parties. The basis for these interactions was established in the Transportation Institutional Plan issued in 1986.[32]

Because many parties participate in the transportation program and because the program continues to evolve, continuing interaction among all parties is essential to its success. A valuable forum for our interactions has been the Transportation Coordination Group. The Group includes representatives from the regional and national organizations representing States, Indian Tribes, and industry; their individual member organizations; and other parties, such as cities, counties, individual Indian Tribes, emergency responders, regulators, carriers, and utilities.

We also interact with other Departmental and interagency programs, such as the Transportation Emergency Preparedness Program Steering Committee under the Department's Office of Environmental Restoration and Waste Management; the Hazardous Materials Transportation Uniform Safety Act Interagency Task Force, coordinated by the U.S. Department of Transportation; and the Federal Radiological Preparedness Coordinating Committee.

To further develop our transportation program, we will pursue the following efforts:

Revise the transportation plan and issue discussion papers. After this Mission Plan Amendment is issued in final form, we will issue a new transportation plan. The plan will provide more-detailed information about our transportation strategy.

We will also update the issue discussion papers, which address specific transportation issues raised by interested parties. Originally issued as an appendix to the Transportation Institutional Plan,[32] the papers summarize 13 institutional issues related to waste transportation to a repository or an MRS facility. The papers provide general background information on major issues, reviews of related issues, preliminary plans to address the issues, and estimated schedules for policy decisions.

The issues they have addressed are prenotification of waste shipments; physical protection procedures; highway routing; routing by rail and barge; inspection and enforcement for highway, rail, and barge shipments; emergency response; liability coverage for transportation to waste facilities; cask design and testing; overweight truck and heavyweight rail shipments; mix of transportation modes; transportation infrastructure improvements; transportation operational procedures; and State, Indian Tribal, and local regulation of transportation.

Provide funding and technical assistance. The Nuclear Waste Policy Act as amended requires us to provide technical assistance and funding to States for the training of public-safety officials of units of local government and Indian Tribes through whose jurisdictions waste shipments will be transported. This training will cover routine as well as emergency procedures.

To provide this assistance, a number of implementation issues must be clarified. To develop a strategy for implementation, we are working to identify, research, analyze, and resolve issues through a combination of in-house studies, research undertaken by organizations with which we hold cooperative agreements, interactions with other interested parties, coordination with other Departmental programs, cooperative efforts with other Federal agencies, and conflict-resolution techniques.

We have prepared a preliminary draft strategy for providing this assistance and are now modifying the draft to incorporate comments received from members of the Transportation Coordination Group. We will issue a final draft strategy paper for public comment. Once key issues are clarified and resolved through discussions, we will issue three documents—a policy options paper, the OCRWM assistance policy statement, and an implementation plan—that will define our implementation policies. We will issue these documents in draft form and will hold workshops to solicit further comments from interested parties. We will review all comments and revise the documents, as appropriate. The final policy statement will be published in the *Federal Register* and distributed to all participants involved in the review-and-comment process.

Training assistance will be provided in phases, according to a process to be outlined in the policy statement and the implementation plan. Those eligible for technical assistance and funding will be notified formally in writing.

Foster interactions within the transportation program. We will continue to foster close interactions between our technical and institutional staffs and interested groups, so that institutional concerns are fully considered in formulating and resolving technical issues. These efforts will continue through a variety of mechanisms: holding semi-annual meetings of the Transportation Coordination Group; conducting periodic public meetings; reviewing written comments on planning and policy documents; interacting through other program activities; providing written materials, visual aids, speakers, computer data bases and models, and technical and planning documents; holding technical workshops; meeting with transportation officials; and attending the meetings of regional, national, and professional organizations.

So that we can better understand the context within which our transportation program evolves, we will continue to follow media coverage of transportation activities; track changes in Federal, State, Tribal, and local legislation and regulations; and study lessons learned in other shipping campaigns. We will apply to our shipping program what we learn from the Department's experience in shipping transuranic radioactive waste to the Waste Isolation Pilot Plant in New Mexico.

Use cooperative agreements. We use cooperative agreements to support activities appropriate to the various phases of the transportation program.

Organizations with which we have agreements study regional or national transportation issues and formulate recommendations to us on planning options or policies. These organizations include the Western Interstate Energy Board, Southern States Energy Board, Midwestern Office of the Council of State Governments, National Conference of State Legislatures, and National Congress of American Indians.

We have also established agreements with the Commercial Vehicle Safety Alliance and the Conference of Radiation Control Program Directors to support the study of operational issues related to State inspection and enforcement. We will continue to use cooperative agreements to support activities appropriate to the various phases of the transportation program. In fiscal year 1992, we will enter into a cooperative agreement with a northeastern regional organization.

As the transportation program evolves, we will interact more closely with specific parties—individual utilities, carriers, States, Indian Tribes, and local governments—to coordinate shipping arrangements, clarify individual responsibilities for transportation activities, and finalize shipping policies.

The MRS host

If the Nuclear Waste Negotiator is successful in negotiating a proposed agreement with a State or Indian Tribe willing to host an MRS facility, and the proposed agreement is approved by the Congress, the framework for our interactions with the MRS host will be defined by the terms of that agreement. It is expected that the terms will specify an extensive role for the host in MRS development and operations.

For a site selected by the Secretary, it would be our policy to encourage the host to play the same kind of substantive, active role as would likely have been defined by a negotiated agreement. The Secretary would offer to negotiate a consultation-and-cooperation agreement with the host, and he could offer to enter into a benefits agreement under the terms specified by the Amendments Act.

Building ties to more organizations

Because the management and disposal of spent fuel and high-level radioactive waste involve issues concerning the environment and the health and safety of workers, we invited representatives of environmental groups and organized labor to participate in our strategic-principles workshops, and we are working to build closer ties with them. We are also working to identify more organizations that are national in scope and may want to learn more about our program. Such organizations, which have potentially divergent views on program-related issues, include environmental, consumer, and other public-interest organizations; labor and trade unions; and intergovernmental, professional, and trade associations.

In addition to the cooperative agreements that support our transportation program, we maintain cooperative agreements with governmental, Tribal, and civic organizations. They disseminate program information, provide forums for the discussion of issues, and help us formulate policy options. We exchange information with them, send speakers and exhibits to their meetings, and invite them to participate in workshops and to provide review and comment on program documents.

The Nuclear Waste Negotiator

The Secretary has chosen to rely, at this time, on the efforts of the Nuclear Waste Negotiator to negotiate a proposed agreement with a volunteer host for an MRS facility. In November 1990, we signed a memorandum of understanding with the Office of the Nuclear Waste Negotiator that outlines initial procedures for our interactions. The memorandum establishes a working relationship that ensures a timely flow of information between us; provides the Negotiator with the use of Departmental services, facilities, and personnel as appropriate; and maintains each party's independence.

To further support efforts to identify a volunteer site for a repository or an MRS facility, we provide the Negotiator with comprehensive information about the waste-management system, and we keep him updated on program developments. We are prepared to undertake analyses he might request to support his efforts. We participate in meetings he requests and will provide information he needs to help interested parties understand the potential benefits and effects of hosting an MRS facility.

Another area of support for the Negotiator's efforts is our issuance of MRS feasibility assessment grants. The Amendments Act authorizes the Secretary to make grants to States, Indian Tribes, or affected units of local government to assess the feasibility of siting an MRS facility. We have issued a solicitation[28] formally requesting proposals.

At the Negotiator's request, we will conduct environmental assessments of potential MRS sites (as well as potential repository sites), as required by the Amendments Act. During the preparation of the assessment, we will hold public hearings in the vicinity of the site to receive comments on what should be addressed in the environmental assessment.

We are drafting an outreach implementation plan that describes how we intend to interact with various parties in conducting environmental assessments and presents timeframes for our interactions. We will consult with potential hosts to ensure that this plan meets their needs before we issue it in final form.

Electric utilities

In planning to meet their future spent-fuel management needs, electric utilities must make assumptions about the development of the waste-management system and how and when it will reduce their spent-fuel inventories. To provide the utilities with as stable a planning base as possible, we attempt to reduce uncertainties in system development. Close communication between us and the utilities contributes to sound planning assumptions.

We will increase our interaction with utility organizations to more closely involve them in program planning and technical-issue resolution.

The utilities pay for their share of the costs of developing the system by collecting fees from their ratepayers: the Act requires that the costs of the program be borne by the owners and generators of spent fuel and high-level radioactive waste. Accordingly, the utilities are also concerned about program efficiency and cost containment.

We have entered into contracts with the owners and generators of spent fuel. The terms of these contracts cover their fees to pay for their share of program costs and our acceptance of title, transport, and disposal of their spent nuclear fuel. We issue an annual report assessing the adequacy of the fee. The assessment is based on a comprehensive analysis of the total cost of the waste-management system over its complete life cycle.

We are working with the Edison Electric Institute's Nuclear Waste Management and Transportation group and the U.S. Council on Energy Awareness to address contractual issues of mutual concern through the issue-resolution process for the annual capacity report (Chapter 8).

We meet regularly with the Institute's transportation working group, annually with the its repository-information-exchange team, and individually with utilities and other utility groups. They review documents and provide comments to us. We present exhibits and participate actively in utility-industry meetings. We also interact with the American Committee on Radioactive Waste Disposal, a group of utility chief executive officers; the American Nuclear Energy Council; and the Electric Power Research Institute. Under cooperative agreements with utilities we have conducted demonstration projects involving various technologies for spent-fuel storage.

The organization of utility regulators, the National Association of Regulatory Utility Commissioners, provides us with ratepayers' perspectives on program issues.

Because the utilities are concerned about many program issues, we will increase our interactions with utility organizations to more closely involve them in program planning and technical-issue resolution. In general, we will be guided by the strategic principle that states that we will "diminish uncertainties related to spent-fuel management by the utilities."

Regulatory, oversight, and review bodies

In addition to the oversight exercised by affected governments, we are subject to regulation, oversight, and review by other entities. Our principal regulator is the Nuclear Regulatory Commission, from which we must obtain licenses for the repository and the MRS facility. Our interactions with the Commission include technical exchanges and meetings, monthly management meetings, bimonthly quality-assurance meetings, quarterly meetings for scheduling future interactions, and meetings with the Advisory Committee on Nuclear Waste and the Center for Nuclear Waste Regulatory Analysis. These interactions are essential vehicles for exchanging technical information, providing feedback, and sharing concerns and priorities.

In addition to its role in licensing, the Nuclear Regulatory Commission is one of two Federal agencies with principal responsibilities for regulating the transportation of radioactive waste, the other agency being the U.S. Department of Transportation. The Nuclear Regulatory Commission is responsible for safety in the receipt, possession, and transfer of radioactive materials, whereas the Department of Transportation regulates safety in the transportation of all hazardous materials, including radioactive waste. Thus, the Nuclear Regulatory Commission regulates those who possess and use radioactive material; it regulates the design, construction, use, and maintenance of shipping casks; and it enforces special transport controls (physical protection requirements) to protect against acts of sabotage. The Department of Transportation, on the other hand, regulates the carriers of radioactive material and the conditions of transport, such as routing, handling and storage, requirements for vehicles, and the qualifications of drivers. The Department of Transportation also coordinates the Hazardous Materials Transportation Uniform Safety Act Interagency Task Force, with which we interact.

Under the Nuclear Waste Policy Act, the Environmental Protection Agency is responsible for issuing the environmental standards that will govern the management and disposal of spent nuclear fuel and high-level waste (40 CFR Part 191). In addition, the Agency has oversight responsibilities in our program. In particular, the Agency will review the environmental impact statements we will prepare to determine whether they are satisfactory from the standpoint of public health or welfare and environmental quality.

The Nuclear Waste Technical Review Board was created by the Congress to provide independent review of our technical work. The members of the Board are nominated by the National Academy of Sciences and appointed by the President of the United States. They are eminent experts in various scientific disciplines relevant to our program and they have exercised their responsibilities actively. The Board holds numerous meetings open to the public and reports at least twice each year to the Congress and the Secretary. It not only provides valuable expertise that strengthens the program technically, it provides a forum in which affected governments and interested parties can observe technical deliberations, and we expect that its review will contribute to public confidence in our work.

We have provided a great deal of information to the Board both in written form and through extensive briefings. We review their recommendations closely and have developed an automated tracking system to help us respond promptly to their comments, recommendations, and requests for information.

We will continue to turn to the National Academy of Sciences for expert review of selected program issues.

The Board on Radioactive Waste Management of the National Academy of Sciences is an important source of peer review. Among its recent contributions are its July 1990 position statement "Rethinking Radioactive Waste Management,"[40] which offered a valuable assessment of overall program issues, and its September 1990 symposium on repository licensing requirements. The Academy's 1989 publication *Improving Risk Communication*,[41] jointly funded by the Department, other Federal agencies, and private industry, made an important contribution to the growing understanding of that subject.

We are continuing to implement recommendations made by the Academy in its July 1990 report. We await the findings of the 17-member panel the Board on Radioactive Waste Management has convened to examine a controversial theory on natural processes at the Yucca Mountain candidate site. We will continue to turn to the Academy for expert review of selected program issues.

An agency that has conducted many reviews of our activities is the General Accounting Office. These reviews have been conducted in response to specific Congressional requests and on the agency's own initiative. They have covered technical, management, and institutional topics. We also expect to continue receiving comments on the repository program from the headquarters of the U.S. Geological Survey. The Survey submitted detailed comments on the draft environmental assessments we issued in 1984 for the potentially acceptable sites and on the site characterization plan for the Yucca Mountain candidate site. And we have executed a memorandum of understanding with the Mine Safety and Health Administration of the Department of Labor for technical support and oversight during site characterization at the Yucca Mountain candidate site—in particular, the construction of the exploratory-studies facility.

Other agencies are involved in, or contribute to, our program in a review, permit-issuance, or advisory capacity. Among them are agencies with which we will consult during the preparation of environmental documents and which will review our environmental impact statements because of their jurisdiction by law or special expertise. Some agencies will be involved in both the repository and the MRS programs; they include the U.S. Fish and Wildlife Service, with which we will consult about endangered, threatened, or otherwise protected species, wilderness areas, and national wildlife refuges; the Corps of Engineers, which has jurisdiction over floodplains and navigable waterways; the Advisory Council on Historic Preservation; and the Department of Commerce, which has expertise in socioeconomic impacts. Other agencies are more likely to be consulted only in connection with siting an MRS facility; they include the National Park Service of the Department of the Interior and the Department of Agriculture; the latter is responsible for protecting national forest lands and prime farmland.

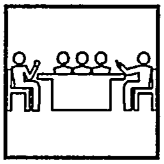
Evaluating our efforts

If the activities presented above are to be effective, they must be evaluated on a continuing basis—not just by us, but by the parties with whom we interact. Accordingly, an informal but very valuable source of evaluation will be direct feedback from those parties themselves, and we will actively solicit their views.

On a formal basis, we will employ external review through the Director's forum (see page 125), asking that group to periodically assess our interactions and communications efforts and help us determine how to improve them. Independent experts in such disciplines as organizational behavior, intergovernmental relations, and risk communication can also provide useful advice.

But the success of our efforts, finally, will be evident in the extent to which we actually build constructive relationships with affected governments and interested parties and earn the trust and confidence of the public. This is a stern test, and it should remind us all of how much is at stake in our institutional program.

8. PROGRAM MANAGEMENT



To achieve success, management must be responsive to the demands imposed by the program's combination of requirements: technical excellence, regulatory compliance, the involvement of affected governments and interested parties, public confidence, and fiscal responsibility. To perform the technical work, we rely on the Nation's best scientific and engineering expertise. To control the program, we will use integrated technical, cost, and schedule baselines subject to strict change control.

To manage the waste-management program specified by the Nuclear Waste Policy Act, the Congress established the Office of Civilian Radioactive Waste Management in the U.S. Department of Energy. Effective management is critical to the success of this complex program, and since the inception of the program, management has received a great deal of attention from the Congress, the electric utility industry, and affected governments and interested parties.

Our overall management goal is to accomplish the mission of the program in accordance with the Nuclear Waste Policy Act as amended, implement the policies established for the program, and achieve our objectives. The specific goal is to provide efficient and cost-effective program execution.

Management structure

The Office of Civilian Radioactive Waste Management

To strengthen the framework for carrying out the restructured program and for developing our initiatives, we have completed a major reorganization of the Office of Civilian Radioactive Waste Management (OCRWM). Our purpose in doing this was to provide clearer lines of responsibility, authority, and accountability; increase our effectiveness in implementing the program; and clearly separate the policy-and-guidance role of our Headquarters organization from the field implementation role. The management structure, formally approved in October 1990, is project oriented, with a single office responsible for the MRS facility and transportation and another office responsible for geologic disposal. The Yucca Mountain Site Characterization Project Office in Las Vegas, Nevada, reports directly to the latter office.

To strengthen the framework for carrying out the program and for developing our initiatives, we have completed a major reorganization.

As shown in Figure 8-1, the OCRWM organization consists of eight offices; all report directly to the OCRWM Director. These offices are the following:

- **Office of Quality Assurance,** which is responsible for developing quality-assurance requirements and overseeing compliance, and for interfacing with the U.S. Nuclear Regulatory Commission on quality-assurance matters.

- **Office of Strategic Planning and International Programs,** which conducts strategic, long-range, and contingency planning and manages relations with the waste-management programs of other nations.

- **Office of External Relations,** which manages intergovernmental relations and education and public information programs.

- **Office of Program and Resources Management,** which is responsible for controlling program costs and schedules, managing financial and other resources, managing information resources, and providing administrative support, including the acquisition and development of human resources.

- **Office of Geologic Disposal,** which is responsible for the scientific evaluations needed to determine whether the Yucca Mountain candidate site in Nevada is suitable for a geologic repository and for waste-package and repository design and development.

- **Office of Systems and Compliance,** which establishes requirements for the program and for the waste-management system, oversees regulatory compliance and the implementation of program requirements, conducts program self-assessments, and integrates the system.

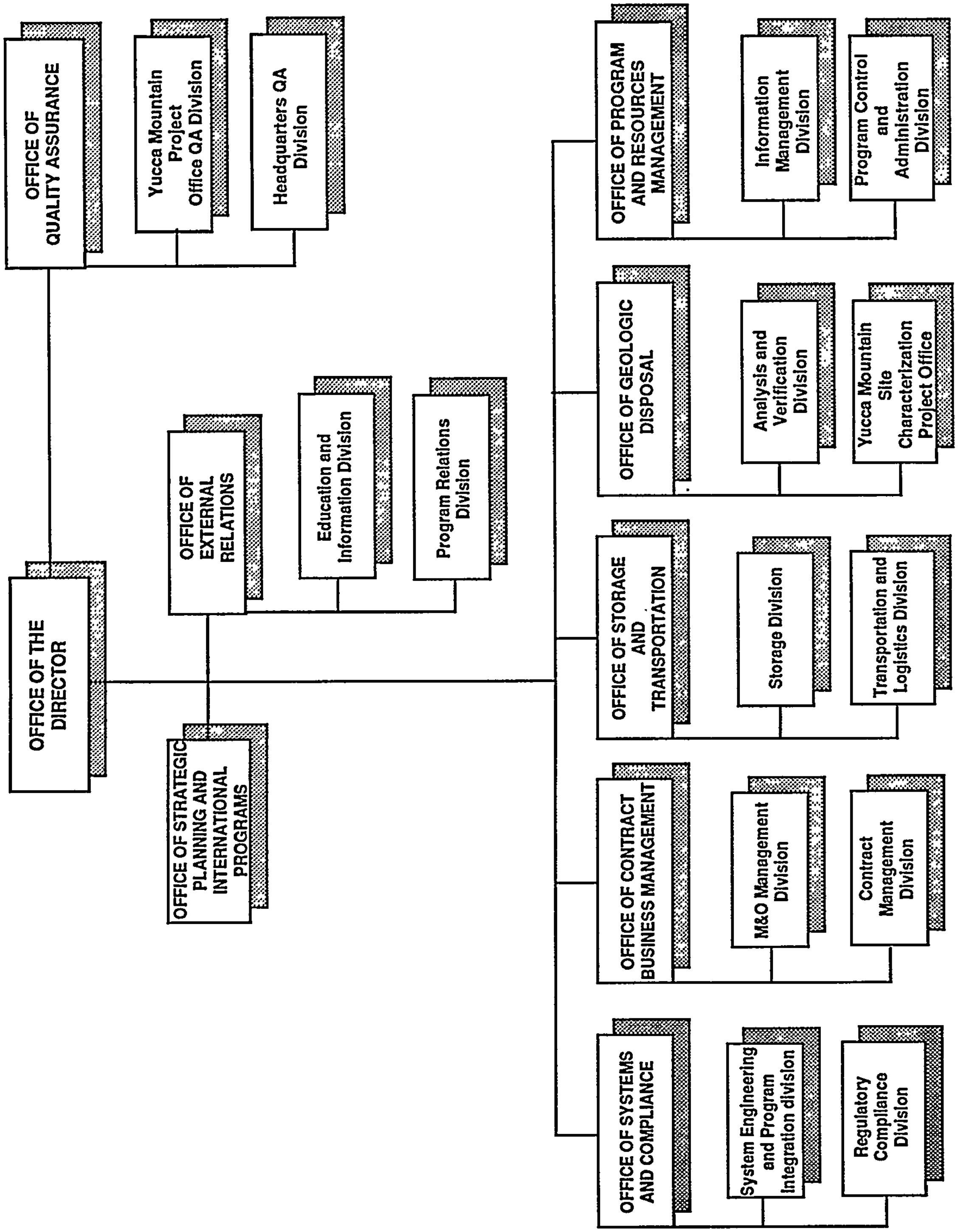


Figure 8-1. Organization of the Office of Civilian Radioactive Waste Management.

- **Office of Storage and Transportation,** which is responsible for directing the MRS program, developing a transportation system, developing shipping casks, developing systems for spent-fuel acceptance, and system logistics.

- **Office of Contract Business Management,** which manages business relations with the management-and-operating contractor and support-services contractors and consolidates contractor services.

Support from contractors and other participants

To perform the technical work of the program, we have obtained the very best scientific and engineering expertise in waste management and repository development. This expertise is provided by the U.S. Geological Survey, the national laboratories, and specialized contractors who supply technical support and assistance. In addition, we contract for outside experts to support or improve program analysis, management, and administration and to support or improve the operation of management systems. All the contractors and other participants in the program work under our direction. The Office of Contract Business Management was created specifically to place proper emphasis on the effective management of contractors.

The changes resulting from the Secretary's reassessment of the program[27] reduced near-term needs for contractor support (in both the number of contracts and the number of contract employees) in many areas, including the designs of the repository and the waste package. We have therefore reduced the overall number of contractors supporting the program.

We are developing a contract-work consolidation plan that we will use to further consolidate or terminate work performed by contractors, integrate the work into the work scope of the management-and-operating (M&O) contract that we have awarded, and plan the consolidation of other work as appropriate. As part of this process we are reviewing and updating our internal procurement procedures to reflect evolving procurement policies of the Department as well as the direct-line reporting relationship between the Yucca Mountain Site Characterization Project Office and Headquarters.

The management-and-operating contract

We awarded an M&O contract on February 12, 1991. The M&O contractor is responsible for the design and analysis of the waste-management system to ensure that the system is optimized and that the interfaces between system elements are clearly specified and controlled. The contractor also is responsible for supporting our efforts to ensure that the Yucca Mountain candidate site is characterized in accordance with regulatory requirements and assisting us in obtaining a license for a repository from the Nuclear Regulatory Commission. For the MRS facility, the M&O contractor will assist us, if necessary, in siting and will provide design and licensing services. In addition, the M&O contractor will integrate the work of the various program participants. We expect the contractor to provide us with the best possible information and advice on the improvement of program content, schedules, and costs.

We will continue to exercise our responsibilities to establish the policy of the program as well as its overall objectives. We will continue to be responsible for schedules and the allocation of resources. Specifically for the M&O contract, we will define work packages, establish negotiated schedules and budgets for the work, define reporting requirements and deliverables, provide timely approval or disapproval of actions proposed by the M&O contractor, and fairly evaluate the contractor's performance to both protect the Government's interests and encourage superior performance by the contractor.

Program Management System

To assist in managing the program, we established the Program Management System (PMS). We have recently completed a systematic review of management requirements and implemented a number of significant improvements in our management system, including changes in program planning and control.

The Program Management System consists of all the baselines (reference sets of data and requirements that are strictly controlled), plans, policies, procedures, systems, and processes that, taken together, serve as the mechanism for managing the program in a cohesive, cost-effective manner. It adapts the basic requirements of the Department's project management system[42] to the specific needs of our program and to the regulatory requirements of the Nuclear Regulatory Commission for licensing nuclear facilities. In addition, it specifies the means for planning and controlling all major activities in the program, including technical activities, cost and schedules, quality assurance, regulatory compliance, institutional planning, records management, and the management of information resources.

We have completed a systematic review of management requirements and implemented a number of significant improvements in our management system, including changes in program planning and control.

The PMS Manual

The Program Management System Manual[43] is our top-level management directive. The manual is the principal source of program-specific policies and requirements for developing baselines, management plans, and procedures. It facilitates effective program management by providing policies and requirements for organizing, planning, directing, and controlling the activities of the program. It establishes and describes the hierarchy of plans required to develop and maintain the program's baselines and establishes the management policies and procedures used in program implementation. In addition, it assigns responsibilities for the preparation, concurrence, and approval of the baseline, policy, and procedural documents and changes thereto.

The Management Systems Improvement Strategy

Shortly after reorganizing, we developed a Management Systems Improvement Strategy (MSIS).[4] This strategy relies heavily on a rigorous analysis to define in detail the functions to be performed by the waste-management system and each of its elements. The MSIS provides a framework that will enable us to accommodate the unique characteristics of the program and to accomplish our mission. It is expected to produce improvements to the technical baseline and other major management documents.

Included in the MSIS approach is the broadened use of systems engineering to plan, control, and integrate technical activities. Specifically, systems engineering is used to specify the sequence of technical activities necessary to define the requirements the system must satisfy, to develop the system, to relate the system elements to each other, and to determine how the system can be optimized to most effectively satisfy the requirements. It is an iterative process in which the system is evaluated and optimized at different phases of analysis and design in order to further define or refine the requirements. Its expanded use will allow us to evaluate and use the most appropriate technology and expertise to provide waste management and disposal in a manner consistent with our policies.

Configuration management

A program as complex and long-lasting as ours requires good planning and control. To achieve this, we are implementing a comprehensive configuration-management program to ensure that all parts of the waste-management system are clearly defined and controlled throughout the design, development, and acquisition process. Configuration management will help us ensure that the various parts of the program are integrated.

To provide the necessary control, we will use a set of integrated baselines—that is, reference sets of data and requirements that are strictly controlled—for technical work, costs, and schedules. These baselines are controlled at three levels of detail corresponding to the three levels in our management hierarchy: the Department level (the Chairman of the Energy System Acquisition Advisory Board, currently the Undersecretary), the program level (the Director of the Office of Civilian Radioactive Waste Management), and the project level.

Our technical, cost, and schedule baselines are derived from program-planning activities and are formally reviewed before incorporation into the program baseline. Readiness reviews and approval of baselines are prerequisites to decisionmaking at key decision points and the release of funds for future work.

We have set for the cost and schedule baselines thresholds that may not be exceeded without action by a change-control board, and change-control boards have been established at each of the three management levels to assess the effects of proposed changes to the baseline and to approve or disapprove the proposed changes. And we have developed procedures to ensure that changes are reviewed at the appropriate level of management and that corrective action is taken if appropriate. The use of formal change control also ensures that all program participants are using only the current approved documents. Periodic reports are submitted to management to show the status of controlled documents (i.e., their latest revision numbers and dates).

Planning and control of technical activities

The technical baseline. The technical baseline was established through the process of systems engineering. Its purpose is to ensure that all program participants use the same information in developing the system and that changes are evaluated carefully before being made; this baseline is described in our Systems Engineering Management Plan.[44] We plan to establish three interrelated baselines, collectively called the "program technical baseline," at certain decision points during the design of the waste-management system. All technical requirements for design and site-characterization activities will be contained in the technical baseline. The three baselines are the requirements baseline, the system-configuration baseline, and the "as-built" system-configuration baseline.

The requirements baseline consists of requirements for the entire waste-management system and for each of its parts. It is presented in five documents specifying requirements for the overall system, waste acceptance, waste transportation, waste storage, and waste disposal. The configuration baseline documentation is prepared for each part of the system to reflect the technical baseline at each design phase. The "as-built" configuration baseline documentation will reflect the design at the completion of construction.

We will document the technical baseline, in accordance with appropriate quality-assurance procedures, to support the technical decision process and provide a traceable record for licensing and for the requisite environmental documentation, such as environmental impact statements. The documents that comprise the technical baseline are provided to all program participants.

Control of the technical program. We use several mechanisms to control the technical program. They include control of the technical baseline, control of the design process, and evaluation of system development. We have also established a process for controlling the scientific investigations in site characterization.

The documents comprising the technical baseline must be prepared, reviewed, and approved in accordance with formal procedures for quality assurance and change control. The key elements in the design-control process are the establishment of quality-assurance procedures, establishment and control of input and input documents, design reviews, control of changes to design, and control of output documents.

We evaluate system development by reviewing the progress of design activities, verifying the adequacy of the design, and verifying compliance with quality-assurance procedures. The reviews include technical reviews, readiness reviews, design reviews, and peer reviews. We have developed specific administrative quality-assurance procedures for all of these reviews.

Planning and control of costs and schedules

We have baselined both the costs and the schedule of the program in the Program Cost and Schedule Baseline document.[45] The document describes how we manage the cost and schedule baselines and explains their relationship to the technical baseline. It also specifies the thresholds at which proposed changes to the baselines must be reviewed and approved or disapproved at the next higher level of management. The cost and schedule baselines are consistent with the technical baseline and the planned activities.

To improve the control of costs and schedules, we have integrated the work scope, cost estimates, and schedules and the measurement of work performance.

To develop the cost and schedule baselines, we start with the required technical work scope and the relationships between activities, using schedule networking techniques. After these networks are reviewed by management and adjusted as required, we add costs to the networks, which are adjusted again to optimize resource utilization.

We coordinate the control of the cost and schedule baselines with the control of the technical baseline. Changes in costs and schedules at any level must be reviewed for impacts on the cost and schedule baselines, and any changes must be approved, using the formal change-control process. The objective is to optimize prospects for timely mission accomplishment while minimizing program costs.

The cost and schedule baselines do the following:

- Identify the cost and schedule components that are subject to change control and establish their baseline values in dollars and completion dates, including explicit criteria for defining the completion of each schedule milestone.

- Provide a measurable basis from which to analyze the cost and schedule impacts associated with proposed changes to the technical baseline.

Project Decision Schedule

The Congress recognized the program's dependence on timely actions by other Federal agencies in meeting the schedule for the repository; it therefore included in the Nuclear Waste Policy Act the requirement that a project decision schedule be developed and updated, as appropriate, in cooperation with affected Federal agencies to portray the optimum way to achieve the operation of a repository. The Project Decision Schedule describes actions required to be taken by other Federal agencies and establishes deadlines for their completion.

The Project Decision Schedule has been revised and is being reviewed by the Department. The revision was coordinated with seven Federal agencies, whose comments were incorporated. Upon issuance, this document will constitute a commitment by affected Federal agencies to support the schedule for the repository.

Risk management

Most activities involve some degree of risk, and every organization faces risks in trying to achieve its goals. Many government agencies and private companies have responded to the risks they face with a risk-management program that provides a framework for systematically identifying, assessing, controlling, and communicating risks.

We have been working since the beginning of the program to characterize the risks of waste management and communicate with external parties about those risks. We believe these efforts can be improved by better integrating our risk-assessment, decisionmaking, and communication activities. We are therefore initiating a risk-management program that will take a more comprehensive and systematic approach to identifying, assessing, and controlling risks. Effective communication, both within our organization and with external parties, will be critical for this program to succeed.

Our risk-management program has six objectives:

- To identify the risks of waste storage, transportation, and disposal to public health and safety and the environment.

- To assess these risks by using appropriate quantitative and qualitative methods.

- To identify options for avoiding, reducing, and controlling risks.

- To choose among risk-management options.

- To establish a process that integrates our technical and institutional programs to ensure that risks are systematically identified and addressed.

- To establish effective communication on risk issues with affected governments, interested parties, and the general public.

This is a long-term effort that will be closely related to other program-management initiatives, notably the Management Systems Improvement Strategy. The risk-management program will focus in the near term on establishing goals, developing a management process, and establishing communication channels needed for a process that is integrated and traceable.

Peer review

A peer review is a documented critical review performed by persons who have technical expertise in the subject matter of concern but are not directly involved in the analysis, study, or plan under review. Peer reviews are management tools for interpreting and verifying or validating assumptions, plans, results, or conclusions that are critical to the success of a program. They yield multiple benefits: the expert appraisal of plans, methods, analyses, and results bolster technical confidence, and the use of recognized independent authorities strengthens program credibility; they may generate fresh ideas and approaches to problems, by, for example, making participants aware of technologies and experiences in other fields that could be introduced into their program; and they ensure that managers do not overlook important factors. Peer reviews have limits, of course; they are generally of narrow scope and short duration, and may not be sensitive to all regulatory, institutional, and management concerns.

We traditionally have used peer reviews in our program and will continue to do so. Our peer reviewers come from organizations both directly involved in the program and outside it. Our plans, procedures, and reports receive extensive technical reviews from technical peers in the Office of Civilian Radioactive Waste Management, participating contractors, national laboratories, and other Departmental organizations; these reviews may carry a document through several cycles of qualified technical review.

Just as important, a number of outside parties perform peer reviews of our program. These parties include the staff of the Nuclear Regulatory Commission, the Nuclear Waste Technical Review Board, and affected governments; often, oversight groups conduct reviews on an ongoing basis throughout the course of an activity. And our program has been, is being, and will be examined by experts from the National Academy of Sciences, other public and private research institutions, other countries, and the readers of professional journals.

We will continue to engage in peer reviews frequently and in a focused manner. We intend to expand our current peer review of technical and institutional activities and products. Similarly, we intend to have experts review our management program. For those issues in which peer review is appropriate, we plan to establish a formal process for the selection of the members of peer-review panels in order to ensure independent and objective reviews; this process may be similar to that already used by the National Academy of Sciences. We will continue to make our peer-review process as open as possible and document the program changes that result from peer reviews. We intend to respond to the recommendations of each peer review and to incorporate the recommendations deemed appropriate into our plans and operations. We will use the peer-review process in conjunction with applicable quality-assurance procedures, and the findings will be considered part of our management decisionmaking process.

Quality assurance

We now have in place a quality-assurance (QA) program that meets the requirements of NQA-1, the consensus standard[2] for the application of quality assurance to nuclear facilities and the requirements of the Nuclear Regulatory Commission.[3] The development and implementation of this program is a major achievement. It represents one of the largest and most concentrated commitments of time and effort since the inception of the waste-management program. Our QA program is applicable to the quality-affecting activities of all program elements and provides requirements for effective QA implementation for us and all other program participants.

Well-defined QA programs describing the appropriate management controls needed to achieve our objectives have been established and are being effectively implemented by all participating organizations, including the Office of Civilian Radioactive Waste Management, the Yucca Mountain Site Characterization Project Office, participating Department operations offices, contractors, subcontractors, national laboratories, and other government agencies or program participants performing activities affecting quality for the program. Quality assurance is a continuing responsibility of management as well as staff at all levels of our program.

The QA program provides for both the achievement of quality and the verification of that achievement. The line organization has the responsibility for the achievement and the verification of quality. The QA program also requires the OCRWM Director to conduct, or to have conducted, an annual QA management assessment to evaluate the effectiveness of QA implementation throughout the Office of Civilian Radioactive Waste Management.

The QA organization maintains a strong overview presence in the QA program. To implement a strong overview program, the QA organization performs verifications such as audits, surveillances, and assessments on activities affecting quality. Overview activities are scheduled to address the concerns of management and complement the actual performance of QA-affecting activities. The overview process has the flexibility needed to accommodate changes in work activities and to address newly identified concerns.

Effective implementation of our QA program will ensure that activities involved in accomplishing our mission will be performed in a manner that protects the health and safety of the public and workers and the quality of the environment.

Self-assessment

We have made self-assessment a strategic principle for our program because we intend to rigorously assess our own performance. We will expand our current assessment program to objectively evaluate our performance. We will regularly and systematically apply performance measures to determine how we can strengthen our efforts. And we will involve external parties in the assessment program through a variety of mechanisms to assess how well we are doing in implementing the strategic principles.

In addition, as part of the Department of Energy and under the direction of the Secretary, we already undertake activities to assess our performance. To ensure compliance with all environmental, safety, and health requirements, the program provides a mechanism for independent review, planning, implementation, and verification of performance and compliance in four areas: environment, safety, and health; nuclear safety; the reporting of unusual occurrences; and performance-indicator evaluations. The requirements, strategies, responsibilities, and approaches for implementing the self-assessment program are described in a self-assessment management plan. Implementing procedures for each of the four self-assessment functions are documented in separate implementation plans, which establish approaches, training requirements, reporting requirements and responsibilities, corrective-action procedures, and schedules. The results of surveys and appraisals performed for the program are published in site-visit reports and periodic summaries.

Information resources

We have developed a comprehensive approach to the management of information resources—an approach that is integrated and controlled through a combination of management techniques, functions, and technologies. The term "information resources" refers to the data, procedures, hardware, software, and telecommunications that support the collection and dissemination of information needed to accomplish our mission and objectives.

In order to facilitate the capture, storage, processing, retrieval, security, transmission, and dissemination of data and information, we have established a base of computer hardware, software, and communications equipment. This computing infrastructure supports the program's office-automation systems, records management, data bases, and local- and wide-area networks. A feature of our computer-indexed records system is the Licensing Support System (LSS). The LSS will be an automated system that will facilitate the review of licensing information by providing full text-search capability and decrease the time required for the submittal of motions and other documents through electronic document transmission.

To further facilitate the sharing of information, we plan to publish a quarterly catalog of data. This catalog will list the data acquired, describe the data, specify where and when the data were acquired, and specify how and where the data are available. We will respond to specific requests.

We annually define the information resources needed to achieve the objectives of the program and each of its major elements. In this process planning for information resources is closely linked to planning for the primary program functions, such as systems engineering, design, site-suitability determination, licensing, quality assurance, and program control. To integrate information resources among the major sites involved in program activities, we have created a centralized office to establish policies and directives governing information resources and to coordinate information-resource plans, procedures, and practices.

Contracts with waste generators

In accordance with the Nuclear Waste Policy Act, we have entered into contracts with the owners and generators of commercial spent nuclear fuel and commercial high-level waste. Under these contracts, we agree to take title to, transport, and dispose of spent nuclear fuel and high-level waste delivered to us by the owners and generators in return for their payment of fees into the Nuclear Waste Fund for these services.

In accordance with the terms of the contracts, we issue annual capacity reports. These reports project both the annual acceptance capacity of the waste-management system and a priority ranking for contract holders for 10 years after the start of facility operations. The information in these reports is for planning purposes only.

In the first annual capacity report,[46] we offered to cooperate with owners and generators of spent fuel to identify, set priorities for, and evaluate solutions to issues of mutual concern arising from the implementation of the standard disposal contract. In response to our offer, the Edison Electric Institute, in cooperation with the U.S. Council for Energy Awareness, established a committee to represent the owners and generators of spent fuel in the issue-resolution process for the annual capacity reports. This cooperative effort is an ongoing process.

Our contract with the generators of waste requires an acceptance priority ranking to be published annually, beginning in 1991. This ranking will identify the order in which we will allocate the Federal waste-acceptance capacity. In accordance with the contract, we are preparing to process delivery commitment schedules, which will be submitted by the owners and generators beginning in

January 1992. These schedules will identify, among other things, the locations at which we plan to pick up spent fuel.

> ***We intend not only to increase our interactions with utility organizations but also to reduce the uncertainties they face in managing spent fuel.***

We intend not only to increase our interactions with utility organizations, as indicated in the preceding chapter, but also to reduce the uncertainties they face in managing spent fuel. For example, we will establish our position on what constitutes spent fuel. This decision will include which types of non-fuel-bearing components are to be accepted and what the fuel-assembly dimensions are to be, both with and without hardware. In addition, we will establish acceptance criteria for spent fuel and associated material.

Funding

The Nuclear Waste Policy Act as amended specifies that the cost of waste disposal is to be borne by the generators and owners of the waste and established the Nuclear Waste Fund for that purpose. For the disposal of spent nuclear fuel, revenues for the Fund were to come from two types of fee:

1. A fee of 1 mill per kilowatt-hour on electricity generated and sold after April 7, 1983.

2. A one-time fee on spent nuclear fuel used to generate electricity in civilian nuclear power reactors before April 7, 1983.

We are required by law to determine every year whether the 1-mill fee will provide sufficient revenue to offset the costs of the program. We publish the results in fee-adequacy reports, the most recent of which was issued in November 1990.[47] All of the reports to date have concluded that the fee did not yet need adjustment.

The Act provides that any monies in the Fund that exceed current needs may be invested in Treasury securities. As of December 31, 1990, investments in U.S. Treasury securities totaled nearly $2.8 billion. Our investment policy for the Fund is to provide cash when required to meet program expenditures while balancing between higher investment earnings and the potential for capital gains and losses. Our basic investment strategy is to maximize earnings while providing the funds needed for operations without exposing the Fund to unnecessarily high risks of loss. Through December 31, 1990, the interest earnings of the Fund totaled more than $898 million.

In accordance with a decision made by the President in 1985, the repository developed under the Act will provide disposal for high-level waste from national defense activities. The Department of Energy is committed to paying its fair share of program costs to the Nuclear Waste Fund.

Costs and cost effectiveness

Each year, we perform a comprehensive analysis of the total cost of the waste-management system over its complete life cycle; this analysis establishes the reference long-term cost for the total program. The main use of cost estimates is to determine whether the fees paid by the owners and generators of spent nuclear fuel and high-level radioactive waste will be sufficient to recover the full cost of the program. The most-recent analysis,[48] published in December 1990, indicates that the total-system life-cycle cost for a system including one repository and an MRS facility is estimated to be about $25.6 billion in 1988 dollars.

Cost effectiveness is a key part of the program. We have made cost effectiveness a basic policy and management principle of the program. Two aspects of cost effectiveness are important: one is cost-effective development and operation of the waste-management system; the other is cost-effective management of the program.

Costs play an important role in making program decisions affecting system design and operations. The decision to include defense high-level waste in the civilian repository is an example of a decision where cost implications were considered. The decision in 1989 to focus scientific investigations at Yucca

Mountain on the early identification of potentially adverse conditions is another instance where cost considerations have played a major role in decisionmaking. The extensive cost analyses performed as part of the MRS system studies in 1988 and 1989 were considered in defining our position on the type of MRS facility preferred—namely, a facility that could be developed quickly and at a lower cost than other MRS concepts considered at the time. Costs were also included in the study of alternatives for the exploratory-studies facility to determine the optimum concept for underground testing.

We have made cost effectiveness a basic policy and management principle of the program.

The above examples are all the results of special studies designed to provide a decision of programmatic significance from an analysis of options. In addition, the program has institutionalized the use of cost effectiveness in design decisionmaking by requiring cost-impact assessments to be performed when changes to the program's technical baseline are considered. Since the program's formal change-control system was initiated in the mid-1980s, consideration of cost impacts has been required, along with technical, regulatory, safety, schedule, and other impacts, to accompany change proposals brought before the Program Change Control Board. Thus, the change-control system provides a formal means of incorporating cost impacts into the program's technical decisionmaking.

The principle of cost effectiveness has also been followed in the execution or management of program activities. For example, the steps embodied in the budget-formulation process afford one of the best means of providing cost control. During the multiyear planning process, oversight groups both internal and external to the program participate in exercising budget control. Once the program's budget is established, costs are closely monitored through financial management systems to prevent overruns. A key component of cost-effective management of the program resources is also the control of schedules. Although we will not jeopardize health and safety merely to control cost and schedule, we regard our schedules as important and will strive to maintain them through careful monitoring and attentive management.

A key element of practicing cost-effective management is to have a sound basis and method for developing cost estimates. To ensure that this basis and method are as sound as possible, the program's cost analyses are subject to regular external reviews. For example, the annual total-system life-cycle cost analysis mentioned above is regularly reviewed by the Department's Office of Independent Cost Estimating and the General Accounting Office. These regularly performed assessments have contributed toward standardizing the cost-estimating process and have provided increased accountability. Our technical work is subject to review by the Nuclear Waste Technical Review Board, and these reviews contribute to a sound technical basis for the cost estimates. This basis is reinforced by the scrutiny that our technical, institutional, and managerial programs receive from a wide variety of organizations outside the Federal Government, including the States, the affected local governments, the utilities, and other interested parties.

We also expect that such actions as the consolidation of contracts will contribute to further cost effectiveness.

Audits

We are unique in the Department of Energy with respect to audit oversight of our activities. We employ the services of a certified public accounting firm to conduct annually an independent financial audit of the Nuclear Waste Fund. In addition, the Nuclear Waste Policy Act requires the General Accounting Office to conduct an annual audit of our program. The General Accounting Office also conducts numerous nonrecurring audits of our activities in response to specific Congressional requests and on its own initiative. In addition, a number of audits are performed each year by the Department's Inspector General.

It is our policy to cooperate fully with audit organizations and to implement any appropriate corrective actions in a timely manner. Having the benefit of such disinterested reviews of the program has proved useful to us in developing overall strategies as well as in improving the efficiency and economy of day-to-day activities.

Alternative means of managing the program

In the National Energy Strategy[1] we promised to evaluate the suitability of alternative ways to carry out the Civilian Radioactive Waste Management Program. The alternatives include an independent corporation or some other nongovernment management structure; their potential advantages are the ability to recruit necessary skills and expertise outside the Federal personnel system, insulation from annual budgetary pressures, flexibility to ensure early and frequent involvement of those with a stake in the safe management of the waste, and the ability to implement a program that extends over decades.

It is the Congress that has directed us to manage the program, and we believe that we should continue to manage it for the time being. The primary issues confronting the program are political, legal, legislative, and regulatory. Therefore the entity running the program now must be at parity with the other Federal entities shaping the program's future.

As the program enters the implementation stage—that is, construction and operation—another entity might be better suited for its management. Thus, we will continue to evaluate the merits of turning over responsibility at the implementation stage. The decision process will be set in motion early enough that if the Congress decides to transfer responsibility, the transfer can be effected with minimal loss of program momentum.

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LIST OF ACRONYMS

ACD	advanced conceptual design
BLM	Bureau of Land Management
BWR	boiling-water reactor
CFR	Code of Federal Regulations
DEIS	draft environmental impact statement
DOE	Department of Energy
DOT	Department of Transportation
EA	environmental assessment
EIS	environmental impact statement
EPA	Environmental Protection Agency
ESF	exploratory-studies facility
FEIS	final environmental impact statement
FPCD	final procurement-and-construction design
LA	license application
LAD	license-application design
MRS	monitored retrievable storage
MSIS	Management Systems Improvement Strategy
MTL	main test level
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act of 1969
NRC	Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act of 1982
OCRWM	Office of Civilian Radioactive Waste Management
PMS	Program Management System
PWR	pressurized-water reactor
QA	quality assurance
SCP	site characterization plan
SRR	site-recommendation report

GLOSSARY

Act	The Nuclear Waste Policy Act of 1982.
advanced conceptual design	The phase in the design of a repository or a waste package in which selected design alternatives are explored and design criteria and concepts are refined. This phase follows the conceptual design and is followed by the *license-application design.*
affected	The designation as established by the Nuclear Waste Policy Act as amended that a State, Indian Tribe, or unit of local government is a potential host for a repository or MRS facility. The term also applies to an Indian Tribe that the Secretary of the Interior finds would experience substantial and adverse effects from an MRS facility or a repository. Such term may at the discretion of the Secretary include contiguous units of local government.
Amendments Act	The Nuclear Waste Policy Amendments Act of 1987.
anticipated processes and events	The natural processes and events that are likely to happen during the period in which an intended performance objective of the repository is to be achieved.
at-reactor storage	The retention of spent nuclear fuel at the site of a nuclear reactor or power plant, usually where it was used to produce power.
backfill	The general fill placed in the excavated areas of an underground repository.

	Backfill materials may be tuff excavated during the development of the repository or other earthen materials. Also refers to the process of refilling an excavation.
barrier	Any material or structure that prevents or substantially delays the movement of water or radionuclides.
baseline	A reference set of assumptions, requirements, and data that is used to define, compare, or control a system or subsystem; an example is the program cost baseline.
benefits agreement	As provided by Section 170 of the Nuclear Waste Policy Act as amended, a legal compact specifying the benefits due to the State of Nevada for hosting a repository and any State or Indian Tribe willing to host an MRS facility. Only one benefits agreement for a repository and only one benefits agreement for an MRS facility may be in effect at any one time.
borehole	A hole made with a drill, auger, or other tool to explore rocks, search strata for minerals, supply water for blasting, prove the positions of old workings or faults, or release accumulations of gas or water.
borosilicate glass	A silicate glass containing at least 5 percent boric acid and used to solidify high-level waste.
burnup	A measure of nuclear reactor fuel consumption expressed either as a percentage of the fuel atoms that have undergone fission or as the amount of

energy produced per unit weight of fuel.

Calico Hills	A tuff formation located beneath the horizon or layer of the proposed repository at Yucca Mountain.
candidate site	An area in a geologic and hydrologic system recommended by the Secretary, approved for site characterization under Section 112 of the Amendments Act or undergoing site characterization under Section 113.
cask	A waste receptacle designed to safely hold one or more spent-fuel assemblies during transportation to or storage at a repository or MRS facility.
conceptual design	The formulative phase in design; it develops project scope to satisfy program needs, operating needs, and statutory requirements; ensures project feasibility and attainable technical performance levels; identifies and quantifies any project risks; and develops a reliable cost estimate and a realistic performance schedule. For the repository and the waste package, this phase is followed by the advanced conceptual design.
consolidation	An operation performed on spent-fuel assemblies in which the hardware that holds the spent-fuel rods together is removed and the fuel rods are tightly bundled for insertion into a canister or container.
containment	The confinement of radioactive waste within a designated boundary.

coring	To drill into rock so as to withdraw adjacent cylindrical samples for analysis.
criticality	The point at which a reactor achieves a self-sustaining chain reaction. When a reactor reaches criticality, various technical means are used to control the heat necessary to generate electricity.
decommissioning	The permanent removal from service of the facilities and other components of a repository or an MRS in accordance with regulatory requirements and environmental policies.
decontamination	The removal of radioactive contamination from facilities, equipment, or soils by washing, heating, chemical action, electrochemical action, mechanical cleaning, or other techniques.
dedicated train	A railroad train purposefully configured and operated to serve a specific function, such as to move a certain commodity.
defense in depth	A strategy for helping a system perform its function by providing it with a series of independent protective measures. "Design redundancy" is a synonym. An example is creating a repository with multiple barriers, both natural and engineered.
development area	The underground area that is being prepared for the emplacement of waste in the repository. Development includes the excavation of emplacement drifts and boreholes, the installation of rock supports in the drifts, and outfitting the emplacement holes with

liners and covers. When the development of a waste-emplacement panel has been completed, bulkheads are installed to seal the panel from the development area, and the panel is added to the ventilation circuit of the waste-emplacement area, thus becoming part of the waste-emplacement area.

direct-line reporting	Management authority to direct a component of an organization without the need to send directions through intermediates.
displacement	A general term for the relative movement of the opposing sites of a geologic fault.
disposal	The emplacement in a repository of high-level waste, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste.
disposal container	The metal-barrier portion of the waste package placed around a waste form.
disposal contract	A standard agreement under which the Department of Energy has agreed to take title to, transport, and dispose of spent nuclear fuel and high level radioactive waste delivered to the Department by the owners and generators in return for their payment of fees into the Nuclear Waste Fund.
drift	A horizontal or nearly horizontal mined passageway.

drilling fluid	The medium, such as water or air, that is used in drilling to remove the cutting from the drilling bit, carry cuttings to the surface for disposal, cool the bit, stabilize the borewall in open intervals, and energize downhole drilling tools.
dry storage	A waste storage method that uses air as the cooling medium.
dual-purpose cask	A cask designed for use in both transportation and storage.
emplacement	The act of placing waste containers in prepared positions. For the proposed repository at Yucca Mountain, two methods are currently being considered: emplacement of a single waste container in a shallow vertical borehole in the floor of the emplacement drift or emplacement of multiple waste containers in long horizontal boreholes in the wall of the drift.
engineered-barrier system	The waste packages, underground facility, and other man-made components of a disposal system designed to prevent the release of radionuclides from the underground facility or into the geohydrologic setting.
environmental assessment	An evaluation of environmental impacts required by the Nuclear Waste Policy Act for potentially acceptable sites for a repository and by the Act as amended for an MRS site.
environmental impact statement	An evaluation of environmental impacts, required by the National Environmental Policy Act of 1969 for major Federal actions having significant environmental impacts. Section 114 of the Nuclear

	Waste Policy Act as amended establishes specific provisions for an EIS accompanying a recommendation to the President for approval of a repository site. Section 148(a) of the Nuclear Waste Policy Act as amended establishes specific provisions for an EIS addressing an MRS facility.
environmental permit	Authorization by a responsible agency of government that a proposed action may proceed, consistent with an environmental law or regulation.
exploratory-studies facility	A facility constructed for the purpose of performing underground studies during site characterization.
fault	A break in the continuity of a rock formation, caused by a shifting or dislodging of the earth's crust, in which adjacent surfaces are differentially displaced parallel to the plane of the fracture.
final procurement-and-construction design	The phase in the design of a repository or a waste package in which the final drawings and specifications for procurement and construction are completed.
fracture	A general term for any break in a rock, whether or not it causes displacement, due to mechanical failure by stress. Fractures include cracks, joints, and faults.
fuel assembly	The smallest regular package of nuclear fuel pellets, rods, and joining hardware. Typically a square array of metal rods containing enriched uranium dioxide

	fuel pellets. Fuel for a nuclear power plant is loaded into the reactor core in the form of fuel assemblies.
functional analysis	An approach in the practice of systems engineering for analyzing performance requirements and dividing them into discrete tasks or activities.
ground water	Underground water as distinct from surface water.
high-level waste	The highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products (nuclides produced by the fission of a heavier element) in sufficient concentrations, and other highly radioactive material that the Nuclear Regulatory Commission, consistent with existing law, determines by rule to require permanent isolation.
horizon	In geology, a particular position in a stratigraphic sequence.
host rock	The rock in which radioactive waste is emplaced. (At the Yucca Mountain candidate site, the likely host rock would be the welded tuff of the Topopah Spring Member of the Paintbrush Tuff Formation.)
in-situ testing	Testing in the subject environment, such as underground at the candidate repository site, as opposed to testing in another environment, such as at the surface or in a laboratory.

interested parties	Parties who do not qualify as *affected* but nonetheless have legitimate concerns in the waste-management program, such as environmental groups and electric utilities.
license-application design	The phase in the design of a repository or a waste package that completes the resolution of the design and licensing issues identified in earlier phases and develops the design of the items necessary to demonstrate compliance with the design requirements and performance objectives of 10 CFR Part 60. This phase follows the *advanced conceptual design* and is followed by the *final procurement-and-construction design*.
licensing	The process of obtaining the permits and authorizations required to site, construct, operate, close, and decommission a repository or an MRS facility.
low-level waste	Radioactive material that is neither high-level waste, spent fuel, transuranic waste, nor byproduct material as defined in Section 11a(2) of the Atomic Energy Act of 1954.
matrix	In geology, relatively fine-grained material in which coarser fragments or crystals are embedded.
mechanical mining	Excavation with a tunnel-boring machine, as opposed to tunneling with the use of explosives.

metric ton of uranium	Measurement of the quantity of fuel mass in metric tons (each equivalent to 2204.6 pounds avoirdupois) considering only the radioactive heavy-metal content and treating it as if it were uranium.
mitigation	(1) Avoiding an impact altogether by not taking a certain action or parts of an action, (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation, (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment, (4) reducing or eliminating an impact over time by preservation and maintenance operations during the life of the action, or (5) compensating for the impact by replacing or providing substitute resources or environments.
MRS facility	A facility integrated into the waste-management system to provide monitored retrievable storage for spent fuel, to stage spent-fuel shipments to the repository, and to perform other functions that may be needed by the system.
multiple-barrier system	A system of natural and engineered barriers, operating independently or relatively independently, that acts to contain and isolate the waste.
natural barrier	The physical, mechanical, chemical, and hydrologic characteristics of the geologic environment that individually and collectively act to minimize or preclude radionuclide transport.
natural system	A host rock suitable for repository construction and waste emplacement and the surrounding rock formations.

	Includes the natural barriers that provide (1) waste isolation by limiting radionuclide transport to the accessible environment and (2) conditions that will minimize the potential for human interference in the future.
nuclear fuel	Fissionable material usable as the source of power when placed in a critical arrangement in a nuclear power reactor. Uranium fuel is the most common kind of nuclear fuel.
passive cooling	Cooling by natural mechanisms only, not requiring manmade devices such as pumps or fans.
peer review	A documented critical review performed by personnel who are independent of those who performed the work but have technical expertise at least equivalent to those who performed the original work.
performance assessment	Any analysis that predicts the behavior of a system or a component of a system under a given set of constant or transient conditions.
pillar	A solid mass of rock left standing to support a mine roof.
postclosure	The period of time after the closure of the geologic repository.
preclosure	The period of time before and during the closure of the geologic repository.
quality assurance	All the planned and systematic actions necessary to provide adequate confidence that a structure, system, or component is constructed to plans and

	specifications and will perform satisfactorily.
radionuclide	An unstable nuclide that decays toward a stable state at a characteristics rate by the emission of ionizing radiation.
repository system	The geologic setting at the site, the waste package, and the repository all acting together to contain and isolate the waste.
site characterization	Scientific investigations performed to obtain the information needed to determine whether a candidate site is suitable for a repository, acquire data for developing more-advanced designs for the repository and the waste package, and conduct the performance assessments needed to license the repository.
spent fuel	Fuel that has been withdrawn from a nuclear reactor after irradiation. Spent fuel emits heat and is highly radioactive.
study plan	A plan that describes the coordination of the site-characterization work in more detail than that given in the Site Characterization Plan.
system performance	The complete behavior of a system in response to the conditions, processes, and events that may affect it.
Title I design	The second design phase for an MRS facility. It continues the design effort, using the conceptual design and the project design criteria as a basis for MRS development. It is followed by the Title II design.

Title II design	The third and final design phase for an MRS facility. It continues MRS development on the basis of the approved Title I design. It includes any revisions required of the Title I effort, such as the preparation of final working drawings, specifications, bidding documents, and cost estimates; coordination with all parties that might affect the project; and the development of firm construction and procurement schedules.
tracer	A material, such as a dye, introduced into the ground-water system to aid studies of ground-water movement.
trenching	The digging of shallow trenches to expose the underlying stratigraphy, structure, etc., for inspection and sampling.
tuff	A compacted deposit of volcanic ash and dust that may contain rock and mineral fragments.
underground repository	The underground structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals.
unsaturated zone	The zone between the land surface and the water table. Generally, water in this zone is under less than atmospheric pressure and some of the voids in the rock may contain air or other gases at atmospheric pressure. Beneath flooded areas or in perched-water bodies, the local water pressure may be greater than atmospheric.

waste	Spent nuclear fuel or high-level radioactive waste.
waste form	The radioactive waste and any encapsulating or stabilizing matrix.
waste isolation	The inhibition of the transport of radioactive materials so that the amounts and concentrations of this material entering the accessible environment will be kept within prescribed limits.
waste package	The waste form and any containers, shielding, packing, and other absorbent materials immediately surrounding an individual waste container.
water table	The depth or level below which the ground is saturated with water.

Appendix A

BACKGROUND INFORMATION

The Nuclear Waste Policy Act of 1982

The Nuclear Waste Policy Act of 1982 (Public Law 97-425) assigned to the U.S. Department of Energy (DOE) the responsibility for managing the disposal of spent nuclear fuel and high-level waste from civilian sources and established the Office of Civilian Radioactive Waste Management for that purpose. It authorized the construction of one geologic repository and specified in detail the process for siting that repository. The Act specified that no fewer than five sites were to be nominated for characterization as candidate sites for the first repository; it also required that the Secretary recommend to the President three sites for site characterization. In addition, the Act specified the process for siting a second repository; authorized the development of a waste-transportation system; required us to submit a proposal to construct a facility for monitored retrievable storage (MRS) after conducting a study of the need for, and the feasibility of, such a facility; and required the President to evaluate the use of the repositories to be developed under the Act for the disposal of high-level waste from defense activities. The Act also included specific provisions for the participation of States and affected units of local government and Indian Tribes in the waste-management program.

Our plans for implementing the requirements of the Act were presented in the Mission Plan,[1] which included a schedule showing that the first repository would start operations in 1998 and a second repository, if authorized by the Congress, would begin operations in 2003. The sites considered for the first repository were the nine sites we had identified as potentially acceptable sites in the States of Louisiana, Mississippi, Nevada, Texas, Utah, and Washington. For the second repository, we were conducting preliminary screening for crystalline-rock sites in 17 States in the northeastern, north-central, and southeastern regions of the United States. The Mission Plan also presented an "improved-performance plan" that was based on integrating into the waste-management system an MRS facility that would prepare spent fuel for emplacement in a repository.

In May 1985, we completed a preliminary analysis of the need for, and the feasibility of, an MRS facility,[2] concluding that an MRS facility would be an important component of an integrated waste-management system. In February 1986, we completed the need-and-feasibility analysis and a proposal to construct an MRS facility at a site in Oak Ridge, Tennessee, but were unable to submit the proposal to the Congress until March 1987[3] because of an injunction resulting from a lawsuit filed by the State of Tennessee.

In May 1986, the Secretary of Energy, as required by the Act, recommended to the President three sites for characterization as candidates for the first repository, and the President approved the recommendation[4]; these sites were the Yucca Mountain site in Nevada, the Deaf Smith County site in Texas, and the Hanford site in Washington. They were chosen from five sites nominated as suitable for characterization. In addition to Deaf Smith, Hanford, and Yucca Mountain, these sites were Davis Canyon in Utah and the Richton salt dome in Mississippi. To aid in identifying preferred sites for characterization, we developed and applied a formal siting method, which was reviewed and found appropriate by the National Academy of Sciences[5]; it entailed analyzing the potential performance of each site both before and after the closure of the repository. The results of the analysis predicted that all of the three sites that were subsequently recommended and approved for characterization were likely to perform exceedingly well.

In May 1986, the Secretary also announced our intent to postpone site-specific work for the second repository. The Secretary's announcement was based in part on decreases in the estimates of spent fuel requiring disposal and the cost savings estimated for the postponement.

In June 1987, we submitted to the Congress an amendment to the Mission Plan.[6] Its purpose was to apprise the Congress of (1) significant developments in the waste-management program that had occurred since the publication of the Mission Plan in 1985, (2) a revised schedule for the first repository, with operations starting in 2003, and (3) our views concerning the postponement of site-specific work for the second repository.

At the time the amendment was issued, the preparation of the site-characterization plans for the three candidate sites for the first repository was proceeding on schedule, and the activities identified in those plans had led to increased estimates of the cost of site characterization and repository development at each of these candidate sites. These estimates indicated that characterization would cost approximately 1 billion dollars at each site.

In the face of these developments and growing public concerns about the siting of geologic repositories, the 100th Congress devoted considerable attention to the waste-management program and on December 21, 1987, approved legislation amending the Nuclear Waste Policy Act of 1982. Known as the Nuclear Waste Policy Amendments Act of 1987 and usually referred to simply as the Amendments Act, this legislation was signed into law by President Reagan on December 22, 1987, as part of the Budget Reconciliation Act for Fiscal Year 1988 (Public Law 100-203). On October 18, 1988, the President signed Public Law 100-507, which made two minor modifications to the Amendments Act.

The Nuclear Waste Policy Amendments Act of 1987

The Amendments Act streamlined and focused the waste-management program. It specified that site characterization for the first repository was to be limited to the Yucca Mountain candidate site in Nevada and that only one repository was to be developed at present; it authorized the construction of an MRS facility subject to certain conditions; and it established several new organizational entities.

First repository

Under Section 5011 of the Amendments Act (Section 160 of the Act as amended), only one site—the Yucca Mountain site in Nevada—is to be characterized as a candidate site for the first repository. The rest of the siting and repository-development process is the same as specified in the Act. If after site characterization the Yucca Mountain candidate site is found to be suitable, the Secretary of Energy is to recommend that the President approve the site for a repository. If the President does approve, he will submit the recommendation to the Congress. The State of Nevada may then submit, within 60 days, a notice of disapproval to the Congress. This disapproval prevents the use of the site for a repository unless the Congress passes a joint resolution of repository-siting approval within the next 90 days of continuous session. If no notice of disapproval is submitted or if a notice of disapproval is overturned by a joint resolution, then the site designation becomes effective.

If at any time during the site-characterization process the Yucca Mountain site is found to be not suitable, we are directed by the Amendments Act to terminate all site-characterization activities; notify the Congress and the Governor and legislature of Nevada of the termination; take reasonable and necessary steps to reclaim the site and to mitigate any significant adverse environmental impacts that may have been caused by site-characterization activities; and, within 6 months, submit to the Congress recommendations for further action.

Second repository

Section 5012 of the Amendments Act (Section 161 of the Act as amended) prohibits the Secretary from conducting site-specific activities for the second repository unless the Congress specifically authorizes and appropriates funds for that purpose. It also requires the Secretary to report to the President and the Congress between January 1, 2007, and January 1, 2010, on the need for a second repository.

MRS facility

Section 5021 of the Amendments Act (Sections 142-149 of the Act as amended) annuls and revokes our proposal to locate an MRS facility at Oak Ridge, Tennessee. However, it authorizes the Secretary to site, construct, and operate an MRS facility subject to certain constraints, including the following licensing conditions:

1. Construction of the MRS facility may not begin until the U.S. Nuclear Regulatory Commission has authorized the construction of the repository.

2. Construction of, or waste acceptance at, an MRS facility is prohibited if the repository license is revoked or the construction of the repository ceases.

3. The quantity of waste present at the MRS facility at any one time may not exceed 10,000 metric tons of uranium (MTU) until the repository starts accepting waste and 15,000 MTU at any time thereafter.

The Amendments Act also established an independent MRS Review Commission, appointed by the Congress, which was to report to the Congress on November 1, 1989. (The date for the submittal of this report was changed from June 1, 1989, to November 1, 1989, by Public Law 100-507.) As required, the Commission submitted its report to the Congress on November 1, 1989.[7]

The Amendments Act establishes dual paths for siting the MRS facility: (1) siting through a survey-and-evaluation process directed by the Secretary and (2) siting through the efforts of the Nuclear Waste Negotiator. For the first process, the Amendments Act imposed the constraint that no MRS site is to be selected until the site for the repository is recommended to the President and the limitation that no MRS facility may be constructed in the State of Nevada. As in the case of the repository site, the State or the affected Indian Tribe may submit a notice of disapproval that can be overridden only by a joint resolution of the Congress. Once the selection of the site is effective, the Secretary may submit an application to the U.S. Nuclear Regulatory Commission for a license to construct and operate the MRS facility. An environmental impact statement is to be included with this application.

Transportation

Section 5061 of the Amendments Act (Section 180 of the Act as amended) requires that the designs of the casks used for transporting waste to a repository or an MRS facility be certified by the U.S. Nuclear Regulatory Commission; it also requires us to comply with the Commission's regulations regarding the advance notification of State and local governments before the transportation of waste. In addition, it provides for technical assistance and funds to States for training the public-safety officials of local governments and Indian Tribes through whose jurisdictions we plan to transport waste; training is to cover procedures required both for the safe transportation of waste under normal conditions and for emergency-response situations.

Benefits agreement

The provisions contained in Section 5031 of the Amendments Act (Sections 170-173 of the Act as amended) permit the Secretary to enter into a benefits agreement with the Governor of Nevada concerning a repository or with a State or Indian Tribe concerning an MRS facility. By entering into such an agreement, the State or Indian Tribe would become eligible for financial and other benefits but would waive the right to disapprove the selection of the site and to obtain impact assistance under other provisions of the Act as amended.

Payments under the benefits agreement would be made according to a specified schedule, and any State that receives a benefits payment is to transfer at least one-third of the amount to affected units of local government.

As part of the benefits agreement, review panels are to be established for the oversight of the repository and the MRS facility. Each panel would consist of members selected by the State or Indian Tribe that is party to the agreement, by the affected units of local government, and by the Secretary of Energy. The duties of the review panels include advising the Secretary on the repository or the MRS facility, including issues related to design, construction, operation, and decommissioning; evaluating the performance of the repository or the MRS facility; and recommending corrective actions.

Special consideration for the repository host State

As an added benefit, the Amendments Act specifies that the Secretary, in siting Federal research projects, is to give special consideration to "proposals from States where a repository is located."

The Nuclear Waste Negotiator

Section 5041 of the Amendments Act (Sections 401-411 of the Act as amended) established in the Executive Office of the President the Office of the Nuclear Waste Negotiator. The primary role of the Negotiator is to attempt to find a State or Indian Tribe willing to host a repository or an MRS facility at a technically qualified site on reasonable terms. This is to be accomplished by negotiating a proposed agreement specifying the terms and conditions under which the State or Indian Tribe would host the facility. In addition, the Negotiator is to consult with any State, unit of local government, or Indian Tribe that he determines may be affected by the siting of a repository or an MRS facility pursuant to such an agreement. The proposed agreement may include provisions the Negotiator considers appropriate for accommodating the concerns of the potentially affected parties. Together with an environmental assessment, the proposed agreement is to be submitted to the Congress, and will become effective only if enacted into law by the Congress.

Subsequently, Public Law 100-507 amended the Amendments Act to specify that the Office of the Nuclear Waste Negotiator is to be "an independent establishment in the executive branch" (i.e., outside the Executive Office of the President). The Office of the Nuclear Waste Negotiator will cease to exist in January 1993.

The Nuclear Waste Technical Review Board

Section 5051 of the Amendments Act (Sections 501-510 of the Act as amended) provides for oversight of the waste-management program through the establishment of an independent Nuclear Waste Technical Review Board. The 11 members of the Board are to be appointed by the President from candidates nominated by the National Academy of Sciences. The nominees are to represent a broad range of scientific and engineering disciplines and are to be eminent in their field.

The Board is to evaluate the technical and scientific validity of the activities that we will conduct after the enactment of the Amendments Act. These activities include site characterization and activities related to waste packaging and transportation. At least twice a year, the Board is to report its findings, recommendations, and conclusions to the Secretary of Energy and the Congress. The Board will cease to exist 1 year after the receipt of spent fuel at the repository.

Our response to the Amendments Act

In response to the Amendments Act, we redirected the repository program to focus on site characterization at one candidate site for the first repository, phasing out activities at the other two candidate sites. And having received congressional authorization, we actually started planning for, rather than just proposing, an integrated waste-management system that would include an MRS facility. Our activities and plans were described in the draft 1988 amendment to the Mission Plan, released for public comment in June 1988.[8]

While revising the draft 1988 Mission Plan Amendment in response to public comments, the new Secretary of Energy decided to postpone the publication of the document until he had had an opportunity to reassess the program. This reassessment prompted significant changes in the program and a decision to draft a new Mission Plan Amendment for public comment. These changes include the development of an action plan for restructuring the program. The plan was directed at strengthening the management of the program, conducting scientific investigations to evaluate the suitability of the Yucca Mountain site for a repository, and establishing an MRS facility with a target for spent-fuel acceptance in 1998. The results of the reassessment were presented in a report[9] prepared in response to congressional concerns about the schedule and the management of the program. This report, however, presented only the basic elements of the program, with a more comprehensive discussion of the plans for implementing them to be provided in a subsequent Mission Plan Amendment.

References

1. U.S. Department of Energy, *Mission Plan for the Office of Civilian Radioactive Waste Management*, DOE/RW-0005, Washington, D.C., 1985.

2. U.S. Department of Energy, *Need for and Feasibility of Monitored Retrievable Storage—A Preliminary Analysis*, DOE/RW-0022, Washington, D.C., 1985.

3. U.S. Department of Energy, *Monitored Retrievable Storage Submission to Congress*, DOE/RW-0035, three volumes, Washington, D.C., 1987.

4. U.S. Department of Energy, *Recommendation by the Secretary of Energy of Candidate Sites for Characterization for the First Radioactive-Waste Repository*, DOE/S-0048, Washington, D.C., 1986.

5. U.S. Department of Energy, *A Multiattribute Analysis of Sites Nominated for Characterization for the First Radioactive-Waste Repository—A Decision-Aiding Methodology*, DOE/RW-0074, Washington, D.C., 1986.

6. U.S. Department of Energy, *OCRWM Mission Plan Amendment*, DOE/RW-0128, Washington, D.C., 1987.

7. Monitored Retrievable Storage Review Commission, *Nuclear Waste: Is There a Need for Federal Interim Storage?*, Washington, D.C., 1989.

8. U.S. Department of Energy, *Draft Mission Plan Amendment*, DOE/RW-087, Washington, D.C., 1988.

9. U.S. Department of Energy, *Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program*, DOE/RW-0247, Washington, D.C., 1989.

Appendix B

PROJECTION OF SPENT-FUEL DISCHARGES, TYPES OF WASTE TO BE ACCEPTED, AND WASTE-ACCEPTANCE SCHEDULE

This appendix describes (1) the methods by which we determine the amount of spent fuel that will be accepted, (2) the types of waste to be accepted; (3) the quantities of waste to be accepted, and (4) the waste-acceptance schedule.

Projection of spent-fuel discharges

As a basis for planning, we use forecasts by DOE's Energy Information Administration (EIA) of the rates at which spent fuel will be discharged from U.S. reactors. The EIA forecasts are generated by computer models that predict electricity generation and aggregate spent-fuel discharges. These models use certain data supplied by the utilities and incorporate numerous assumptions on the future deployment and operation of commercial reactors as well as macroeconomic assumptions of the growth rates for the gross national product.

The EIA defines three cases for the domestic nuclear-energy capacity: no-new-orders, upper reference and lower reference. The three cases reflect different assumptions about schedules for the construction of nuclear power plants, cancellations of nuclear power plants that are being constructed or are on order, and new orders. In the lower reference and the upper reference cases, the United States will have 116 and 146 net gigawatts-electric, respectively, of operable nuclear-power capacity in 2020. In the no-new-orders case, the capacity will peak at 104 gigawatts-electric by 2000 and decrease to 54 gigawatts-electric by 2020 as it is assumed that nuclear power plants are retired 40 years after the issuance of their operating licenses. In the most recent report, the projections of spent-fuel discharges extend through the year 2040 for the no-new-orders case, the last year in which fuel is discharged, and through 2030 for the other cases.

Table B-1. Spent-fuel discharges from U.S. nuclear power plants: total from 1957[a,b]
(In metric tons of uranium)

Year	No-new-orders case	Lower reference case	Upper reference case
1990	21,800	21,800	21,800
1995	31,400	31,400	31,400
2000	40,400	40,400	40,400
2005	49,400	49,400	49,400
2010	58,600	58,800	59,100
2015	68,500	70,000	72,000
2020	74,800	80,200	84,400
2025	80,300	92,400	99,300
2030	83,200	104,800	115,600
2040	84,100	NA[c]	NA

a From *World Nuclear Fuel Cycle Requirements 1990.*[1]
b Total spent-fuel discharges include all discharges since 1957 that were not reprocessed by the U.S. Government. (The year 1957 was the start of commercial nuclear power in the United States.)
c Not applicable.

Projections of cumulative spent-fuel discharges through the year 2040 are given in Table B-1, and summaries of recent EIA projections through the years 2000 and 2020 are given in Table B-2. As shown in Table B-2, there has been a continually decreasing trend in the projection of spent-fuel discharges since 1984 for each of the three cases included in the EIA reports. Since 1984, the projection of discharges by the year 2020 has decreased by nearly 23,000 metric tons of uranium (MTU), or 23 percent, in the no-new-orders case, while in the upper reference case, the projection has decreased by about 46,000 MTU, or 35 percent.

The markedly decreasing trend in the EIA projections has many causes, including problems affecting nuclear power in the United States since 1978, the last year in which a new nuclear power plant was ordered, and decreases in the demand for new central-station power plants. Another reason for decreasing

Table B-2. Summary of spent-fuel forecasts by the Energy Information Administration
(In metric tons of uranium)

Report date	By the year 2000: No-new-orders case	By the year 2000: Lower reference case[a]	By the year 2000: Upper reference case[b]	By the year 2020: No-new-orders case	By the year 2020: Lower reference case[a]	By the year 2020: Upper reference case[b]
1983[c]	45,600	45,600	48,200	84,500	108,300	132,600
1984[d]	46,400	46,800	49,000	97,700	111,000	130,300
1985[e]	39,861	39,864	41,658	74,635	87,397	106,404
1986[f]	40,800	40,800	41,600	79,300	86,800	106,000
1987[g]	40,100	40,100	41,000	77,800	87,500	98,200
1988[h]	40,200	40,200	41,000	77,400	84,500	96,700
1989[i]	40,100	40,200	40,600	75,100	82,400	92,600
1990[j]	40,400	40,400	40,400	74,800	80,200	84,400

a Referred to as the "low case" in EIA reports published before 1986.
b Referred to as the "middle case" in EIA reports published before 1986.
c *World Nuclear Fuel Cycle Requirements 1983.*[2]
d *World Nuclear Fuel Cycle Requirements 1984.*[3]
e *World Nuclear Fuel Cycle Requirements 1985.*[4]
f *World Nuclear Fuel Cycle Requirements 1986.*[5]
g *World Nuclear Fuel Cycle Requirements 1987.*[6]
h *World Nuclear Fuel Cycle Requirements 1988.*[7]
i *World Nuclear Fuel Cycle Requirements 1989.*[8]
j *World Nuclear Fuel Cycle Requirements 1990.*[1]

spent-fuel projections is the increasing level of nuclear-fuel "burnup," which is the amount of energy produced per unit weight of fuel.

Types of waste to be accepted

The dominant waste form to be accepted by the waste-management system is spent fuel from commercial nuclear reactors from across the United States. The spent fuel will consist primarily of intact assemblies from two types of light-water reactors: pressurized-water reactors and boiling-water reactors. Some consolidated assemblies from these reactors as well as spent fuel from other commercial reactor types, such as the high-temperature gas-cooled reactor, may also require geologic disposal. The system will also accept high-level waste solidified in metal canisters from both defense and commercial generators, with defense sources expected to provide practically all such waste.

In addition to spent fuel and solidified high-level waste, nonfuel components from commercial reactors will also be accepted. Moreover, if an alternative to a geologic repository acceptable to the Nuclear Regulatory Commission is not developed for the disposal of commercial "greater-than-class-C" waste, this waste may also be consigned to the repository. However, to date, no definitive characterization or quantification of any additional wastes requiring disposal in a repository has been performed; thus we are not currently planning for the disposal of these wastes.

Quantities of waste to be accepted

The EIA forecasts are based on three distinct scenarios for the domestic nuclear-energy capacity through the year 2030. These scenarios differ in the underlying assumptions concerning future orders for nuclear power plants in the United States. However, our current policy is to use the no-new-orders, end-of-reactor-life case as the primary basis for planning. The no-new-orders, end-of-reactor-life case is essentially based on only those nuclear plants that are currently operating and under active construction; as such, it represents the minimum expected quantity of spent fuel. It also represents the highest cost for handling and disposal per unit quantity of waste and thus the "worst case" for current utility fees.

The decision to use this case is based on recommendations by the General Accounting Office,[9] on discussions with representatives with the nuclear utility industry, and on the following reasons:

- The no-new-orders case provides a realistic basis for planning.

- The no-new-orders case provides a conservative estimate of the amounts of money paid by the utilities into the Nuclear Waste Fund.

The total quantity of spent fuel discharged from U.S. reactors through the year 2020 is assumed to be about 74,800 MTU, and the quantity discharged through the year 2040 (assumed to be the last year of operation for the reactors currently operating or being constructed) is 84,100 MTU. The standard contract with the utilities[10] specifies that standard spent fuel accepted for disposal is to have a minimum cooling age of 5 years; however, most of the spent fuel to be accepted by the Federal system is expected to be at least 10 years old.

The quantity of defense high-level waste to be disposed of in a repository is estimated at about 17,750 canisters; since a canister of high-level waste will be equivalent to about 0.5 MTU, the amount of waste is estimated at 8875 MTU.

The commercial high-level waste will consist of about 300 canisters of high-level waste from the West Valley Demonstration Project. A canister of commercial high-level waste is equivalent to about 2.2 MTU, and the total quantity of this waste is estimated to be 640 MTU. It is assumed that no additional commercial high-level waste will be generated during the operating lifetime of the repository.

There is considerable uncertainty about how much, if any, waste other than spent fuel and high-level waste will require disposal in a geologic repository. If it is ultimately decided that other forms of waste require geologic disposal in a repository, we will incorporate appropriate assumptions in our planning. Such a decision could substantially affect the planning and the design of the repository.

Waste-acceptance schedule

Table B-3 presents a preliminary schedule for waste acceptance by the waste-management system. The schedule shows the MRS facility starting to accept spent fuel in 1998 and is based on the statutory limits on MRS capacity (10,000 MTU before the start of operations at the repository and 15,000 MTU thereafter); the first 10 years of the waste-acceptance schedule (1998-2007) correspond to the lower-bound schedule published in the Annual Capacity Report.[11]

Spent-fuel acceptance at the MRS facility starts at an initial rate of 300 MTU per year. The rate increases to 400 MTU in 1999 and 500 MTU in the year

2000, reaching 875 MTU in 2001 and staying at that level until 2010, the year when the repository starts to receive spent fuel; at that point, the rate of MRS acceptance increases to 1800 MTU per year and stays at that level until 2015, when it reaches 3000 MTU. The repository starts receiving spent fuel from the MRS facility in 2010 at an initial annual rate of 400 MTU, which increases to 900 and 1800 MTU in the years 2013 and 2014, respectively, reaching 3000 MTU per year in 2015, the year in which the repository also starts receiving high-level waste at the rate of 400 MTU per year. Thus the maximum acceptance rate for the MRS facility is 3000 MTU per year, while the maximum acceptance rate for the repository is 3400 MTU, including both spent fuel and high-level waste.

The preliminary waste-acceptance schedule presented here shows all spent fuel being shipped to the MRS facility before shipment to the repository. However, fuel from reactors located near the repository may be shipped directly to the repository.

Table B-3. Waste-acceptance schedule
(In metric tons of uranium)

	MRS facility		Repository		Total annual system acceptance	
Year	Spent fuel received	Stored at MRS	Spent fuel from MRS	High-level waste	Spent fuel	Spent fuel and high-level waste
1998	300	300			300	300
1999	400	700			400	400
2000	550	1250			550	550
2001	875	2125			875	875
2002	875	3000			875	875
2003	875	3875			875	875
2004	875	4750			875	875
2005	875	5625			875	875
2006	875	6500			875	875
2007	875	7375			875	875
2008	875	8250			875	875
2009	875	9125			875	875
2010	1800	10,525	400		1800	1800
2011	1800	11,925	400		1800	1800
2012	1800	13,322	400		1800	1800
2013	1800	14,225	900		1800	1800
2014	1800	14,225	1800		1800	1800
2015	3000	14,225	3000	400	3000	3400
2016	3000	14,225	3000	400	3000	3400
2017	3000	14,225	3000	400	3000	3400

Note: This table is for planning purposes only.

References

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