Mission Plan for the Civilian Radioactive Waste Management Program

Volume I

Department of Energy
Washington, DC 20585

TO: Members of Congress and Other Recipients

SUBJECT: Submittal of the Mission Plan as Required by the Nuclear Waste Policy Act of 1982

I am pleased to submit the Mission Plan for the Civilian Radioactive Waste Management Program as required by the Nuclear Waste Policy Act of 1982. I consider that this Plan meets the directive to "provide an informational basis sufficient to permit informed decisions to be made in carrying out the repository program and the research, development, and demonstration programs required under this Act." This document presents our best estimate at the present time of the objectives and the strategy of the Civilian Radioactive Waste Management Program and of the facilities, institutional activities, management approach and information needed to implement the program.

In accordance with the requirements of the Act, the Department of Energy (DOE) submitted a draft of this Mission Plan for comment to the States, affected Indian tribes, the Nuclear Regulatory Commission, other Government agencies, and the public. Approximately 2500 individual comments were received from 102 respondents. In addition to expanding the discussions of various topics in the Mission Plan as suggested in the comments and making changes where appropriate, detailed responses were prepared to address all of the issues raised in the comments. These responses are presented in Volume II of this set of three volumes. Volume III reproduces all of the comments received on the draft Mission Plan.

I believe we have addressed fairly and responsibly all of the comments. We appreciate everyone's interest and involvement as we continue to implement this important national program.

During the conduct of this program, I pledge the best efforts of DOE's Office of Civilian Radioactive Waste Management to observe the following operating principles: to safeguard the public trust; to be open and responsive; to cooperate and act in an evenhanded manner; and to strive for technical excellence, management excellence, and cost effectiveness. With these principles in mind and with the cooperation of all interested parties, I am confident the program will succeed.

Ben C. Rusche

Ben C. Rusche, Director
Office of Civilian Radioactive
Waste Management

DOE/RW-0005
Volume 1 of 3 Volumes

Mission Plan
for the Civilian Radioactive Waste Management Program

Volume I

Part I Overview and Current Program Plans
Part II Information Required by the Nuclear Waste Policy Act of 1982

June 1985

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

PREFACE

In response to the requirement of the Nuclear Waste Policy Act of 1982, the Office of Civilian Radioactive Waste Management in the Department of Energy (DOE) has prepared this Mission Plan for the Civilian Radioactive Waste Management Program.

The Mission Plan is divided into two parts. Part I describes the overall goals, objectives, and strategy for the disposal of spent nuclear fuel and high-level waste. It explains that, to meet the directives of the Nuclear Waste Policy Act, the DOE intends to site, design, construct, and start operating a mined geologic repository by January 31, 1998. The Act specifies that the costs of these activities will be borne by the owners and generators of the waste received at the repository. Part I further describes the other components of the waste-management program--monitored retrievable storage, Federal interim storage, and transportation--as well as systems integration activities. Also discussed are institutional plans and activities as well as the program-management system being implemented by the Office of Civilian Radioactive Waste Management.

Part II of the Mission Plan presents the detailed information required by Section 301(a) of the Act--key issues and information needs; plans for obtaining the necessary information; potential financial, institutional, and legal issues; plans for the test and evaluation facility; the principal results obtained to date from site investigations; information on the site-characterization programs; information on the waste package; schedules; costs; and socioeconomic impacts. In accordance with Section 301(a) of the Act, Part II is concerned primarily with the repository program.

The Mission Plan, identified as Volume I, is supported by two other volumes. Volume II is entitled "Record of Responses to Public Comments on the Draft Mission Plan for the Civilian Radioactive Waste Management Program." It summarizes and answers the comments received on the April 1984 draft Mission Plan, with approximately 2500 comments from 102 respondents being documented by common topical subject. Volume III, entitled "Public Comments on the Draft Mission Plan for the Civilian Radioactive Waste Management Program," reproduces all of the comment letters.

Chapter 3

PROGRAM PLANS

This chapter discusses the following elements of the Civilian Radioactive Waste Management Program: geologic repositories (Section 3.1), monitored retrievable storage and Federal interim storage (Section 3.2), transportation (Section 3.3), and systems integration (Section 3.4). Included in the discussions are the major objectives, current status of the program elements, and future plans and schedules.

3.1 GEOLOGIC REPOSITORIES

Before the passage of the Act, the DOE had selected mined geologic repositories as the preferred means for the disposal of spent fuel and commercially generated high-level radioactive waste (Federal Register, Vol. 46, p. 26677, May 14, 1981). This decision was made after evaluating alternative disposal methods in an environmental impact statement (Final Environmental Impact Statement--Management of Commercially Generated Radioactive Waste, DOE/EIS-0046F, October 1980). To carry out this decision, the DOE has been conducting research and development and performing siting studies as part of the geologic repository program. This decision has since been supported by the Act, which was enacted "to provide for the development of repositories for the disposal of high-level radioactive waste and spent nuclear fuel, to establish a program of research, development, and demonstration regarding the disposal of high-level radioactive waste and spent nuclear fuel, and for other purposes."

After a brief description of geologic repositories (Section 3.1.1) and legislative requirements for the development of licensed repositories (Section 3.1.2), this section discusses the regulatory requirements for licensed repositories, the mission and objectives of the DOE's repository program, and the background and status of the repository program (Sections 3.1.3, 3.1.4, and 3.1.5). It then presents plans for the development of repositories (Section 3.1.6) and schedules for the first and the second repositories (Section 3.1.7).

3.1.1 BRIEF DESCRIPTION OF GEOLOGIC REPOSITORIES

A geologic repository will resemble a conventional mine in many respects. As shown in Figure 3-1, the repository will consist of both surface and underground facilities. The surface facilities will be used while waste is received, handled, and emplaced in the underground disposal rooms. When the repository has been filled to capacity, the surface facilities will be decommissioned and all points of access to the underground repository (i.e., shafts and boreholes) will be filled and permanently sealed.

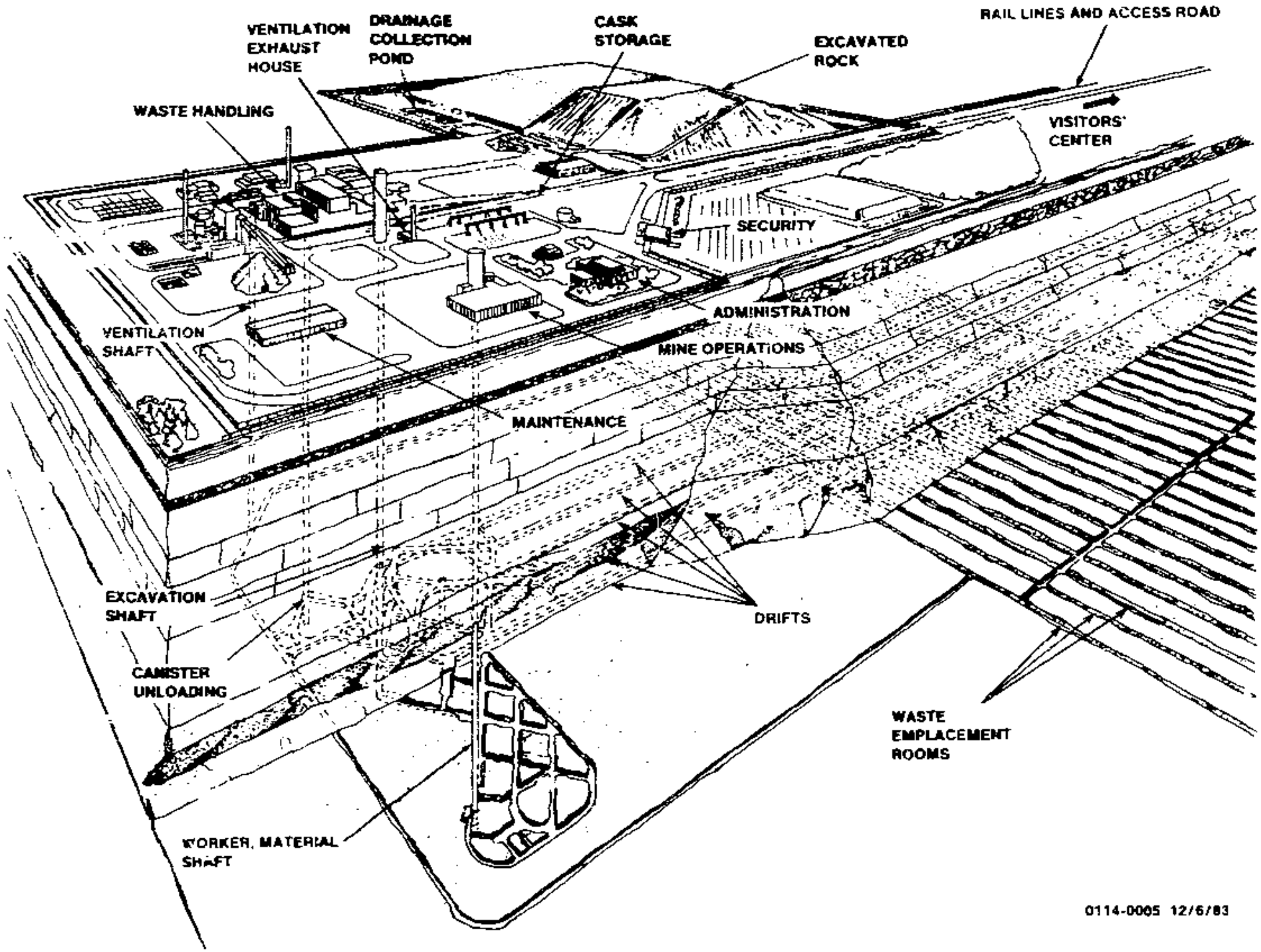

Figure 3-1. Schematic of surface and underground facilities.

The surface facilities will consist of waste-handling systems and other repository support facilities. The waste-handling systems will include receiving, packaging, storing, and transporting facilities. The waste will be received at the repository gate in rail or truck transportation casks and, after inspection and washdown, will be moved into the hot-cell area of the waste-handling building. The waste will then be removed from the casks, packaged, and transported to the waste-handling shaft for transfer underground. Once underground, the waste will be emplaced in boreholes in the floor or walls of disposal rooms.

Sufficient surface storage capacity will be available to accommodate disruptions in operations. Support facilities will include maintenance, utilities, warehousing, storage, administration, security, a visitors center, personnel, training, and other miscellaneous buildings. Emergency power generators as well as shaft-headframe structures, ventilation fans, and hoisting facilities will be provided. Access to the surface facilities will be restricted, and monitoring facilities will be provided. Facilities for the handling and storage of mined rock and for the processing and decontamination of site-generated radioactive waste and effluents will also be provided.

This description, as well as other discussions that follow, is based on the authorized plan described in the preceding chapter. If the improved-performance plan is implemented, then it is expected that several waste-handling functions would be transferred from the repository to a facility for monitored retrievable storage. The repository facilities and systems that support these functions would be redesigned accordingly. The specific effects on the repository program have not been firmly established at this time.

To protect the health and safety of the public over the long term, multiple independent barriers, both natural and engineered, will be used. These barriers are designed to provide waste containment and isolation and are of three types, as shown in Figure 3-2:

1. Natural system
2. Repository
3. Waste package

The natural system will consist of (1) a host rock suitable for repository construction and waste emplacement and (2) the surrounding rock formations. It will include natural barriers that provide containment and isolation by limiting radionuclide transport through the geohydrologic environment to the biosphere and providing conditions that will minimize the potential for human interference in the future.

The repository portion of the total disposal system consists of the underground structures and components, including engineered barriers not associated with the waste package, such as shaft seals, the backfill of tunnels and disposal rooms, and the host rock that supports them. The repository will be designed to mitigate the effects exerted on the natural system by repository construction and waste emplacement.

The waste package consists of the waste form and any containers, shielding, packing barriers, and other absorbent materials that separate the waste from the host rock. The waste package will provide substantially

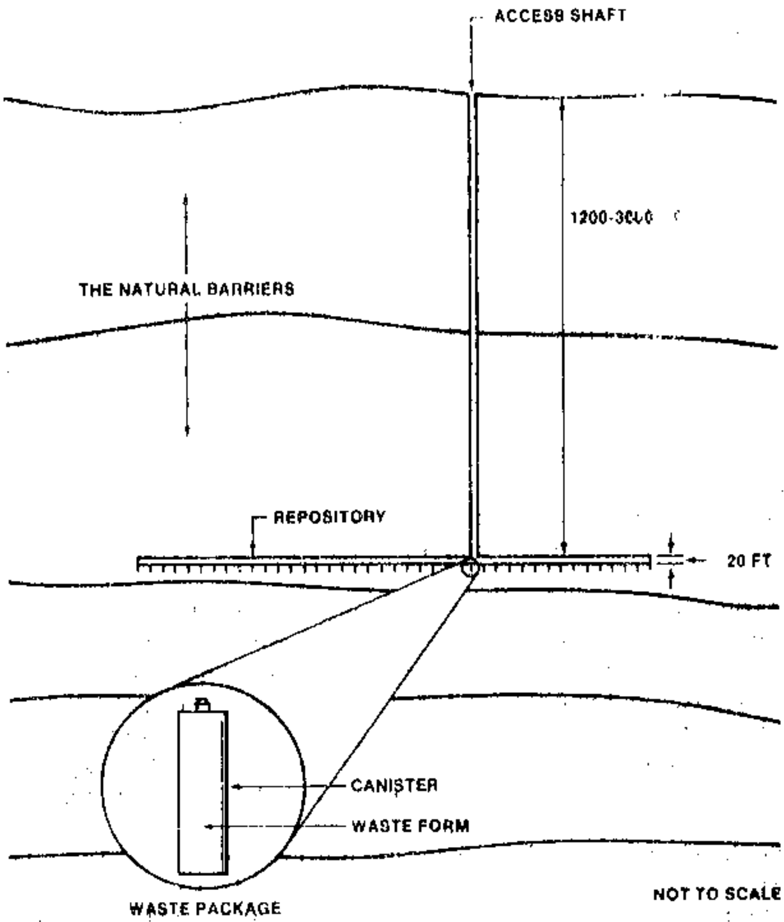

Figure 3-2. Artist's conception of the complete repository system.

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complete containment of the waste for 300 to 1000 years and will contribute to long-term isolation as part of the engineered-barrier system by (1) hindering the dissolution of the waste by any ground water that may reach it and (2) controlling the release and migration of radionuclides into the host rock.

As mentioned in Section 3.1.3, the use of multiple barriers is required by both the Nuclear Regulatory Commission (NRC) in 10 CFR Part 60 and the Environmental Protection Agency (EPA) in proposed 40 CFR Part 191. However, the DOE intends to place primary importance on the capabilities of the natural system for waste isolation. In evaluating the suitability of sites, therefore, the use of an engineered-barrier system will be considered to the extent necessary to meet the performance requirements specified by the Nuclear Regulatory Commission and the Environmental Protection Agency but will not be relied on to compensate for significant deficiencies in the natural system. The role of engineered barriers in the comparative evaluation of sites is discussed in the DOE's final siting guidelines, 10 CFR Part 960.

3.1.2 LEGISLATIVE REQUIREMENTS FOR THE DEVELOPMENT OF LICENSED REPOSITORIES

Before the Act was passed, the DOE was searching for sites for geologic repositories, under authority established by the Atomic Energy Act of 1954, the Energy Reorganization Act of 1974, and the authorization and appropriation bills passed by Congress from 1975 through 1983. The National Waste Terminal Storage program (the predecessor of the current geologic repository program) was initiated in 1976 with the intent of finding suitable sites and to develop the technology necessary for repository licensing, construction, operation, and closure. The Act provides a framework for the completion of these activities.

The Act requires that, within 90 days after its enactment, the Secretary of Energy identify the States with one or more potentially acceptable sites for a repository and within 180 days issue general guidelines for the recommendation of sites. The next step requires the Secretary to nominate sites as suitable for site characterization (at least five sites for the first repository and five sites for the second repository). Each nomination is to be accompanied by an environmental assessment that evaluates the site in terms of the guidelines and requirements specified by the Act. Before nominating any site, the Secretary is required to hold public hearings in the vicinity of any site under consideration. These hearings are to inform the residents of the DOE's intent to nominate sites and to receive their recommendations on issues that should be addressed in the environmental assessments and the site characterization plans.

The Secretary is then required to recommend at least three of the nominated sites in at least two different types of host rock to the President for characterization. The President may approve or disapprove the recommendation, permit the characterization to proceed by taking no action within 60 days, or delay the decision for 6 months, if, in his opinion, insufficient information is available.

During site characterization, the DOE will collect detailed information about the site, as specified in a site-characterization plan. This plan is to be submitted for review and comment to the Nuclear Regulatory Commission, the State in which the site is located, and the governing body of any affected Indian tribe; it will also be available for public review and comment. Site characterization will involve a wide range of activities, including the construction of exploratory shafts for tests and studies at repository depth. Before sinking the first exploratory shaft, the DOE is to hold public hearings in the vicinity of the site to inform the residents of the site-characterization plan and to receive their comments. When site characterization has been completed, public hearings are to be held to inform the residents of the area that the site is being considered for development as a repository and to obtain their comments.

The next step is for the DOE to recommend to the President a site to be developed as a repository. This recommendation is to be accompanied by a comprehensive statement that provides the basis for the recommendation. The comprehensive statement, or site-selection report, will include, among other things, a final environmental impact statement.

After a site is recommended by the President for development as a repository, the affected State and/or an affected Indian tribe on whose reservation the site is located may submit, within 60 days, a notice of disapproval to Congress. If no notice of disapproval is filed, then the site becomes "the designated site" 60 days after the site is recommended. If a notice of disapproval is filed, then Congress has 90 days of continuous session to act on the notice and override the disapproval by passage of a joint resolution. If Congress does not override the disapproval, then the disapproval stands and the President must recommend another site not later than 1 year after the disapproval.

Within 90 days of site designation, the DOE is required to apply for a license from the Nuclear Regulatory Commission to construct the repository. The Act allows the Nuclear Regulatory Commission up to 3 years to review this application and to extend the review period by 1 year if needed.

After construction and the receipt of a license to receive and possess radioactive waste, the DOE will begin emplacing spent fuel and high-level waste in the repository. These disposal operations for the first repository will begin by January 31, 1998, as directed by the Act.

The Act also authorizes the DOE to develop a test and evaluation facility for research and the demonstration of the integrated technologies needed for geologic repositories. The DOE was to report to Congress on whether the facility will be located at the site of the repository. This is discussed in Section 3.1.5.3.

3.1.3 REGULATORY REQUIREMENTS FOR LICENSED REPOSITORIES

The Act established a schedule for the promulgation of regulations by two other Federal agencies--the Nuclear Regulatory Commission and the Environmental Protection Agency. The Environmental Protection Agency is to promulgate generally applicable standards for protecting the public from the radioactive material in repositories. The EPA standards are to be implemented and enforced by the Nuclear Regulatory Commission, which is required to issue technical criteria for that purpose. Both sets of regulations have been under development for several years and were used in developing the siting guidelines. Both regulations will be complied with during repository siting, design, construction, operation, closure, and decommissioning.

The EPA standards were defined in Section 2(a)(6) of Reorganization Act No. 3 of 1970 as limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material. In fulfilling this responsibility, the Environmental Protection Agency has proposed, in 40 CFR Part 191, a radiation-protection standard for both the management and the disposal of spent fuel, high-level waste, and transuranic waste. A key provision is a limit on the amount of radioactivity that may enter the environment for 10,000 years after disposal. The Act required the final rule to be issued by January 1984. Drafts of the final rule have been prepared and are under consideration by the Environmental Protection Agency. The final rule is expected to be published in the summer of 1985.

The NRC regulations in 10 CFR Part 60 consist of rules that establish (1) procedures for the licensing of geologic repositories and (2) technical criteria to be used in the evaluation of license applications under those procedural rules. The procedural rules were published in February 1981. The Nuclear Regulatory Commission issued in January 1985 a proposed amendment that will make the procedural rules conform with the Act. These revised procedural rules should become final in late 1985.

The final technical criteria were issued in June 1983. An amendment to the criteria regarding disposal in the unsaturated zone has been proposed and is being evaluated. The objective of the criteria is to provide reasonable assurance that geologic repositories will isolate the waste for at least 10,000 years without posing undue risk to public health and safety. Undue risk is defined as risk that is unnecessary and could be prevented or risk that is excessive.

The key provisions of the technical criteria are as follows:

1. The waste package is to provide substantially complete containment of the waste for 300 to 1000 years.

2. The rate at which each significant radionuclide is released from the engineered-barrier system is not to exceed one part in 100,000 per year of the inventory of that radionuclide at 1000 years after permanent closure.

3. The pre-waste-emplacement ground-water travel times from the repository (more precisely, from the "disturbed zone" around the repository) to the accessible environment are to exceed 1000 years.

The Nuclear Regulatory Commission will review the technical criteria after the Environmental Protection Agency's final standards are published and will initiate subsequent rulemaking actions, as necessary, to make the criteria and standards consistent.

3.1.4 MISSION AND OBJECTIVES

The mission of the DOE's repository program is to develop mined geologic repositories for the permanent disposal of spent fuel and high-level waste in a manner that protects the health and safety of the public and the quality of the environment and in a time frame responsive to national needs. To meet this mission, the DOE has established the following objectives for the repository program:

1. Nominate at least five sites in a variety of geohydrologic settings as suitable for site characterization for the first repository and five sites for the second repository in accordance with the siting guidelines.

2. Recommend three sites for site characterization for the first repository and three sites for the second repository in accordance with the siting guidelines.

3. Establish and maintain effective mechanisms for the involvement of State and local governments and affected Indian tribes in the repository program.

4. Acquire through site characterization sufficient data to support the preparation of environmental impact statements and subsequent site-selection decisions for the first and the second repositories.

5. Develop the necessary engineering data and complete designs for repositories and waste packages that will meet NRC licensing requirements for a repository at the selected site.

6. Obtain a construction authorization from the Nuclear Regulatory Commission by filing a license application within 90 days of repository-site designation.

7. Construct the first repository to the approved design in a safe and cost-effective manner.

8. Obtain from the Nuclear Regulatory Commission a license to receive and possess radioactive waste at the site of the first repository.

9. Obtain Congressional approval for the construction of the second repository.

10. Proceed with the second-repository program through the receipt of a construction authorization from the Nuclear Regulatory Commission and construct the repository if authorized by Congress.

11. Once the repositories have been filled, obtain appropriate NRC license amendments to permit repository closure and decommissioning.

Sections 3.1.5 and 3.1.6 briefly describe the current statue of the repository program and discuss the major elements of the plans for meeting the objectives listed above. Section 3.1.7 presents the schedule for achieving these objectives.

3.1.5 BACKGROUND AND STATUS OF THE REPOSITORY PROGRAM

This section summarizes the history and the status of major program efforts. The discussion first considers the siting process and then the development of technology.

3.1.5.1 Siting

The suitability of a site for a geologic repository depends on answers to four basic questions:

1. Will the repository, consisting of multiple natural and engineered barriers, isolate the radioactive waste from the accessible

environment after closure in accordance with the requirements set forth by the Nuclear Regulatory Commission and the Environmental Protection Agency?

2. Will predicted radiological exposures of the general public and any predicted releases of radioactive materials to restricted and unrestricted areas during repository operation and closure meet applicable safety requirements set forth by the Nuclear Regulatory Commission and the Environmental Protection Agency?

3. Can the repository and its support facilities be sited, constructed, operated, closed, and decommissioned so that the quality of the environment will be protected and can waste-transportation operations be conducted without causing unacceptable risks to public health and safety?

4. Are repository construction, operation, closure, and decommissioning feasible on the basis of reasonably available technology and are the associated costs reasonable?

These questions are the same as the key issues presented in Chapter 1 of Part II.

This section describes the approach used by the DOE in addressing these questions and discusses the status of the siting program for the first and the second repositories. Final answers to the questions posed above can be established only after site characterization and repository designs are complete.

3.1.5.1.1 First Repository

Beginning in 1976, the DOE (then the Energy Research and Development Administration) started a search for sites with geologic and hydrologic characteristics suitable for long-term isolation and rock characteristics suitable for the construction of a large underground facility. This search, or site-screening process, was based on a twofold approach. The first approach focused on a systematic survey of areas underlain by salt. The second approach was to search for suitable repository sites on some Federal lands where radioactive materials were already present; this approach was recommended by the Comptroller General of the United States and a House resolution. Although land use was the initial basis for this screening of Federal lands, the subsequent progression to smaller land units was based primarily on evaluations of geologic and hydrologic suitability. This twofold screening approach allowed the DOE to consider sites in diverse geohydrologic environments and rock types.

During site screening, the DOE's studies focus on areas of successively decreasing size to determine whether they contain sites that warrant more detailed examination. Site screening consists of up to four stages: national or province surveys, regional surveys, area surveys, and location surveys. National or province and regional surveys are based on national maps of faults, earthquake epicenters, land use, recent volcanic activity, locations of potential host rock and of mineral resources, geohydrologic conditions, and other information available in the open literature. The screening for potential sites in salt began with national surveys and with the cooperative assistance of the U.S. Geological Survey.

Area and location surveys require more thorough examination, including field exploration and testing. Since the Federal lands under consideration were small in comparison with a province or a region, the screening of these lands started at roughly the area stage of the process. Typically, the field studies included the drilling of boreholes to investigate subsurface conditions and to determine whether a potentially suitable host rock occurs at the depths of interest; hydrologic testing in boreholes to determine the hydrologic parameters of the various subsurface formations; evaluation of aerial photographs and satellite data to help identify faults that might affect the performance of the repository; field mapping; and geochemical analyses of selected formations and ground water to establish mineral stability, ground-water chemistry, and the chemistry of the environment that would be in contact with the waste package. Geophysical surveys were used to supplement the geologic field work.

The field studies were supported by laboratory studies that focused on the isolation and engineering characteristics of the rock. Examples of the properties important to isolation are sorption coefficients, effective porosity, permeability, mineral composition, and radionuclide solubility in the ground water. Examples of the properties important to engineering include strength, elastic properties, coefficients of thermal expansion, and thermal conductivity. Measurements of ground-water characteristics were also made and included the concentration of anions and cations in solution, the pH value, the oxidation-reduction potential, the particulate composition, organic constituents, the isotopic distribution of selected anions and cations, and the variation of composition with location and depth.

When the Act was passed, the DOE's program had already completed the location phase in five different geohydrologic settings. Field and laboratory testing as described above had been under way at nine different sites, and varying quantities of data had been collected for each site. Preliminary designs for exploratory shafts in all geohydrologic settings had been completed. The design of the shafts differed from site to site because of differences in the geologic and hydrologic conditions. Also in progress were systems analysis, waste-package development, and repository-design efforts. In accordance with the Act, the DOE formally identified, in February 1983, nine sites as being potentially acceptable, thus concluding the site-screening portion of the first-repository program.

The nine potentially acceptable sites are located in six States, as shown in Figure 3-3. Seven of the sites are in salt: two sites in the bedded salt of the Palo Duro Basin in Deaf Smith and Swisher Counties, Texas; two sites in bedded salt at Davis Canyon and Lavender Canyon in the Paradox Basin, Utah; and three salt domes in the Gulf Interior region of the Gulf Coastal Plain (the Richton and the Cypress Creek Domes in Mississippi and the Vacherie Dome in Louisiana). The site in basalt is on the Hanford Site in the Pasco Basin in Washington, and the site in tuff, known as the Yucca Mountain site, is adjacent to the Nevada Test Site in the southern Great Basin.

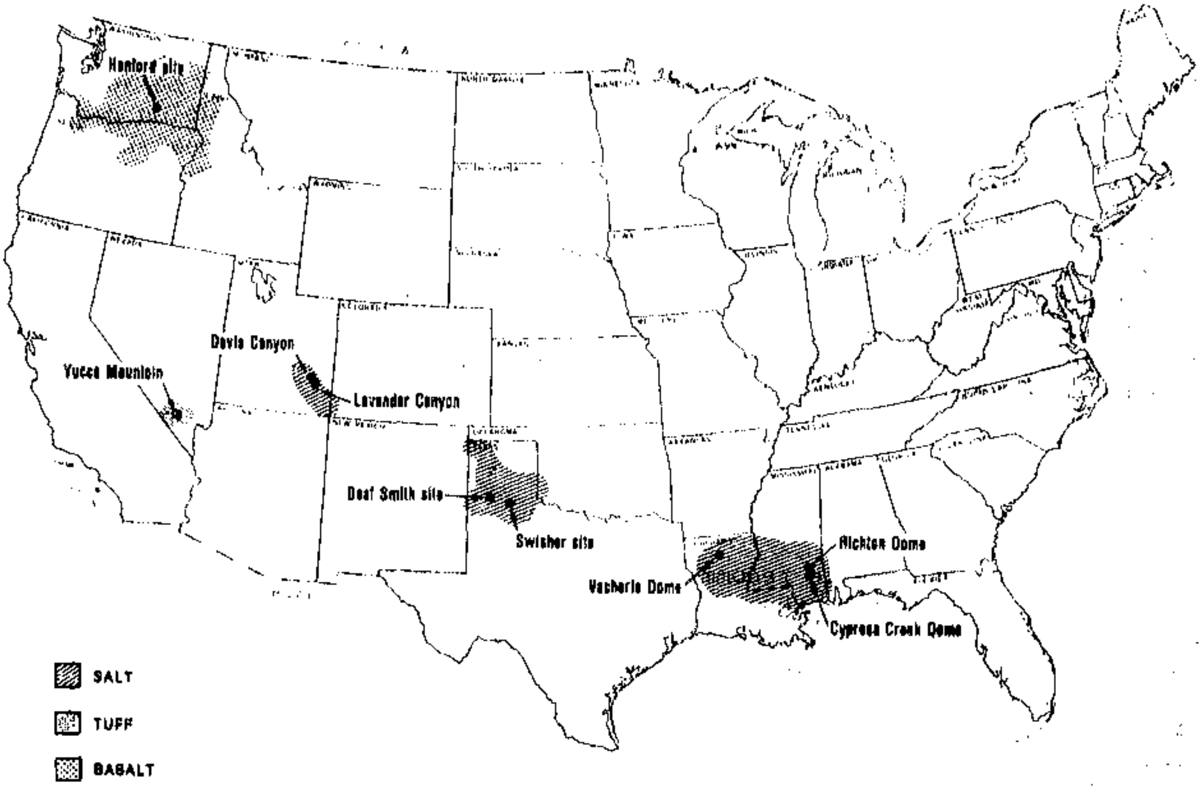

Figure 3-3. Potentially acceptable sites for the first repository.

The siting process continued with the development of siting guidelines. The first draft of the siting guidelines was issued in February 1983. After a long review process, including several public hearings and consultation with affected States, Indian tribes, and key Federal agencies, the DOE's proposed final guidelines were forwarded to the Nuclear Regulatory Commission for concurrence in November 1983. The Nuclear Regulatory Commission concurred with the guidelines by unanimous vote at a public meeting held in June 1984. The guidelines were issued in final form in November 1984 and published in the Federal Register in December 1984; they became effective on January 7, 1985. The guidelines are presented in Appendix B of Volume I of the Mission Plan.

After the issuance of the guidelines, the DOE issued, in December 1984, nine draft environmental assessments, one for each potentially acceptable site. These draft environmental assessments evaluated each site in terms of the siting guidelines and, when final, will be the basis for the nomination and recommendation of sites for site characterization. In the draft environmental assessments, the DOE announced the proposed sites for nomination and recommendation. The proposed sites for nomination are Deaf Smith County, Texas; Hanford Site, Washington; Yucca Mountain, Nevada; Davis Canyon, Utah;

and Richton, Mississippi. Of these five sites proposed for nomination, the DOE proposed to recommend to the President the Deaf Smith County, the Hanford, and the Yucca Mountain sites for site characterization

As required by the Act, the DOE conducted public hearings on the DOE's intent to nominate sites and to receive recommendations on issues to be addressed in the environmental assessment and in any site characterization plan to be used if the site is approved by the President. These public hearings were held in the States of Washington and Nevada in March 1983, in Mississippi in April and May 1983; and in Utah, Louisiana, and Texas in May 1983. Although not required by the Act, about 50 formal briefings and 19 public hearings were held in early 1985 in the six States containing potentially acceptable sites to receive comments on the draft environmental assessments. About 650 individuals presented written and oral testimony at these hearings. The comments received at these hearings, as well as written comments, will be considered in preparing the final environmental assessments.

3.1.5.1.2 Second Repository

In 1979, in response to recommendations by the Interagency Review Group (Report to the President by the Interagency Review Group on Nuclear Waste Management, TID-29442, U.S. Department of Energy) to consider alternative host rocks for geologic repositories, the DOE initiated a national survey of crystalline rocks (granite). This survey identified for further study near-surface and exposed crystalline-rock formations in 17 States. As shown in Figure 3-4, these States are divided into three regions: northeastern (Maine, Vermont, New Hampshire, New York, Pennsylvania, Connecticut, Massachusetts, New Jersey, and Rhode Island); north-central (Michigan, Minnesota, and Wisconsin); and southeastern (Maryland, Virginia, North Carolina, South Carolina, and Georgia). These States have been notified that the DOE is undertaking further study of crystalline-rock formations within their boundaries to evaluate their suitability for repository development. Because these investigations are still very preliminary, it was not possible to include crystalline-rock sites in the screening process for the first repository.

The screening process for the second repository is currently in the regional-survey stage. In May 1983, the DOE issued for State review draft regional characterization reports, which compiled open-literature information on the geologic, environmental, and socioeconomic conditions of each region. The DOE had intended to issue these reports in final form after State review and to use them as the basis for recommending areas for field investigations. However, because of comments received on the draft regional characterization reports and the comments submitted by the States on the siting guidelines, the DOE decided to develop and issue a screening-methodology document that describes how the region-to-area screening will be conducted and then to reissue the regional characterization reports in draft form for further State review and comment. This resequencing of activities allows the review of the regional characterization reports to consider the way in which the DOE will use the information presented in the reports.

The screening-methodology document was issued in draft form in September 1984 and in final form in April 1985. This document was developed in consul-

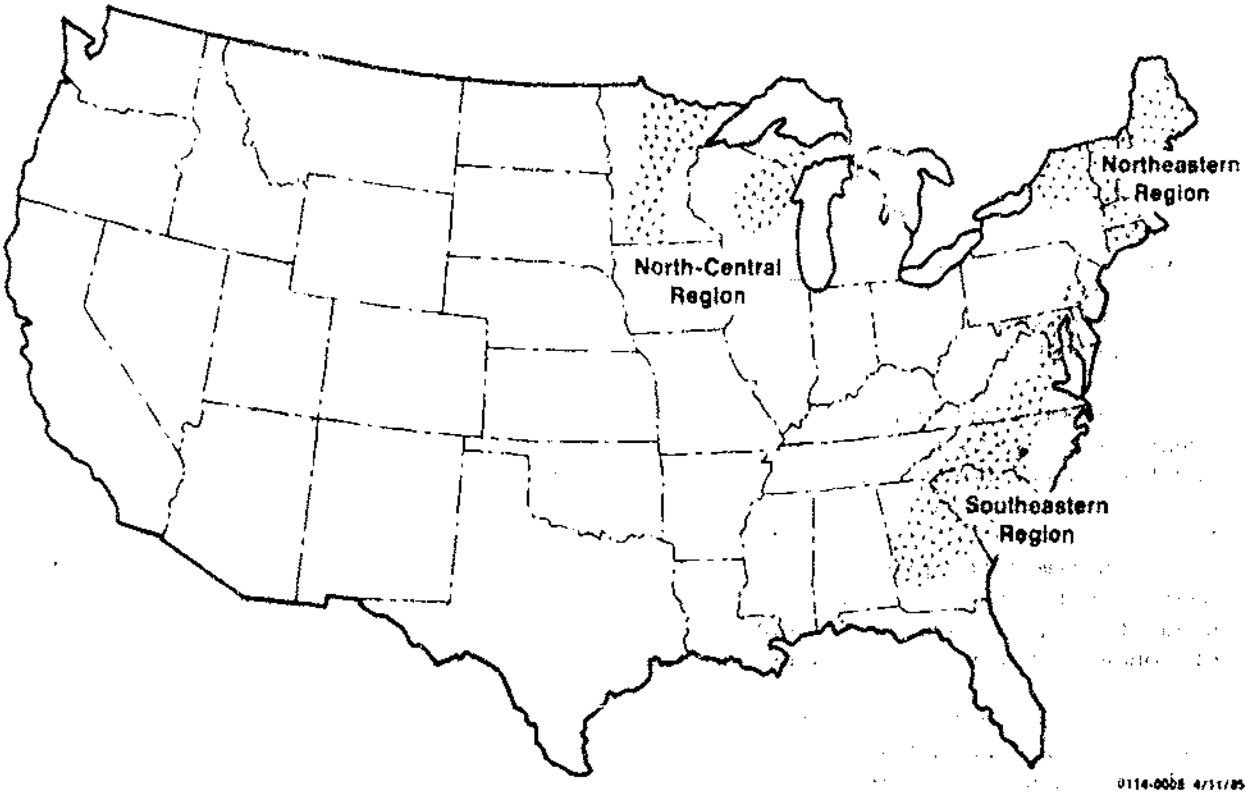

Figure 3-4. Regions being considered for the second repository.

tation with the 17 affected States and is based on the siting guidelines. The DOE revised and reissued, in December 1984, the draft regional characterization reports.

3.1.5.1.3 Long-Range Alternatives

Alternative Host Rocks

In accordance with the Act, the DOE will continue to consider a variety of rock types as long-range alternatives if more than two repositories are needed.

The DOE is examining the literature on the generic characteristics of sedimentary rocks not previously considered; these rocks include limestone, sandstone, anhydrite, chalk, and argillaceous rocks like shale. The literature search will use only existing data sources. Rock types will be compared in terms of intrinsic properties, such as strength, permeability, and sorption characteristics. This rock evaluation will not involve site-screening activities and will be completed during 1985.

Subseabed Disposal

As required by the Act, the DOE will continue and accelerate a program of research, development, and investigation of alternative means and technologies for the permanent disposal of spent fuel and high-level waste. As an alternative to mined geologic repositories, subseabed disposal is currently funded by the DOE in collaboration with a number of other nations. The primary mission of the subseabed disposal program is to assess the feasibility of isolating radioactive waste within the thick stable beds of sediments under the ocean floor. If demonstrated to be feasible, subseabed disposal could provide a potential future repository for the United States or could serve as an international repository. Various institutional issuee will have to be addressed and resolved.

The DOE's subseabed disposal program began in 1973. Five areas in two oceans are currently being evaluated: three areas in the North Pacific Ocean and two in the North Atlantic Ocean. In addition, the DOE has developed mathematical models that predict sediment response to various chemical, thermal, and mechanical conditions. Laboratory tests completed in December 1982 confirmed the predicted thermal effects on deep ocean sediments. In-situ heat-transfer tests are scheduled for 1986. The characterization of the deep-ocean biological system is continuing for use in risk analyses. Field tests of concepts for wasts-container emplacement are under way.

In addition to the United States, nine countries and the Commission of the European Communities are investigating subseabed disposal through the Seabed Working Group, which was formed in 1977 under the auspices of the Nuclear Energy Agency of the Organization for Economic Cooperation and Development. Those countries are Belgium, Canada, the Federal Republic of Germany, France, Italy, Japan, the Netherlands, Switzerland, and the United Kingdom. Each nation has agreed to coordinate its research and development efforts to determine the feasibility of subseabed disposal. The major activities include site assessments, barrier assessments, engineering studies, safety assessments, and legal and institutional studies. The DOE is cooperating with these international subseabed disposal activities.

3.1.5.2 Technology Development

In parallel with the siting efforts, an extensive program is under way to develop the site-specific technology for repository licensing, construction, operation, and closure. These technology-development activities have been broadly grouped into the categories of systems, repository, and waste package. The status of each category is summarized below. More detailed discussions are presented in Chapter 2 of Part II.

3.1.5.2.1 Systems

Activities in the systems category are directed at performance assessment--the analytical evaluation of the capability of the total disposal system to contain and isolate the waste--and at systems engineering--the organization of the technical activities necessary to achieve the program's objectives.

In the performance-assessment category, the first-repository program is in the process of identifying and developing the analytical techniques to be used for evaluating system and component performance and is identifying the procedures for the verification and validation of these techniques. These activities are needed to give reasonable assurance that compliance with the NRC and EPA regulations can be demonstrated.

To support the plans for site characterization, site-specific performance-assessment plans are being prepared. These plans will lay out the technical approach, planned activities, and schedule for evaluating the preclosure and the postclosure phases of the repository and for identifying disruptive-event scenarios in terms of the magnitude and the likelihood of resulting radionuclide releases. A national peer-review panel has been established to examine various technical and analytical aspects (e.g., assessment methods, scenario-development methods) of the performance-assessment efforts in order to strengthen and improve these plans. As a first step toward the application of performance assessment to the siting process, the DOE conducted preliminary assessments, based on data available before site characterization, of the potentially acceptable sites for the first repository. The results of these preliminary assessments were reported in the environmental assessments.

The other key effort, systems engineering, provides a disciplined, systematic approach to planning and analysis. Overall generic requirements for the mined geologic disposal system have been developed; these requirements provide top-level design bases, functional requirements, performance criteria, and constraints for the system. These overall requirements are being used to develop site-specific system requirements tailored to the unique characteristics of each site. Further descriptions of plans in the systems tasks are given in Section 2.6 of Part II.

3.1.5.2.2 Repository

Activities in the repository-technology category are directed at the development of site-specific repository designs, with supporting efforts under way in the development of a repository data base, equipment and instrumentation, as well as backfills and seals. Various preconceptual design studies have been completed for salt, basalt, and tuff. A conceptual design for a basalt repository at the Hanford Site was completed in 1983; additional efforts in 1984 were directed at upgrading the design of the underground facilities to reflect new site-specific data and design requirements. Also, during 1984, engineering feasibility studies were completed for a two-phase repository in tuff, salt, and basalt. These studies indicated that the two-phase approach, which is discussed in Section 3.1.6.1.2, is feasible and could provide the capability for limited repository operations in 1998.

Current design work is focused on developing the conceptual design for the site-characterization plan (SCP). This design will meet the requirements of the Act (Section 113(b)(1)(c)) and 10 CFR 60.11(a)(6)(ii) and reflect the conditions expected at each of the three sites recommended for site characterization. Each design will be separately documented in an SCP conceptual design report. A summary of the design and its basis will be presented in Chapter 6 of the site-characterization plans, which will also include a discussion of the information needs identified to support the design. These information needs will form the basis for the test plans discussed in Chapter 8 of the site-characterization plans.

The SCP conceptual design for each site will be sufficiently detailed to provide the basis in the site-characterization plan for identifying the number and the type of tests and analyses to be performed during site characterization. The design will also reflect the integration of the site-characterization (exploratory shaft) facilities with the repository in terms of design, construction, and performance, so that their impacts with respect to the suitability of the site can be assessed in the site-characterization plan.

A significant portion of the design basis is the compilation of data on the rock characteristics that affect the structural behavior of the repository. Field and laboratory testing is under way to acquire these data, with plans to collect in-situ data in the exploratory shafts. The program is in the early stages of identifying the required analytical techniques and instrumentation as well as the plans for their development. These needs are expected to provide support for the design of underground openings, the drilling and backfilling of waste-emplacement holes, shaft-sinking, etc., and are dependent on the specific sites and host rocks under consideration. As an element of repository design, work is also proceeding on the development of seals for shafts and boreholes. The approach to the development of permanent seals is similar to that of the waste-package program, with both design development and materials evaluation progressing in parallel. To date, work has concentrated on generic design concepts and characterization of a wide range of sealing materials, with plans being developed for laboratory and field tests. More-detailed discussions of work in the repository task are given in Section 2.4 of Part II.

Repository design and operation will conform to the latest requirements of the Environmental Protection Agency and other regulatory agencies in maintaining radiation exposure, radiation levels, and the releases of radioactive materials into the environment within prescribed limits.

The status of technology development described above applies only to the sites that are candidates for the first repository. Technology development for the second repository is limited at this time to preliminary engineering studies, cooperative international efforts, and monitoring the plans and activities of the first repository.

3.1.5.2.3 Waste Package

As one of the engineered barriers, the waste package is being developed to work in concert with the host rock to ensure adequate waste containment and isolation. This requires a thorough understanding of the geologic, hydrologic, and geochemical environment or conditions to which the waste package will be exposed--conditions that are markedly different from site to site. Knowledge of the expected environment will allow the design of packages that will meet or exceed regulatory requirements for performance as well as being cost effective. Therefore, at this time, site-specific waste packages are being developed, with efforts conducted in parallel in two major areas--design development and materials testing.

Waste packages are being designed to have the following capabilities: (1) to provide radionuclide containment in accordance with the performance objectives of the NRC regulations in 10 CFR Part 60; (2) to contribute to the performance of the total engineered-barrier system in limiting radionuclide releases to the host rock in accordance with the performance objectives of the NRC regulations in 10 CFR Part 60; (3) to provide for safe handling; (4) to preserve the ability to safely retrieve the waste up until repository closure; and (5) to meet the latest EPA requirements in 40 CFR Part 191.

Conceptual waste-package designs for salt, basalt, and unsaturated tuff have been completed. As part of the design effort, reference and alternative materials have been chosen for the waste container and packing, where the latter is necessary. The reference material for the waste container is low-carbon steel for salt and basalt, and stainless steel for tuff. The DOE is also examining the potential use of copper and selected copper-based alloys for waste containers in basalt and tuff. Copper along with other candidates will also be considered in the crystalline-rock studies for the second repository. For emplacement-hole packing in basalt, a mixture of crushed basalt and bentonite clays is being considered, whereas for salt, the use of crushed salt is planned; for tuff, either no packing or crushed tuff may be used. Interaction tests are being conducted for various combinations of host rock, ground water, and waste-package materials to determine behavior under expected repository conditions. Other tests will measure the radionuclide-release characteristics of spent fuel and high-level waste. Requirements for the waste form are being developed to establish the acceptance criteria for receipt at the repository.

As discussed in Section 3.3 of this chapter, the DOE is studying the possibility of a universal cask that could be used for spent-fuel storage, transportation, and emplacement in the repository without further repackaging or overpacking. If it is determined that this type of package is feasible and offers significant benefits to the waste-management system, it will be incorporated into the repository program.

More-detailed discussions of the plans for the waste-package task are given Section 2.5 and Chapter 8 of Part II.

3.1.5.3 Test and Evaluation Facility

After the Act passed, the DOE evaluated the role and location of the test and evaluation facility. The DOE has concluded that a test and evaluation facility, if needed, should be colocated with the repository and could provide data after the site-characterization phase at the selected repository site in three areas: (1) geotechnical data for design verification, (2) engineering data for site-performance confirmation, and (3) the development and demonstration of technology for repository operations. The need for these data will become clear as site-characterization plans for the three candidate sites for the first repository are issued and evolve through interactions with the

Nuclear Regulatory Commission. Therefore, the DOE will delay the decision on the need for a colocated test and evaluation facility until the program's data needs are better established. In order to allow for orderly facility planning and design, the DOE plans to make a decision on the need for a colocated test and evaluation facility in late 1987. A more detailed discussion of the test and evaluation facility is presented in Chapter 4 of Part II.

3.1.5.4 <u>Institutional Relations</u>

A major element in the repository program has been and continues to be that of institutional relations, including interactions with other Federal agencies, with Congress, with States, with affected Indian tribes, and with the public. The program has placed emphasis on an open, two-way flow of information. The governing principles are consultation and cooperation with the States and affected Indian tribes and sensitivity to the social and economic effects of repository siting and development to ensure that all valid concerns are addressed. A more detailed discussion of the DOE's institutional relations program is presented in Chapter 4 of Part I.

3.1.5.4.1 Information Exchange and Financial Assistance

The DOE has conducted information dissemination and exchange activities for 6 years in the States of Louisiana, Mississippi, Texas, and Utah and longer in the States of Washington and Nevada. Recently, information-exchange seminars have been held in communities near some of the potential sites. Information offices have been established in Moab and Monticello, Utah; Minden, Louisiana; Richton, Mississippi; and Tulia, Hereford, and Vega, Texas. The Federal sites maintain information offices for the States of Nevada and Washington, and local and State libraries continue to be involved in extensive dissemination of information. As part of the information-dissemination program, progress meetings and technical seminars have been conducted for representatives from the States.

Financial assistance has been provided to the States with potentially acceptable sites and affected Indian tribes to encourage participation in the analysis of technical information. This assistance can be used to fund technical review programs or to acquire the services of technical experts. Other financial assistance has been made available to the States for funding State library and information-dissemination activities.

3.1.5.4.2 Consultation and Cooperation

The DOE has begun to develop written consultation-and-cooperation agreements with the potential host States and affected Indian tribes. Negotiations with the State of Washington have proceeded to a point where only several issues remain to be resolved before a final agreement can be reached. Negotiations have also begun with the Yakima Indian Nation, but these are in abeyance, at the request of the Yakimas, until the Washington agreement is signed.

In the 17 States being considered for the second repository, workshops on the region-to-area screening methodology and consultation meetings on the siting guidelines have been of major importance. In addition, the DOE has conducted briefings for various State officials and the public in several of the 17 States. Funding for reviewing the regional characterization reports and other activities pertinent to the region-to-area screening process has been made available to the States. The DOE has begun negotiations with the State of Wisconsin regarding an informal consultation-and-cooperation agreement, which is not required by Section 117(c) of the Act.

Additional information on consultation and cooperation can be found in Chapter 4 of Part I and Chapter 3 of Part II.

3.1.5.4.3 Identification and Mitigation of Socioeconomic Impacts

The DOE is committed to developing a close dialogue and collaboration with States, affected Indian tribes, and local communities in order to understand, anticipate, and provide a cooperative response to the potential sociocultural and economic impacts of the waste-management program. The evaluation of social and economic impacts has been under way since the inception of the program. The work completed includes the identification and development of methods for assessing socioeconomic impacts, the screening of potential sites against socioeconomic criteria, and the development of comparable data bases for each potential site. Investigations have been made of alternative approaches to impact-mitigation measures, such as job training, housing, citizen involvement, and local management and planning techniques. Various documents have been produced to promote understanding among the States, affected Indian tribes, local governments, and the DOE concerning potential community-development issues and their resolution. The DOE has reviewed the impact-monitoring programs at other large-scale construction projects to provide input into the design of a program for monitoring and mitigating repository impacts. Chapter 11 of Part II discusses the potential socioeconomic impacts of repository development in more detail.

3.1.6 PLANS FOR THE DEVELOPMENT OF GEOLOGIC REPOSITORIES

This section describes the approach the DOE plans to use in order to achieve the objectives of the repository program. It also discusses long-range alternatives to the present program--specifically, the concept of sub-seabed disposal and the use of other host rocks not now being considered for either the first or the second repository.

An integral part of these plans is a quality-assurance program. A formal quality-assurance program that addresses the 18 criteria of the NRC's 10 CFR Part 50, Appendix B, and the national consensus standard known as ANSI/ASME NQA-1 (Quality Assurance Program Requirements for Nuclear Facilities) is being planned and implemented by the DOE and its contractors. This program will cover the total spectrum of activities associated with the siting, design, construction, operation, closure, and decommissioning of repositories. During site characterization, the quality-assurance program will provide assurance that the data collected for siting decisions and the license application are accurate, verifiable, and retrievable. A description of the quality-assurance program that was applied during site screening and will be applied to site-characterization and design activities will be provided to the Nuclear Regulatory Commission in the site-characterization plan for each site to be characterized. As part of the license application, the DOE will submit a detailed description of the quality-assurance program for the design, fabrication, inspection, construction, testing, and operation of the repository structures, systems, and components that are important to safety and the barriers that provide waste isolation. The requirements that the DOE's quality-assurance program must satisfy are set forth in the Nuclear Regulatory Commission's rule, 10 CFR Part 60. A more detailed discussion of the DOE's quality-assurance program is presented in Chapter 5 of Part I.

3.1.6.1 Plans for the Development of the First Repository

This section presents the plans for the first repository in two parts: (1) site characterization and supporting-technology development and (2) licensing, design, construction, operation, closure, and decommissioning.

3.1.6.1.1 Site Characterization and Supporting-Technology Development

The significant activities to be performed during site characterization and supporting-technology development are summarized below. Discussions of these activities can be found in Chapters 2 and 7 of Part II.

Site-characterization activities will begin after site approval and the issuance of the site-characterization plans that describe the testing program for each site. Critical activities include the obtaining of permits, site-preparation work, the procurement of long-lead-time items, and the final design of the exploratory shafts. The construction of the exploratory-shaft facility will include constructing and outfitting the shafts, developing the underground drifts, and installing test equipment. The DOE is planning to sink two exploratory shafts at each candidate site. The second shaft will support the safe operation of the underground testing program and will provide flexibility in the scope and the duration of in-situ testing. More information on the exploratory shafts is presented in Sections 2.3 and 7.2 of Part II.

After the completion of shaft sinking and outfitting, and the development of underground test tunnels, in-situ testing will begin and will be conducted in both shafts in accordance with site-specific test plans and coordinated with the Nuclear Regulatory Commission and affected parties. Surface-based site characterization—such as the drilling of geologic and hydrologic boreholes, geophysical logging, and trenching—will be initiated in accordance with additional test plans. The results of the characterization work and any necessary changes to the site-characterization plan will be reported every 6 months to the Nuclear Regulatory Commission, affected States, and affected

Indian tribes. Concurrently with site characterization, the DOE will conduct environmental and socioeconomic studies at each of the candidate sites. Steps will be taken to ensure access to, and the acquisition of, land as necessary to allow these site-characterization activities to be conducted and to preserve the integrity of the candidate sites as possible locations for a repository.

The development of supporting technology will continue for each of the candidate sites. Site-specific advanced conceptual repository design studies will be completed, and new data acquired from the site-characterization program via the exploratory shafts will be used in the formulation of license-application (Title I and selected Title II) design criteria. The development of the waste package will continue in parallel. A site-specific advanced conceptual design for the waste package will be completed, and design inputs will be used in the ongoing repository-design, performance-assessment, and in-situ testing programs. Efforts will continue on the testing and analysis of barrier materials as well as the laboratory and engineering-scale testing of packages. The results of these activities will form the basis for the license-application design of the waste package. The development of repository equipment and instrumentation as well as the testing and evaluation of seal designs and materials will continue.

In the area of performance assessment, computer codes will be developed and tested, disruptive-event scenarios will be postulated and evaluated, and data uncertainties and system sensitivities will be analyzed.

As site characterization proceeds, license-application designs for the repository and the waste package will be initiated for each of the three candidate sites. The designs will reflect completed efforts in related areas, such as repository sealing and equipment and instrumentation development. The completed license-application (Title I and selected Title II) designs will support the preparation of the documentation required for the license application, which will be developed in consultation with the Nuclear Regulatory Commission.

In-situ testing and other site-characterization activities will be completed to allow for the determination of site suitability in terms of the DOE siting guidelines (10 CFR Part 960), the NRC criteria in 10 CFR Part 60, and the EPA standards (to be codified as 40 CFR Part 191) and for the preparation of documentation for repository-site selection, including the environmental impact statement and the site-selection report. The results of the site-characterization activities will be incorporated into such documentation, as appropriate for each candidate site. Confirmatory testing in support of the license application may continue at the recommended repository site as needed.

As previously stated, the need for a test and evaluation facility colocated at the repository site will be evaluated in 1987. If a decision is made to proceed with the colocated test and evaluation facility, a memorandum of understanding with the Nuclear Regulatory Commission will be prepared to establish procedures meeting the requirements of the Act for the Commission's review of the test and evaluation facility. Initial test-planning and facility-design studies will be conducted for each of the candidate repository sites.

3.1.6.1.2 Licensing, Design, Construction, Operation, Closure, and Decommissioning

Significant activities are summarized below. More detailed information, particularly about design, is given in Chapter 2 of Part II.

The DOE's approach to licensing reflects an overriding commitment to protecting public health and safety as well as the quality of the environment. In order to facilitate the NRC licensing process, the DOE has planned a significant amount of interaction with the Nuclear Regulatory Commission before submitting a license application for the construction of the repository. These interactions will focus on the development and implementation of the site-characterization plans. The DOE also plans to continue an open two-way communication with the Nuclear Regulatory Commission before submitting a license application. To facilitate liaison between the two agencies, the NRC will station onsite representatives at the DOE Operations Offices involved in the repository program, and the two agencies will hold frequent technical meetings and workshops. Some issues may also be resolved in formal NRC rulemaking actions, which can be subject to judicial review. It is expected that this approach will allow technical issues to be identified in the prelicensing phase. The issues can then be resolved without delay, or activities leading to a resolution can be instituted.

The design of the repository (complete Title II design) will be made final during the NRC review of the license application (for the construction of the repository). It will provide the basis for procurement and construction and for the updated license application (to receive and possess radioactive waste) for phase 1 of the repository; this updated license application will be submitted to the Nuclear Regulatory Commission while construction is proceeding. Included in the final procurement and construction design of the repository will be the associated design of the waste package; it will be based on data from tests conducted on waste packages of the license-application design, the DOE's extensive research program, and the results of performance modeling.

After a construction authorization is received from the Nuclear Regulatory Commission, the construction of the repository will begin. The DOE is planning to construct the repository in two phases. Phase 1 will consist of the construction of the surface, shaft, and underground facilities that are needed to allow the DOE to accept small quantities of spent fuel beginning in 1998. Phase 2, which will begin at the same time as phase 1, will consist of the construction of the remaining facilities needed to develop the repository to its full-scale capacity.

It is estimated that the phase 1 facilities will be able to receive commercial spent fuel at a rate of 400 MTU per year or an equivalent amount of other waste types. Emplacement rates vary somewhat with each host rock. Phase 1 facilities will not have the capability to consolidate spent fuel, but phase 2 facilities will. The phase 2 facilities will be able to receive and emplace a maximum of 3000 MTU per year of spent fuel and/or solidified high-level waste, including high-level waste from the West Valley Demonstration Project and from defense activities (see Chapter 1 of Part I). Current plans call for phase 2 facilities to accept only spent fuel until they reach the emplacement rate of 3000 MTU per year. At that time it may also be possible to dedicate the phase 1 facilities entirely to the emplacement of defense waste. In any case, the phase 1 facilities will continue to operate at a rate of 400 MTU per year once the phase 2 facilities reach their maximum emplacement rate.

Upon receipt of the license for phase 1, operational activities will begin. An application for an amended license (to receive and possess radioactive waste for phase 2) will subsequently be submitted to the Nuclear Regulatory Commission Upon receipt of the amended license, phase 2 facility operations will begin. Operational activities will include waste receipt, inspection, consolidation (phase 2 only), encapsulation in containers, if required, handling, and emplacement; continued underground construction of the waste-emplacement rooms and supporting services (ventilation, power, etc.); the storage and management of mined rock for later use as repository backfill; the conduct of a performance-confirmation program throughout the operational period in accordance with 10 CFR Part 60; other support services (quality assurance, operational safety, security, administration); and the possible retrieval of the waste, as required. Operational safety will be the responsibility of the DOE, and all applicable requirements of the Occupational Safety and Health Administration and the Mine Safety and Health Administration will be met.

The DOE's recently published Generic Requirements for a Mined Geologic Disposal System (DOE/NE/44301-1, September 1984) shows an approximate total preclosure time of 90 years for the repository. Six years of this 90-year period will be used for construction and 28 years for repository operation. Beginning at the same time as repository operation (i.e., the emplacement of the first wastes) is a 50-year period of waste retrievability. The repository design, in accordance with 10 CFR Part 60, will have the capability to begin retrieval at any time for 50 years after the start of waste-package emplacement. The remainder, 34 years, is the length of time assumed to be necessary for waste retrieval if waste retrieval proves to be necessary at the end of the 50-year period of retrievability. It is assumed that the retrieval would take as long as waste emplacement (28 years) and repository construction (6 years). This length of time is consistent with the NRC's provisions in 10 CFR 60.111, in which public health and safety considerations are of primary importance in any waste-retrieval operation. The 90-year requirement for facility maintainability either in a dormant or an active mode is based on the NRC's 10 CFR 60.111(b). It will provide sufficient time, in accordance with the requirements of 10 CFR Part 60, to successfully complete the performance-confirmation program and the permanent closure of the underground facilities and shafts.

After the repository has been filled and the performance-confirmation program has been completed to the satisfaction of the Nuclear Regulatory Commission, the DOE will submit to the Nuclear Regulatory Commission an application for an amended license that will allow the DOE to close the repository. After NRC approval, the DOE will begin sealing the repository and decommissioning the surface facilities. Repository shafts will be sealed, surface facilities will be decontaminated and dismantled, the mined rock that is not used in backfilling will be stabilized or moved off the site, the surface area will be returned to its original natural condition to the extent feasible, permanent markers will be erected, and equipment for postclosure monitoring or surveillance will be installed as necessary. The last step will be the termination of the repository license.

3.1.6.2 Plans for the Development of the Second Repository

The DOE plans o site the second repository and to request Congressional approval for its construction. The activities described in the preceding section for the first repository with respect to site characterization, supporting-technology development, licensing, design, construction, operation, and closure will be similar for the second repository. The strategy for identifying sites for nomination and recommendation for characterization is discussed below.

After receiving comments from the States on the draft regional characterization reports, the DOE will issue these reports in final form. A draft area-recommendation report containing the results of the region-to-area screening will then be prepared and issued for comment by the 17 States currently under study. This report will identify the areas where the DOE plans to conduct more-detailed studies, including field investigations. The final area-recommendation report will be issued after the consideration of State comments.

The areas identified for further study in the final area-recommendation report may be identified as potentially acceptable sites if the DOE can make the findings and determinations required by the siting guidelines. If such findings and determinations are made at that time, they will be documented in the area-recommendation report; if not, potentially acceptable sites will be identified during the area stage of the program.

Before the area studies begin, a draft area-characterization plan will be prepared and issued for State comment. It will describe the activities the DOE will undertake during the area field investigations. The data collected during these investigations will allow the DOE to evaluate sites that may be suitable for nomination and recommendation for site characterization. These evaluations will be based on the siting guidelines. After the activities described in the area-characterization plan are completed, the process of site nomination and recommendation will be similar to that used for the first repository. More-detailed information on the site investigations is given in Chapters 2 and 7 of Part II.

The Act requires the DOE to nominate five sites for site characterization for the second repository. Three of these sites must be sites that were not nominated for site characterization for the first repository. The Act also permits sites characterized, but not selected, for the first repository to be nominated for the second repository. If this occurs, the shafts, surface facilities, and underground openings at those sites will be maintained while the other second-repository sites are characterized. Since salt, tuff, and basalt may be among the first-repository sites recommended for site characterization, it is possible that as many as two different host rocks now considered for the first repository may be nominated for the second repository. The Act does not allow the two sites that were nominated, but not recommended, for site characterization for the first repository to be nominated for site characterization for the second repository.

3.1.6.3 Long-Range Alternatives

3.1.6.3.1 Alternative Host Rocks

As previously mentioned, a literature study of argillaceous and sedimentary rocks other than salt is currently under way. When this study is completed in 1985, a decision will be made on the feasibility of using these rock types as future repository-siting alternatives.

The U.S. Geological Survey is currently funding two studies that may assist the DOE in evaluating potential geographical areas for investigation as repository sites. One of these studies will identify, on the basis of geologic and hydrologic criteria, areas within eight western States (Arizona, California, Idaho, Nevada, New Mexico, Oregon, Texas, and Utah) that appear to have the characteristics necessary for waste isolation.

The second U.S. Geological Survey study involves crystalline rocks buried beneath sediments. A literature search identified several general regions in the eastern United States where the requisite geologic and hydrologic conditions probably exist. The U.S. Geological Survey is currently reviewing available data in order to more clearly define the regions where the desirable geohydrologic conditions appear to occur. Later efforts will involve some field data collection to verify that the presumed conditions do exist.

3.1.6.3.2 Subseabed Disposal

Future activities for the subseabed disposal program include research and development leading to a report on the feasibility of subseabed disposal in 1990; site studies leading to the ability to recommend a subseabed repository site in 1994 as a potential future repository, if the concept proves feasible; participation in the International Seabed Working Group and in multinationally funded field experiments with the objective of sharing the costs of deep-ocean experiments; and participation in interagency and international meetings on subseabed disposal with the intent of keeping the option open until at least the second repository is approved by Congress.

3.1.6.4 Institutional Strategy

The Act provides a comprehensive guide for dealing with the complex institutional issues associated with this program. These mechanisms should prove useful in resolving institutional problems as they arise. In addition, the DOE plans to effectively use the existing and future mechanisms for communication, consultation, and cooperation. Institutional issues will affect all major stages of repository development. Such issues can be anticipated most clearly during the early stages, such as the issuance of siting guidelines, negotiations for consultation-and-cooperation agreements, and siting decisions by the President and Congress. Other issues will undoubtedly arise, and the institutional strategy must be flexible enough so that these issues can be addressed in a comprehensive and timely fashion. More details are contained in Chapter 4 of Part I and in Chapter 3 of Part II.

3.1.6.4.1 Consultation and Cooperation

Specific plans include the following:

1. Negotiation and signing of written agreements as required by the Act.

2. Public review of, and comment on, the draft environmental assessments, which contain information on site nomination and recommendation.

3. Establishment of mechanisms to provide licensing and technical data on a timely basis.

4. Development of mechanisms for the resolution of objections reised during the planning, siting, construction, operation, closure, and decommissioning of the repository.

In addition to these formal mechanisms, the DOE will seek to encourage informal dialogue with all affected parties and pledges to resolve any issue in an atmosphere of cooperation.

3.1.6.4.2 Identification and Mitigation of Socioeconomic Impacts

The socioeconomic work that is needed to meet the requirements of the Act falls into three general categories: (1) site screening and impact assessment, (2) impact mitigation and community development, and (3) impact monitoring. Site-screening and impact-assessment activities occur throughout the siting process and will end once a site is selected. Impact-mitigation and community-development plans will be formulated during the siting process and will be implemented during repository development. Monitoring activities will begin concurrently with site characterization and will continue throughout repository construction and operation.

The design of the monitoring program will involve the States, affected Indian tribes, and affected communities. The factors to be monitored will be those associated with the economic, demographic, and sociocultural changes occurring in the region of the repository; changes in the requirements for facilities and services; and the resulting fiscal impacts. An analysis of the effectiveness of current mitigation measures will also be performed.

The States, affected Indian tribes, local communities, and the DOE will be using the Act as the framework from which the impact assistance will be negotiated. Current plans include discussions to define (1) the role of each party, (2) the makeup of the impact-management committee or committees, (3) the provisions of the Act concerning front-end financing and jurisdictional allocations, (4) methods for conflict resolution, and (5) mitigation measures, such as long-distance commuting, changes in project schedule, local business development, and housing. More information is provided in Chapter 11 of Part II.

3.1.7 REPOSITORY SCHEDULE

This section consists of three parts. The first part describes the reference schedule and possible schedule durations for the major phases of the repository program. The second part discusses alternative schedules for the first repository. The last part describes the reference schedule for the second repository.

3.1.7.1 The Reference Schedule and Alternative Schedule Cases for the First Repository

The DOE has examined the steps that lead to the beginning of repository operations and, for purposes of this discussion, has divided them into five major phases:

1. Recommend sites for characterization.
2. Characterize sites.
3. Select site and obtain site approval.
4. NRC licensing review.
5. Construct and test repository.

Table 3-1 shows the major activities within each of these phases for the first repository. There are many other activities within each phase that have not been included in this list because they are not as critical to the schedule as those shown.

Table 3-1. Major Phases of the Repository Program

1. RECOMMEND SITES FOR CHARACTERIZATION
   - DOE issues final environmental assessments
   - DOE nominates and recommends sites
   - President approves sites

2. CHARACTERIZE SITES
   - DOE issues site-characterization plans
   - DOE acquires land and obtains applicable permits
   - DOE constructs exploratory shafts
   - DOE performs site characterization to support the draft environmental impact statement

3. SELECT SITE AND OBTAIN SITE APPROVAL
   - DOE issues draft environmental impact statement
   - DOE issues final environmental impact statement
   - DOE submits site-selection report to the President
   - President recommends site to Congress
   - State or affected Indian tribe submits notice of disapproval
   - Congress overrides or sustains disapproval

Table 3-1. Major Phases of the Repository Program (continued)

4. NRC LICENSING REVIEW
   - DOE submits license application to NRC
   - NRC issues construction authorization

5. CONSTRUCT AND TEST REPOSITORY
   - DOE constructs surface and underground facilities
   - DOE completes startup testing
   - NRC issues license
   - DOE begins operations

As the following sections show, the DOE considered many possible alternatives for completing the activities listed for each program phase. After analyzing these alternatives, which are presented here as alternative cases, the DOE selected a reference schedule for the first repository (Figure 3-5). This schedule is consistent with the DOE's strategy to ensure the quality and sufficiency of information used to support program decisions while still adhering to the statutory requirement to begin accepting waste for disposal by January 31, 1998. While there are numerous intermediate dates and key milestones laid out in the Act, the DOE believes the 1998 date is the most important.

The sections that follow are organized by phase. The reference schedule and major milestones for each phase are discussed first, followed by the other schedule cases that were considered but not selected. The effects of these schedule cases are expressed in terms of the potential delay on the reference schedule. Table 3-2 presents the reference schedule by phase and summarizes the schedule cases considered for the five phases of the repository program.

3.1.7.1.1 Recommendation of Sites for Characterization

The reference schedule and the alternative cases that have been identified for phase 1, the recommendation of sites for characterization, are described below.

The Reference Schedule

The specific milestones for phase 1 are as follows:

1. The Secretary of Energy issues the final environmental assessments in November 1985.

2. The Secretary nominates and recommends sites to the President in November 1985, shortly after issuing the final environmental assessments.

3. The President approves the recommended sites in January 1986.

The duration of the reference schedule is 13 months (December 1984 to January 1986).

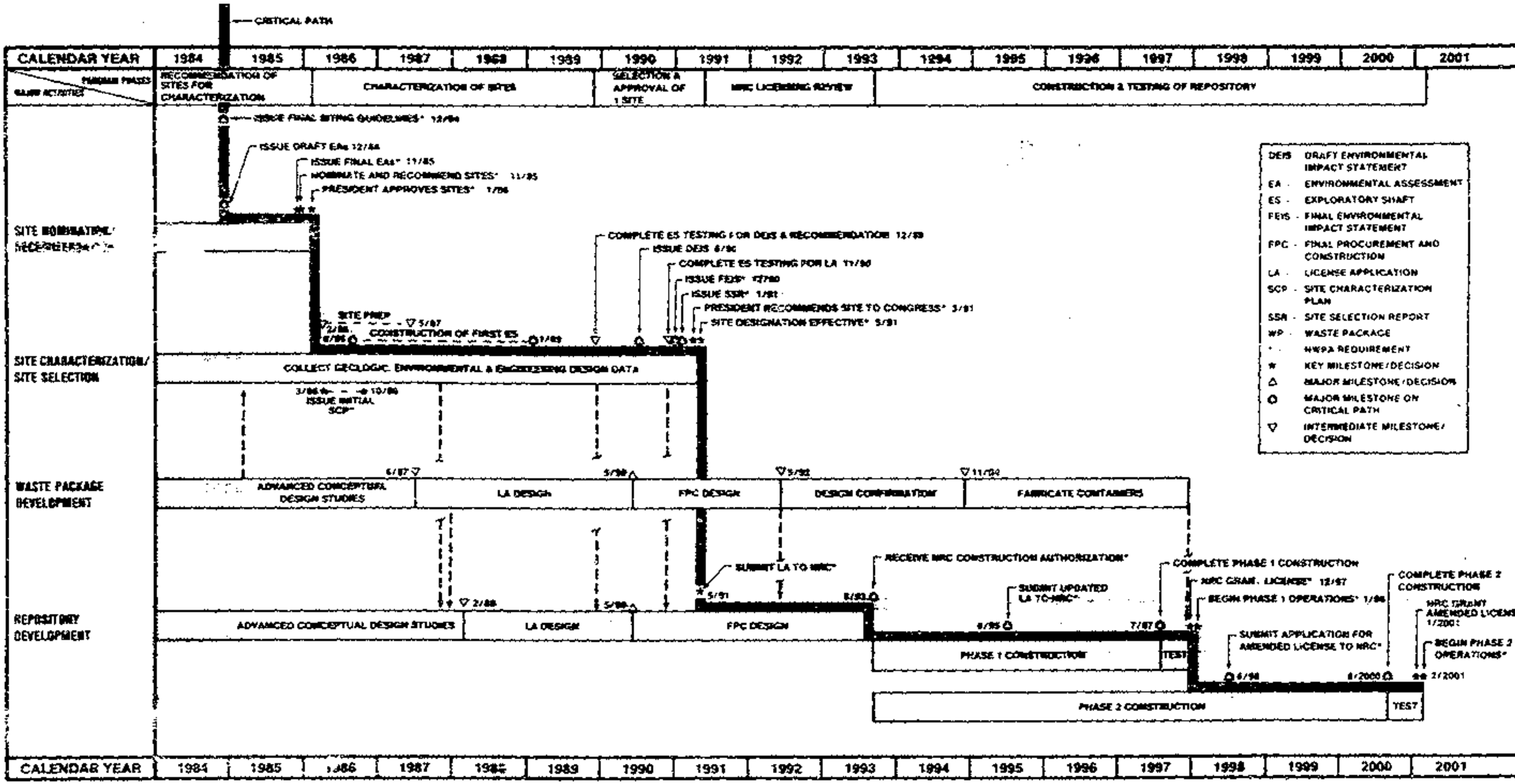

Figure 3-5. Reference schedule for first geologic repository.

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Table 3-2. The Reference Schedule and Possible Alternatives for Completing the Major Program Phases for the First Repository

Major Program Phases	Recommend Sites for Characterization	Characterize Sites	Select Site and Obtain Site Approval	NRC Licensing Review	Construct and Test Repository
Reference schedule (start 12/84)	Secretary recommends 3 sites to President by November 1985, President approves sites in minimum time provided by Act (13 months)	Recommendation based on in-situ testing (47 months)	President recommends site, no State or Indian tribe disapproval (17 months)	NRC review (27 months)	Phased construction, phase 1 complete in 53 months, phase 2 complete in 90 months
Alternative schedule cases and effect on reference schedule	1-A Extensive modifications required to draft EAs (+6 months)	2-A Recommendation based on surface studies and ES construction data only (-11 months)	3-A Additional DEIS review or extensive modifications required (+9 months)	4-A NRC review takes nominal period allowed by Act (+9 months)	5-A Construction delays (+24 months, each phase)
	1-B Secretary requires additional data to support site recommendation (+12 months)	2-B Site permitting delays (+9 months)	3-B State or Indian tribe disapproval submitted; Congress overrides (+5 months)	4-B NRC requires additional review time as allowed by Act (+21 months)	5-B Full-scale repository (+17 months for phase 1 -20 months for phase 2)
	1-C President requires additional review period allowed by the Act (+6 months)	2-C ES construction delays (+24 months)	3-C State or Indian tribe disapproval submitted, site disapproved, new site selected (+19 months)	4-C NRC requires extensive additional information (+33 months)	
		2-D Extensive in-situ testing required (+36 months)		4-D NRC rejects site; new site selected, approved, and CA issued (+48 months)	
Maximum phase duration	37 months	116 months	45 months	108 months	94 months until initial waste acceptance

Abbreviations: CA, construction authorization; DEIS, draft environmental impact statement; EAs, environmental assessments; ES, exploratory shaft.

Case 1-A

One area for potential change in the schedule is the amount of time required to respond to comments on the draft environmental assessments and to prepare the final environmental assessments. Delays of up to 6 months are possible if there are delays in the receipt of comments or if the comments are voluminous and complex, requiring extensive modifications of the documents. Case 1-A would increase the duration of the reference schedule by 6 months.

Case 1-B

After the comments on the draft environmental assessments are reviewed, the Secretary of Energy could find it necessary to acquire additional data to support his nomination and recommendation decisions. This case assumes that 1 year would be needed to gather the necessary data, analyze it, and incorporate it into the environmental assessments. Case 1-B would increase the duration of the reference schedule by 12 months.

Case 1-C

The Act permits the President to request up to an additional 6 months to approve or disapprove the site recommendation. This case assumes that this request is made. Case 1-C would increase the duration of the reference schedule by 6 months.

Summary

The reference schedule does not assume that the approval of the recommended sites is delayed by judicial reviews of the draft environmental assessments. To minimize the probability of other delays such as those described in the alternate cases, the DOE extended its original schedule to allow extra time to prepare thorough draft environmental assessments. Furthermore, preliminary drafts of the environmental assessments were made available to affected States to allow them to become familiar with the documents before the start of the formal review process. The DOE believes that with these early reviews and prudent planning, the reference-case durations for phase 1 activities can be maintained.

3.1.7.1.2 Site Characterization

The reference schedule and the alternative cases that have been identified for phase 2, site characterization, are described below.

The Reference Schedule

The specific milestones for site characterization are as follows:

1. Site-characterization plans are issued in March 1986 for tuff and basalt and in October 1986 for salt.

2. The obtaining of permits and site preparation for salt, which has the most extensive permit requirements, are completed by July 1987.

3. The construction of the first exploratory shaft is completed in November 1987, February 1988, and January 1989 for tuff, basalt, and salt, respectively.

4. The construction of the second shaft is completed in June 1988, December 1988, and January 1989 for tuff, basalt, and salt, respectively.

5. Underground connections are made with the second exploratory shaft in March 1988, February 1989, and April 1989 for tuff, basalt, and salt, respectively.

6. In-situ testing begins in June 1988, October 1988, and April 1989 for tuff, basalt, and salt, respectively.

7. Testing to support the draft environmental impact statement and site recommendation is completed in December 1989. This corresponds to durations of 18, 14, and 8 months available for testing at the tuff, basalt, and salt sites, respectively. Additional testing to support the license application will continue into phase 3 for tuff and basalt, as described later in this section.

More information on the exploratory-shaft and testing schedule can be found in Chapter 2 of Part II. The duration of the reference schedule is 47 months.

Case 2-A

This case assumes that the site-selection decision could be based on surface studies and data obtained during the sinking of the exploratory shafts. No in-situ testing is assumed to support the preparation of the environmental impact statement and the subsequent site recommendation. Since in-situ testing is required by 10 CFR Part 60, the DOE would conduct in-situ testing to support the license application. Test durations of 16, 12, and 6 months are assumed for tuff, basalt, and salt, respectively.

Under these assumptions, all data needed to support the draft environmental impact statement would be collected 36 months after the President approves the recommended site. This corresponds to the time required to issue the site-characterization plan, obtain permits, and construct both exploratory shafts for the reference salt site. Since no in-situ testing is assumed to support site recommendation, case 2-A is 11 months shorter than the reference schedule. Case 2-A would reduce the duration of the reference schedule by 11 months.

Case 2-B

This case assumes that delays are encountered during the process of obtaining permits. Such delays could result from extensive hearings held by the State before the issuance of site permits, from additional data-collection activities that may be needed to support the permit application, and from a protracted review and evaluation of the permit application by the State. Case 2-B would increase the duration of the reference schedule by 9 months.

Case 2-C

Delays in the construction of the exploratory shafts could be encountered. For example, up to 2 additional years could be required if significant problems are encountered in drilling or from rock instability, the installation of the liner, the sealing of aquifers, or the mining of underground drifts. Case 2-C would increase the duration of the reference schedule by 24 months.

Case 2-D

Expanded in-situ testing may also be required to support the site recommendation. For example, additional tests with durations of about 3 years may be required to evaluate the thermal effects of waste emplacement, evaluate coupled thermal-hydraulic-mechanical-chemical effects, and confirm repository engineering designs and technology (e.g., waste-package performance and retrieval). Case 2-D would increase the duration of the reference schedule by 36 months.

Summary

Case 2-A was not selected for the reference schedule, because case 2-A assumed that site selection could be made without in-situ testing data. The DOE believes that some amount of in-situ testing data is necessary for site selection. The other alternative cases for the site-characterization phase assume delays in the permit process (case 2-B), construction delays (case 2-C), or additional in-situ testing requirements (case 2-D). The DOE will comply with State laws or regulations consistent with its responsibilities under the Act. Immediately on recommendation of the three sites by the President for site characterization, the DOE will seek to establish with each of the three States the process and timing for completing any activities that need to occur before the start of exploratory-shaft sinking. The DOE believes that by working closely with State and local authorities, particularly through the open exchange of data and concerns, the permit process can occur expeditiously. Although construction delays are possible, the DOE will work to minimize such delays and believes it is inappropriate to anticipate them in the reference schedule. With respect to the need for additional in-situ testing, the DOE and the Nuclear Regulatory Commission are already working to better define the testing requirements so that the test program can be focused on obtaining only data essential to both the DOE and the NRC actions relating to each site. Therefore, cases 2-B through 2-D were not selected for the reference schedule.

As shown above, site characterization (phase 2) is completed when the DOE has gathered enough data to support site selection on the basis of the siting guidelines. The kinds of information needed to select one site from among the three characterized sites are not necessarily the same as that required for the license application. For example, extremely detailed design information is not necessary to select a site, but it will be required for the license application. The DOE has assumed that this additional level of information will become available through continued in-situ testing during phase 3 of the program. Furthermore, this additional testing may be needed to reduce the uncertainties associated with data obtained from long-term tests.

Because of this approach, the reference schedule assumes that up to another 11 months after the end of phase 2, or until November 1990, is available for additional testing and documentation to support the license application. The reference schedule assumes that an additional 8 and 10 months of testing are required for tuff and basalt, respectively, while no additional testing is believed to be required for salt. This corresponds to a total in-situ test period of 26 months for tuff, 24 months for basalt, and 8 months for salt. Therefore, testing to support the license application would be completed by October 1990. The remaining time, until November 1990, would be used to complete the documentation of the test results. Confirmatory testing may continue, however, at the recommended site as needed. This schedule information is shown in Chapter 2 of Part II (Figure 2-4).

As an additional consideration affecting the site-characterization phase, the Act requires the DOE to have three candidate sites for which a preliminary determination of suitability for repository development can be made by the Secretary of Energy on the basis of the siting guidelines. The Secretary will make this preliminary determination of site suitability at the time he recommends three sites to the President for site characterization on the basis of the evaluations contained in the final environmental assessments. The DOE considers that, if during or after site characterization a site ie found to be unsuitable for further consideration, the DOE can nonetheless proceed with a recommendation to the President of one of the other two sites as the proposed repository site. If three sites must be found to be suitable after site characterization, then the selection of the repository site could be delayed by up to 5 years while a replacement site is selected and characterized, depending on the replacement host rock.

3.1.7.1.3 Site Selection and Site Approval

The reference schedule and alternative cases that have been identified for phase 3, site selection and site approval, are described below.

<u>The Reference Schedule</u>

The specific milestones for phase 3 are as follows:

1. The draft environmental impact statement is issued in June 1990, followed by a 90-day public comment period.

2. Testing for the license application is completed in November 1990.

3. The final environmental impact statement is issued in December 1990.

4. The site-selection report is issued in January 1991.

5. The President recommends the site to Congress in March 1991.

6. The site designation is effective in May 1991.

The duration of the reference schedule is 17 months.

Case 3-A

As previously mentioned, the recommendation to Congress must be accompanied by a final environmental impact statement. As required by the Act, the DOE must receive comments on the draft environmental impact statement from the Department of the Interior, the Council on Environmental Quality, the Nuclear Regulatory Commission, and the Environmental Protection Agency. The DOE believes that it could take as little as 6 months to receive and incorporate the comments and produce the final environmental impact statement. However, the other Federal agencies, the States and affected Indian tribes, and other members of the public may require additional time to review and comment on the draft environmental impact statement. If the comments that might be generated are extensive, additional time may be required for the DOE to incorporate them. This case assumes that 9 additional months of review time would be required. Case 3-A would increase the duration of the reference schedule by 9 months.

Case 3-B

This case assumes that a notice of disapproval is submitted within 60 days, and Congress overrides the notice of disapproval by joint resolution within 90 days. Case 3-B would increase the duration of the reference schedule by 5 months.

Case 3-C

If a notice of disapproval is submitted within 60 days after site recommendation and Congress does not override it by a joint resolution within 90 days, the disapproval stands, and the President must recommend another site not later than 1 year after the disapproval. Assuming that no notice of disapproval is filed for this second recommended site, the site designation would be effective 60 days later. Case 3-C would increase the duration of the reference schedule by 19 months.

Summary

Two of the alternative cases (3-B and 3-C) relate to a notice of disapproval submitted by a State or an affected Indian tribe. The DOE has not assumed a notice of disapproval in the reference schedule, because it believes that an open consultation-and-cooperation process in the years preceding site selection will reduce the probability of such an action by the State or the affected Indian tribe. With respect to additional review time for the environmental impact statement, the DOE can minimize the likelihood of this by early sharing of the data and analyses to be included in the environmental impact statement.

3.1.7.1.4 NRC Licensing Review

The reference schedule and alternative cases that have been identified for phase 4, NRC licensing review, are described on the next page.

The Reference Schedule

The specific milestones for phase 4 are as follows:

1. The DOE submits a license application in May 1 ①.

2. The Nuclear Regulatory Commission grants a construction authorization in August 1993.

The duration of the reference schedule is 27 months. The rationale for the selection of this duration is presented below.

Case 4-A

This case assumes that the Nuclear Regulatory Commission takes the nominal amount of time allowed by the Act, which is 3 years. Case 4-A would increase the duration of the reference schedule by 9 months.

Case 4-B

This case assumes that the Nuclear Regulatory Commission requests a 1-year extension and extends its licensing review to 4 years, as permitted by the Act. This extension could, for example, be needed for additional NRC staff analyses and review or intervention by concerned groups. Case 4-B would increase the duration of the reference schedule by 21 months.

Case 4-C

It is possible that the Nuclear Regulatory Commission may determine during its licensing review that additional information is needed to support the license application. This case assumes that the collection and incorporation of this information into the license application by the DOE would extend the NRC review period to 5 years. Case 4-C would increase the duration of the reference schedule by 33 months.

Case 4-D

If the Nuclear Regulatory Commission determines at the end of its licensing review that the recommended site is unsuitable and subsequently denies the DOE's license application, then up to 4 years may be needed to obtain Presidential and Congressional approval, prepare a new license application, and for Nuclear Regulatory Commission review of the application. Case 4-D would increase the duration of the reference schedule by 48 months.

Summary

The Nuclear Regulatory Commission believes that the minimum licensing review period will be 3 years unless effective steps are taken to identify and resolve potential licensing issues during the next 6 years. The DOE believes that these issues can be identified and resolved through the effective use of the ongoing close and extensive interaction between the two agencies. Through the SCP reports and frequent technical meetings, the Nuclear Regulatory Commission will be continuously informed of the DOE's plans and progress regarding site characterization and repository design. Furthermore, the Commission recently issued detailed site-specific technical positions that provide early guidance on the types of information required in the site-characterization plans and license application. Continued enhanced technical communication of this type should enable the DOE to submit a high-quality license application immediately upon the site designation becoming effective and should expedite the approval of the license application. The DOE believes that the approach presented above will allow the delays described in cases 4-A, 4-B, and 4-C to be avoided. This approach also minimizes the possibility that the Nuclear Regulatory Commission will reject the license application (case 4-D).

3.1.7.1.5 Construction and Testing of the Repository

The reference schedule and alternative cases that have been identified for phase 5, the construction and testing of the repository, are described below.

The Reference Schedule

The construction and preoperational testing of phases 1 and 2 of the repository would be completed in 53 and 90 months, respectively, after the receipt of a construction authorization from the Nuclear Regulatory Commission. The specific milestones for construction and testing are as follows:

1. Repository construction begins in August 1993.

2. The updated license application (to receive and possess radioactive waste for phase 1 of the repository) is submitted in June 1995.

3. The license for phase 1 operations is received in December 1997.

4. Phase 1 operations begin in January 1998, at a receipt rate of 400 MTU per year.

5. The application for an amended license (to receive and possess radioactive waste for phase 2 of the repository) is submitted in June 1998.

6. The amended license for phase 2 operations is received in January 2001.

7. Phase 2 operations begin in February 2001 and reach the 3000-MTU/yr emplacement rate in February 2003.

The duration of the reference schedule is 53 months until initial small-scale waste emplacement and 90 months until full-scale operation.

Case 5-A

Construction delays could result from problems with labor relations; materials delivery; the excavation of shafts, passageways, and panels; acceptance testing; and readiness reviews. The DOE estimates that such problems could result in delays of up to 2 years. Case 5-A would delay initial waste emplacement by 24 months.

Case 5-B

If the DOE proceeded to construct a full-scale facility with no limited phase of operation, the repository would take about 70 months to construct. This is 17 months longer than the duration assumed for phase 1 of the repository in the reference schedule. It is, however, 20 months shorter than the duration assumed in the reference schedule for phase 2 of the repository. This case assumes construction in a salt formation; the duration would be somewhat longer in hard-rock formations. Case 5-B would delay the time until initial waste emplacement by 17 months, but would accelerate full-scale operations by 20 months.

Summary

The DOE has adopted the two-phase construction method described as the reference approach because it provides a mechanism for waste acceptance by January 31, 1998. The construction of a full-scale repository with no limited capacity in the early years (case 5-B) was not adopted in the reference schedule because it did not meet the 1998 milestone in the Act. Case 5-A was not selected because, as previously stated, the DOE believes that it is inappropriate to anticipate construction delays in the reference schedule.

3.1.7.1.6 Comments on the Reference Schedule for the First Repository

The reference schedule is aggressive but achievable, although there is a potential for schedule delays. However, the Act clearly requires a best effort by the DOE to meet the 1998 repository opening date. The DOE will work to minimize or eliminate delays, particularly for those activities that are under its control. If delays are encountered, the DOE will pursue, to the extent possible, alternative cases that allow future phases of the program to be completed in less time than that assumed in the reference schedule. The DOE will continue to examine its program plans and assumptions and will revise its reference schedule as required. The DOE will work with the Congress, States and affected Indian tribes, other Federal agencies, utilities, and the public, to identify potential problems with the reference schedule and will consider their comments as schedule revisions are developed. A significant part of this cooperation involves the development of the Project Decision Schedule. Required by the Act, the Project Decision Schedule identifies the milestones that require interaction with other Federal agencies and are needed to support program decisions. A preliminary draft of this document (DOE/RW-0018) was issued in January 1985 and is currently being revised in response to comments.

3.1.7.2 Alternative Schedules for the First Repository

The DOE considered many combinations of the schedule cases just described before selecting its reference schedule for the first repository. Two of these alternative schedules are shown in Appendix A of Volume I and are described below. These alternatives represent only a few of the many combinations of schedule cases that are possible.

Alternative Schedule 1

This schedule is the same as the reference schedule except that the site-characterization phase is reduced because site selection is based on only surface data and data from exploratory-shaft construction (case 2-A). This allows site designation for the first repository to be effective in June 1990 and leads to the start of limited repository operations in February 1997, which is 11 months earlier than the reference schedule. The DOE did not select this schedule because the selection of a repository site would not be based on any in-situ data.

Alternative Schedule 2

This schedule is the same as the reference schedule through the licensing phase. This schedule then assumes a full-scale repository (case 5-B) is constructed. Construction authorization is granted in August 1993, like the reference case, but construction takes 70 months instead of 53 months. This leads to a June 1999 start of full-scale repository operations. This alternative schedule was not selected, because it does not meet the 1998 date for the start of repository operations.

3.1.7.3 Reference Schedule for the Second Repository

The reference schedule for the second repository is shown in Figure 3-6. The major milestones for the second repository are listed below.

Milestone	Date
Issue report on region-to-area screening methodology	April 1985
Issue final regional characterization reports	July 1985
Issue final area-recommendation report	May 1986
Issue final area-characterization plan	December 1986
Begin area field investigations	December 1986
Identify potentially acceptable sites	To be determined
Complete area field investigations	January 1990
Issue final environmental assessments	September 1991
Nominate and recommend sites for characterization	October 1991
President approves recommended sites	December 1991
Issue initial site-characterization plan	January 1993
Request Congressional approval for construction	June 1993
President recommends site for repository to Congress	March 1998
Submit license application to the Nuclear Regulatory Commission	May 1998
Receive construction authorization from the Nuclear Regulatory Commission and begin construction	August 2000
Begin waste emplacement	June 2006

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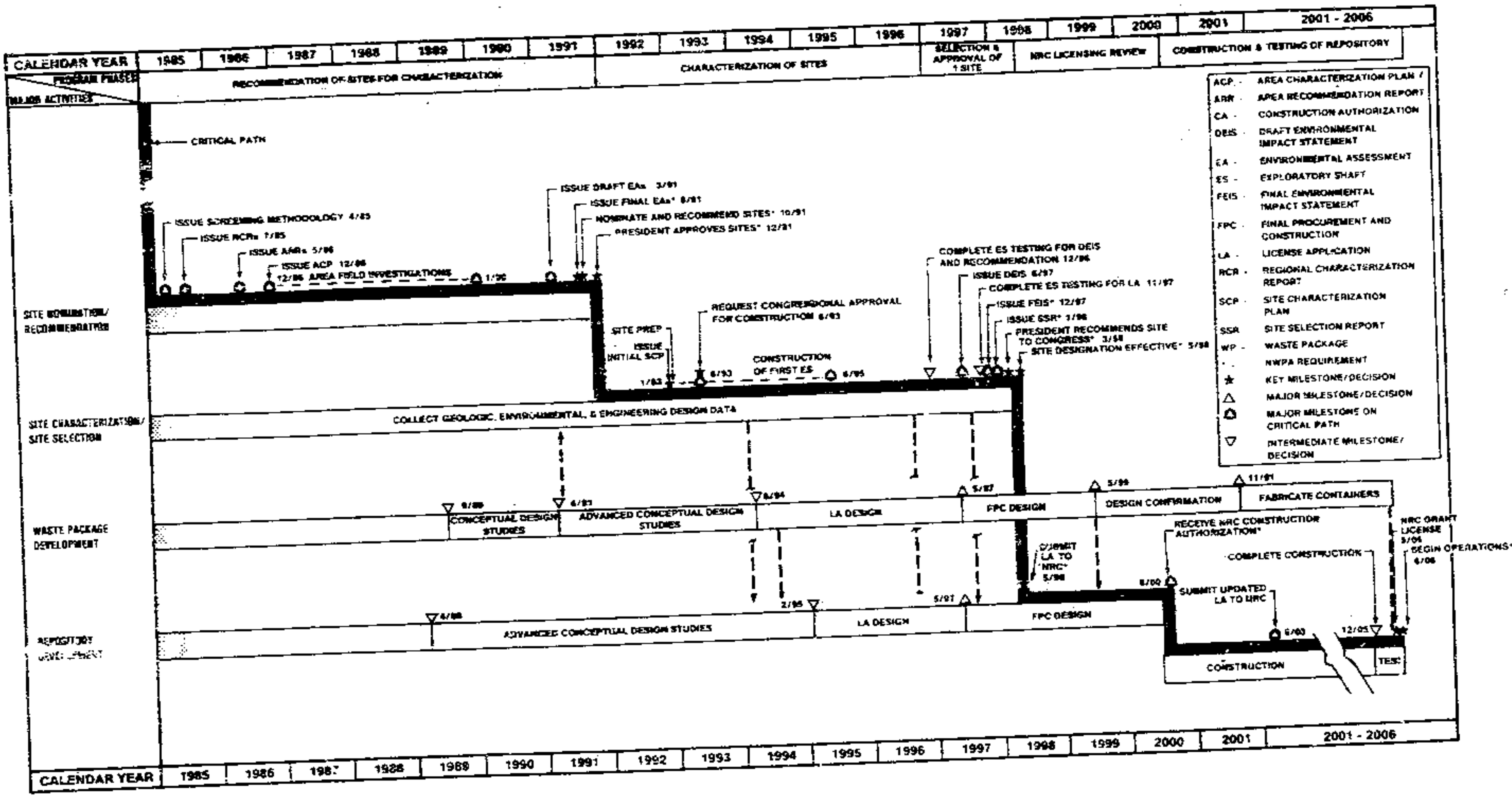

Figure 3-6. Schedule for second geologic repository.

The schedule for the second repository is not based on the phased construction approach that was assumed for the first repository. Instead, the construction of the full-scale repository facilities without any intermediate steps is assumed.

The schedule for the second repository also recognizes the fact that some of the sites not selected for the first repository are eligible for the second repository. This aspect of the second-repository program is directly dependent on the first-repository program. As shown above, sites are nominated for site characterization for the second repository in October 1991, which is after the first-repository site is recommended to Congress in March 1991. This allows the DOE to consider sites characterized, but not selected, for the first repository for nomination for the second repository. This sequencing ensures that the second-repository schedule will not converge with that of the first repository. Furthermore, information gained from the first-repository program can be applied to the second repository, which could result in a technically improved, more cost-effective program.

3.2 STORAGE OPTIONS

The Act recognized that, while the owners and operators of civilian nuclear power reactors have the primary responsibility for providing interim storage of spent nuclear fuel, the Federal Government also has its responsibility to encourage and expedite the effective use of existing storage facilities and the addition of needed new storage. In addition, the Act allows the Federal Government to provide interim storage for up to 1900 MTU of spent fuel from reactors that cannot reasonably provide adequate storage capacity.

The Act also recognized that facilities for monitored retrievable storage (MRS) can provide an option for the safe and reliable management of waste. The DOE believes that, if Congress authorizes an MRS facility as an integral part of the waste-management system, the MRS facility would significantly improve system operations and the timely implementation of system functions.

This section discusses both the integral MRS facility (Section 3.2.1) and Federal interim storage (Section 3.2.2).

3.2.1 MONITORED RETRIEVABLE STORAGE

Section 141 of the Nuclear Waste Policy Act directs the DOE to study the need for, and the feasibility of, monitored retrievable storage (MRS) for spent fuel and high-level waste. It also directs the DOE to submit to Congress a proposal that establishes a program for the siting, construction, and operation of MRS facilities. As discussed in Section 3.2.1.6, the DOE plans to submit this proposal in January 1986. Any further work on MRS facilities requires explicit authorization by Congress.

This section describes the DOE's current plans for the role of an MRS facility, the advantages of an MRS facility that is an integral part of the waste-management system, the facilities and operations of an integral MRS facility, the design basis, the approach to MRS development, and the schedule.

3.2.1.1 The Role of an MRS Facility

The DOE's in tial plans for monitored retrievable storage, as reflected in the April 1984 draft Mission Plan, consisted of an MRS facility to provide backup storage capability should there be significant elays in the availability of a geologic repository. In this case, the DOE planned to build and operate an MRS facility to store spent fuel until the repository was ready to receive it. As soon as the repository became available the spent fuel stored at reactor sites was to be shipped to the repository for packaging and disposal. When the repository had sufficiently reduced the spent-fuel backlog at the reactors, the MRS facility was to ship its spent fuel to the repository for packaging and disposal.

As discussed in Chapter 2 of Part I (see Section 2.3, "Improved-Performance Plan"), the DOE currently is evaluating an integrated waste-management system that consists of both storage and disposal components. An MRS facility is the part of the integrated system that would perform most, if not all, of the waste-preparation functions before emplacement in a repository.

The MRS facility in the integrated waste-management system does not have the same role as the MRS facility studied in the past or described in the draft Mission Plan. Its primary function is waste preparation for emplacement in a geologic repository. Its role in providing backup storage is secondary, although it could provide temporary backup storage if the startup of the repository is delayed.

3.2.1.2 Advantages of an Integral MRS Facility

The DOE's evaluation of an integral MRS facility has identified important advantages in the development and integration of the waste-management system, the operation of the system, and the provision of a cost-effective contingency capability. These advantages are briefly summarized below.

Improvements in System Performance

By being centrally located for most reactors, an MRS facility would significantly reduce the potential impacts of transportation and would improve the management and control of the transportation function. An integral MRS facility would provide a hub for the logistics of managing spent-fuel transportation, cask-fleet operations, and cask-fleet servicing. By shipping to the repository consolidated fuel, possibly in dedicated trains, the number of cross-country shipments could be significantly reduced.

Locating the waste-preparation functions (i.e., spent-fuel consolidation and packaging) in an integral MRS facility would simplify the design, construction, and operation of the repository facilities. The repository can receive a controlled stream of uncontaminated, standard packages that are ready for disposal instead of an irregular flow of truck and rail transportation casks containing contaminated spent-fuel assemblies that need to be prepared for disposal.

The integral MRS facility would increase the flexibility of the waste-management system by separating the waste-acceptance schedule from the capability for waste emplacement. The MRS facility would allow the DOE to accept spent fuel without interruption even if the repository is delayed or its emplacement operations are reduced. The MRS facility would safely store spent fuel until the repository was capable of receiving and emplacing it. Moreover, waste-acceptance activities would not be affected by temporary slowdowns or other operational problems that could be experienced at the repository. Consequently, a firm schedule for spent-fuel acceptance could be established to accommodate the DOE's contractual commitments to the utilities paying fees into the Nuclear Waste Fund. In addition, the MRS facility would improve system flexibility by having the capability to serve the second repository if determined to be appropriate.

Improvements in System Development, Deployment, and Integration

By performing the pre-waste-emplacement functions (waste acceptance, transportation, operational storage, and packaging) at an MRS facility, the development and integration of all system functions would proceed with greater certainty and focus, ensuring that the resources of the Nuclear Waste Fund are effectively used to achieve a fully functioning and integrated disposal system by 1998. The separation of the pre-waste-emplacement functions from the licensing and construction of the geologic repository would provide a clear and well-defined interface with the waste generators (utilities). In addition, the development of the repository could concentrate on demonstrating the safety of long-term isolation. Waste acceptance, transportation, and packaging issues would be separated from the geologic issues related to the long-term performance. This separation would allow early definition of system requirements--including waste-acceptance schedules, transportation routes, and cask-fleet requirements--thus providing utilities with a firm planning basis and providing private industry with the certainty it will need to develop a fully functional transportation system. The MRS facility would also be a focal point for systems-integration activities. It would provide opportunities for the early testing of key system functions and allow the experience gained to improve system operations.

Cost Effectiveness

Because the MRS facility would provide essential packaging and waste-acceptance functions, storage capability would be available at a very low incremental cost, estimated to be less than $20 per kilogram. The cost to utilities of providing dry storage once their storage pools are full is estimated to range from $50 per kilogram to $125 per kilogram. For each year that the repository is delayed beyond 1998 (or the emplacement capability is reduced an equivalent amount) utilities would have to store spent fuel equivalent to 1500 to 1900 metric tons of uranium in excess of the quantity that can be handled in fully reracked pools. The contingency capability provided by the MRS facility would provide storage more cost effectively than additional at-reactor storage.

An integral MRS facility would provide an early focus for developing and integrating the essential operational functions of waste acceptance, transportation, and packaging for disposal. By separating these short-lived operational functions from the repository-development process, which must concentrate on demonstrating that the waste can be safely isolated for thousands of years, they can be developed more quickly and with greater certainty. An integral MRS facility would therefore allow early productivity for the resources of the Nuclear Waste Fund and would provide utilities with the assurance they need to plan for orderly power-plant operations. In addition, an integral MRS facility would add operational flexibility to the total system, improve the management and control of the transportation system, and reduce the potential impacts from transportation because fewer cross-country shipments to a repository would be required (perhaps as few as two or three dedicated trains per month). These significant benefits would be achieved at a very slight increase--about 2 percent--in the costs of the Federal waste-management system. By precluding the need for substantial expenditures by the utilities to provide at-reactor storage after 1998, an integral MRS facility could reduce the total costs to the ratepayers in the long run.

3.2.1.3 Description of an Integral MRS Facility

An integral MRS facility would consist of facilities in which waste would be prepared for permanent emplacement in a repository, an area for temporarily storing the waste, and various support facilities (e.g., cask-fabrication plant, administration building, utilities). An artist's conception of an MRS facility is shown in Figure 3-7. The facility would be designed mainly for spent fuel from commercial power reactors, but it could also accommodate the limited amount of vitrified high-level waste from the facilities in West Valley, New York.

3.2.1.3.1 Waste Preparation for Permanent Disposal

The preparation of waste for permanent disposal in a geologic repository would consist of fuel-rod consolidation and packaging for permanent emplacement in a repository. These operations are briefly described below.

After arriving by truck or rail in heavily shielded transportation casks, the waste would be unloaded into the receiving-and-handling (R&H) building, the main operating area of the MRS facility. Here the waste would be prepared for shipment to a repository or for temporary storage at the MRS facility.

The waste-handling operations in the receiving-and-handling building would be performed by remote control inside "hot cells" to protect the workers from direct contact with, or exposure to, the highly radioactive materials. Hot cells are compartments enclosed with thick concrete walls and equipped with remote-manipulation devices that are operated by remote control by workers stationed outside the hot cells. They are also equipped with highly efficient filter systems that would collect and capture any airborne radioactive particles that may be released during the various waste-handling operations. The receiving-and-handling building would be designed to confine the radioactive materials within the facility, keeping radiation exposure to the workers and to the public well below applicable safety limits.

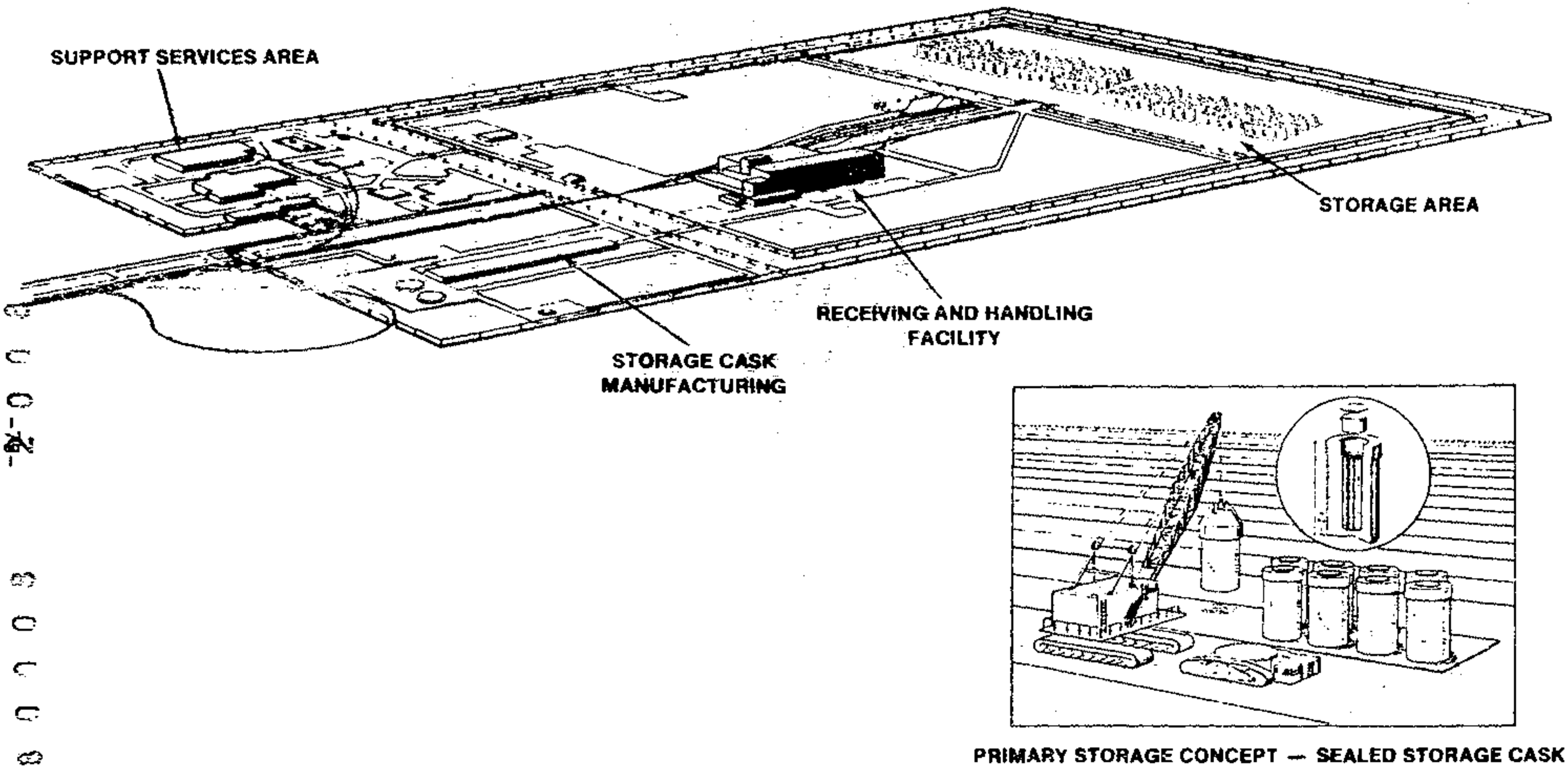

Figure 3-7. Monitored retrievable storage facility.

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Consolidation of Spent-Fuel Rods

One of the operations that would be performed in the receiving-and-handling building is the consolidation of spent-fuel rods. Consolidation is desirable because it would decrease the number of waste packages, thus increasing the efficiency of waste transportation to a repository, handling at the repository, and permanent emplacement. In consolidation, the spent-fuel assemblies (see Figure 1-2) are first disassembled by removing the upper and lower tie plates, the spacer grids that separate the fuel rods, and any other structural members. The fuel rods are then formed into a closely packed bundle for insertion into a canister. The non-fuel-bearing scrap of the fuel assemblies would be compacted and loaded into containers for shipment to a repository if such disposal is deemed necessary.

A small portion of the spent-fuel assemblies will contain fuel rods with cladding defects that could complicate and lead to further cladding damage during the consolidation operation. The defective assemblies would therefore not be consolidated; they would be loaded directly into canisters.

Packaging

In preparation for temporary storage or shipment to a repository, the spent-fuel rods would be loaded into steel canisters. After loading, the canisters would be purged of air, filled with gas (probably argon with a helium tracer) and welded closed. The canisters would be tested for leaks and inspected for weld quality. If necessary, the exterior surfaces would be cleaned to remove any contamination with radioactive material. At this point, the canisters would be ready for any needed storage at the MRS facility. The canisters are expected to range from 12 to 30 inches in outside diameter and from 12 to 16 feet in height.

For shipment to a repository, the canisters may be loaded into steel disposal containers. Similar steel disposal containers could be used to overpack canisters of vitrified high-level waste.

3.2.1.3.2 Storage

Sealed storage casks have been selected as the preferred method for any necessary temporary storage of the canistered waste at an integral MRS facility, with field drywells selected as the alternative storage technology. Both methods have been safely used in similar applications for a number of years; both are low in cost, and both are simple as well as flexible in design. Furthermore, in both methods storage capacity can be expanded in small increments, in response to actual requirements. However, if the MRS facility is authorized, the specific storage method that will be used may be adapted to evolving systems requirements and technology developments.

Both methods are designed to facilitate monitoring of the atmosphere within the storage cavity and of the temperatures of the cavity wall during the storage period. Gas samples would be periodically collected from the storage cavities and tested for any leakage of gases from the sealed waste canisters. If a leak is detected, the storage unit would be returned to the receiving-and-handling building and the canister retrieved for testing and corrective action. The temperature of the storage-cavity wall would be monitored to ensure that the temperature of the waste does not exceed design limitations.

The MRS facility would also be able to accommodate large metal casks, which may be used by some utilities for at-reactor dry storage of spent fuel. The storage units could be enclosed or modified to accommodate local environmental conditions or other concerns.

Sealed Storage Casks

A sealed storage cask is a large steel-lined reinforced-concrete cylinder that holds welded stainless-steel canisters of spent fuel and is closed with a thick concrete shield plug and a welded steel lid. Depending on the type of waste being stored, the casks may range from 17 to 22 feet in height, measure 12 feet in outside diameter, and weigh up to 220 tons when loaded. A cutaway view of a sealed storage cask containing canisters of spent fuel is shown in Figure 3-8, illustrating the top shield plug and the welded steel lid.

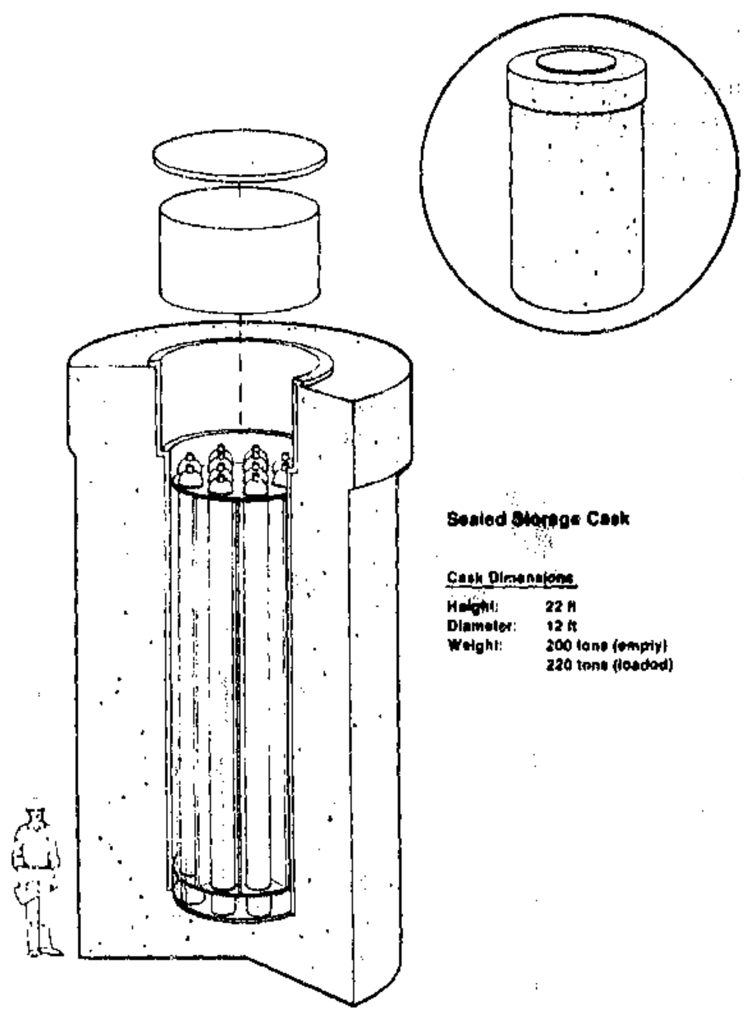

Figure 3-8. Sealed storage cask.

Canisters or other containers of waste would be loaded into the casks inside the receiving-and-handling building, and the cask would be moved to the storage area and placed upright on a concrete pad. The heat emitted by the waste would be conducted through the walls of the cask to the surrounding atmosphere. Temperatures within the cask would be maintained below levels that could result in damage to either the cask or the sealed canisters stored inside it. The thick walls of the cask would keep the radiation levels at the cask surfaces within safe limits.

Each storage module would be capable of being routinely monitored to detect any loss of canister integrity. In addition, the environment of the storage area would be continuously monitored to detect any failures in the containment of the radioactive waste materials.

<u>Field Drywell</u>

The field drywell is an in-ground sealed metal enclosure for storing canisters of waste. The drywells can be bored to different sizes as required to accept different sizes of canisters. The drywell enclosures would extend no more than 21 feet into the ground. The essential features of the field-drywell concept are shown in Figure 3-9.

Waste canisters would be loaded into a shielded transporter vehicle while inside the receiving-and-handling building. The transporter would carry the canister to the drywell, lower the canister into the drywell, and cover the well with the top shield plug.

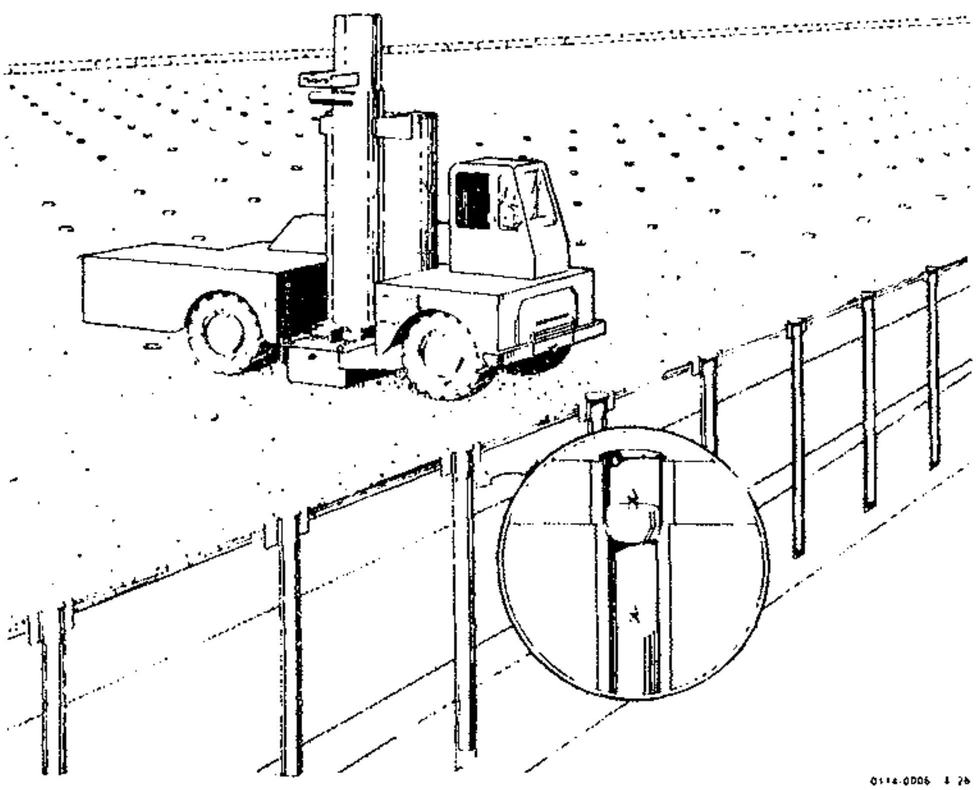

Figure 3-9. Alternative storage concept for monitored retrievable storage—field drywell.

The drywell closure plate would then be welded onto the liner of the cavity. The drywell's metal cavity and the surrounding soil would provide both a radiation shield and a medium for conducting heat away from the stored materials. Drywell storage of radioactive materials has been safely used in many parts of the world for the last 20 years.

Like the sealed storage cask, each drywell can be routinely monitored to detect any leakage from the stored containers. The environment of the storage area would also be monitored continuously.

Transportable Metal Casks

Large metal casks are currently being considered by a number of utilities for the dry storage of spent fuel at reactor sites. Since those utilities may one day wish to ship such casks to an MRS facility, the facility is designed to receive these casks and package their contents, as received. If necessary, these casks could be stored. The current design for storing these casks is illustrated in Figure 3-10, which shows the concrete "saddles" that would support the cask in a horizontal position.

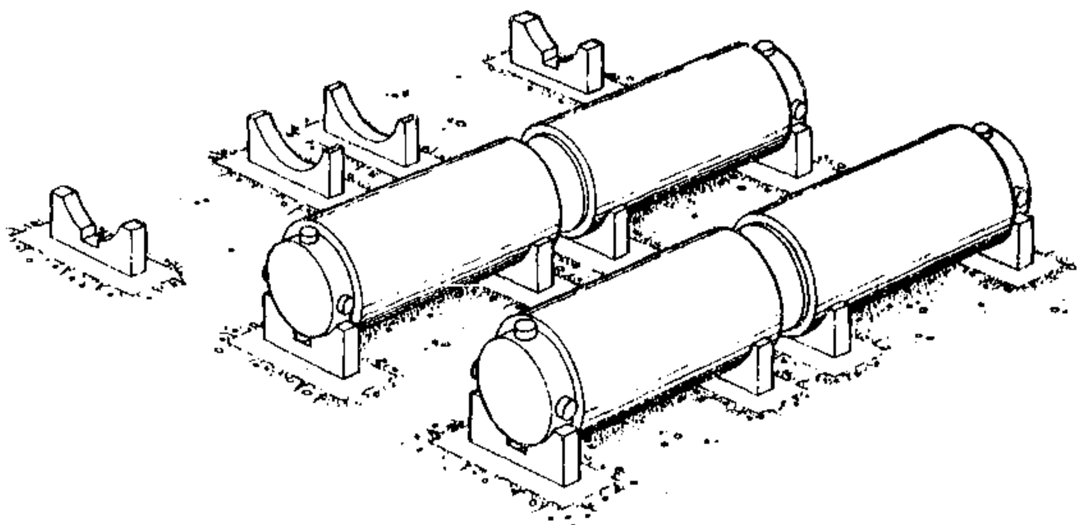

Figure 3-10. Transportable metal casks.

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3.2.1.3.3 Safety Features

A wide range of safety features would be incorporated into the design of the MRS facility to protect the health and safety of the facility workers and the general public. In addition to the standard fire and industrial safety regulations, the facility would operate under the radiation-protection standards established by the U.S. Environmental Protection Agency and the Nuclear Regulatory Commission. A safety analysis report (SAR) would be prepared and submitted with the application for an NRC license. During the construction and preoperational testing phases, an updated SAR would be sent to the NRC as required. Once normal operations begin, the SAR would be updated annually.

The principal MRS design features and characteristics that would keep radiation exposures within permissible limits are described briefly below.

- The spent fuel is in the form of solid oxide pellets in Zircaloy (a zirconium-steel alloy) tubes.

- The spent-fuel tubes are hermetically sealed within the stainless-steel storage canisters.

- Any high-level waste would be in a solid glasslike form, resistant to leaching by moisture, and sealed inside stainless-steel canisters.

- Radiation shielding would be used throughout the facility as appropriate to keep occupational exposures within prescribed limits and as low as reasonably achievable.

- The heating and ventilation system would employ high-efficiency filtration and other equipment to collect and remove essentially all of the particulate radioactive material from the air streams, allowing those materials to be collected, treated, and disposed of safely. Emissions from the MRS facility would be restricted to levels within Federal standards.

- In cask storage, the thick concrete walls of the cask would keep the external radiation levels in the storage area within permissible limits.

- In drywell storage, the top shield plug and cover plate, the steel liner of the cavity, and the surrounding soil would provide sufficient shielding to keep the radiation levels in the storage area within permissible limits.

- Monitoring of the atmosphere within the storage-unit cavities would detect any leaks in the storage canisters, allowing prompt corrective action without any leakage to the environment.

- Monitoring of the facility environment would ensure that any significant releases of radioactive material, either from the receiving-and-handling building or from the storage area, are promptly detected and corrected.

3.2.1.4 Basis for the Design of the MRS Facility

If authorized by Congress, the MRS facility must be able to perform its design functions in a manner that is safe and environmentally acceptable. The construction and operation of the facility must be licensed by the Nuclear Regulatory Commission. To effectively perform its functions within the integrated waste-management system, the MRS facility must have sufficient flexibility in design to accommodate evolving systems needs.

According to the current designs being developed for the proposal to Congress, the integral MRS facility would be able to accept waste at a rate of up to 3600 MTU per year. This waste-acceptance rate could preclude the addition of new at-reactor storage capacity and would allow the orderly removal of aged fuel from reactor sites. It also could accommodate the growth of the reactor population forecasted by the Energy Information Administration in its middle-growth case. The facility would have sufficient capacity to prepare and ship waste to the first repository--and to the second repository if deemed appropriate. The design would provide capability to simultaneously accept spent fuel, package the fuel for direct shipment to the repository or storage at the MRS facility, retrieve fuel from storage and ship to the repository. The MRS facility would be designed to simultaneously accept and unload current-generation truck or rail shipping casks; disassemble and consolidate spent fuel of nearly all designs; and load into canisters spent fuel of all current designs. To prepare waste packages for the repository, the facility would include space in the receiving-and-handling building to overpack the canistered materials if ongoing systems studies confirm this operation to be appropriate at the MRS facility.

The receiving and handling building would include space to provide operational vault storage for approximately 1000 MTU. Such storage would accommodate the expected short-term variations between the repository emplacement capability and spent-fuel transfers from the utilities to the DOE.

The storage method must provide shielding, waste containment, safeguards, and monitoring. A modular storage system is desirable to accommodate capacity uncertainties in a cost-effective manner. Passive, dry storage is preferred for extended storage applications because it does not require any mechanical assistance, such as blowers or pumps, or external power to provide cooling, containment, or radiation shielding. The MRS storage concept will rely on engineered features for safety rather than geologic or physical features that would restrict siting options.

Current estimates indicate that an integral MRS facility would require a storage capacity of approximately 15,000 MTU. A 15,000-MTU facility would provide enough storage to accommodate projected variations in waste-generation rates, waste-acceptance schedules, and repository emplacement capability; it would also provide the utilities with a firm basis for planning. If there are reductions in the waste-generation rate or improvements in the expected repository emplacement capabilities, the required storage capacity at the MRS facility could be reduced.

3.2.1.5 Approach to MRS Development

This section briefly describes the steps being taken to develop the mandated proposal to Congress for the construction of an MRS facility and the schedule for putting such a facility into operation should Congress authorize its construction.

The DOE intends to submit in January 1986 a proposal to Congress requesting authorization for an MRS facility. To provide a technical basis for the Congressional decision, the following documents will be included in or will accompany the proposal to Congress:

- Site-specific facility designs.
- Need and feasibility report.
- Program plan (funding, integration, deployment).
- Environmental assessment.

To establish a sound basis for decisions about an MRS facility, the DOE has undertaken the following activities:

- An assessment of research and development needs.
- The selection of storage concepts for MRS facilities.
- The design of MRS facilities.
- The identification of candidate sites.
- An assessment of environmental impacts.
- Interactions with the candidate host State and the public.

These activities are briefly described below.

Assessment of Research and Development Needs

No additional research and development is required for the completion and submittal of the proposal to Congress. This finding has been reported to Congress in a report issued by the DOE in June 1983 (DOE/S-0021). This report was prepared in accordance with the Act, which requires the DOE to prepare a report describing the research and development required for a proposal to construct an MRS facility.

Selection of Storage Concepts for MRS Facilities

The Act specifically directs the DOE to include in its proposal to Congress "at least three alternative sites and at least five alternative combinations of such proposed sites and facility designs." In response to this requirement, the DOE has decided to select two alternative concepts for the storage function of the MRS facility: (1) sealed storage casks and (2) field drywells.

The selection of these concepts resulted from a comprehensive evaluation of eight storage concepts. The technical feasibility of both concepts is supported by prior demonstrations and use. Designs for both sealed storage casks and field drywells at three potential sites will accompany the proposal to Congress.

The concept-selection process is described in a report entitled Selection of Concepts for Monitored Retrievable Storage in Spent Fuel and High Level Radioactive Waste (U.S. Department of Energy, Richland Operations Office, April 1984).

This selection has been subjected to reevaluation, particularly in light of the change in the MRS role from a backup facility to an integral component of the waste-management system. The integral MRS design incorporates an additional operational storage capacity in the receiving and handling building to facilitate the flow of materials to the repository. The results of the reevaluation supported the initial selection of the sealed storage cask and field drywell as the technically suitable storage concepts for the development of the MRS proposal.

Design of Facilities

Concurrently with the selection of storage concepts, functional design criteria for the MRS facility were developed to guide the design effort. These functional design criteria include the applicable Federal standards; definitions of facility scope and purpose; requirements for accommodating transportation casks; design requirements for protecting the facility from storms, earthquakes, floods, and other natural phenomena; design requirements for the receiving-and-handling building; heat loads; throughputs; requirements for mechanical and electrical systems; performance requirements for the storage facility; requirements for support facilities; and requirements for site improvements and utilities.

Since three alternative sites have been identified, an architect-engineer is now preparing the required site-specific MRS facility designs with associated specifications, cost estimates, and engineering and construction schedules.

Facility designs and supporting data are being developed in compliance with the quality-assurance requirements for licensed nuclear facilities.

Identification of Candidate Sites

In the integrated waste-management system, the MRS facility must be in operation by January 1998 to accept and prepare waste for the repository. Because of this need to proceed expeditiously, the DOE has reconsidered the reference site-facility development plan discussed in the draft Mission Plan and concluded that specific candidate sites should be included in the proposal to Congress. The following three sites have been identified as candidate sites for the proposal to Congress: the former site of the Clinch River Breeder Reactor as the preferred site and the DOE Oak Ridge Reservation and the site of the Tennessee Valley Authority's Hartsville nuclear plant as the alternatives. All three sites are in Tennessee.

Because the MRS designs being pursued by the DOE rely on engineered rather than geologic barriers to ensure safe containment of radioactive waste, technically suitable sites should be available throughout the country. The candidate sites for these designs were therefore selected to enhance the overall operation of the waste-management system. Thus, the identification of candidate sites has been based on two siting considerations:

1. Ability to construct and operate an MRS facility in a safe, cost-effective, and timely fashion without unacceptable effects on the existing environment or socioeconomic conditions.

2. Ability to enhance the contribution of an integral MRS facility to the waste-management system.

With regard to the second consideration, the MRS facility should be so located that the total distance for the transportation of spent fuel from the reactors to the MRS facility and from the MRS facility to the repository is limited. The site-selection process for this "shortest distance" consideration involved identifying the region where the total shipment mileage from the reactors to the MRS facility and from the MRS facility to the repository is reduced to within 20 percent of the lowest mileage achievable.

It is assumed that truck and rail transport will be used from the reactors to the MRS facility and dedicated rail transport will be used from the MRS facility to the repository. This analysis results in the identification of a preferred region that reduces shipment distances, thus limiting impacts relative to all other potential MRS locations outside that region.

A reasonable method to satisfy the first siting consideration mentioned above is to evaluate those sites within the optimal region that were previously planned and "qualified" for nuclear activities (i e., sites within the preferred region owned by the DOE or previously docketed by the Nuclear Regulatory Commission). Existing environmental documentation and data for these sites are of high quality and relevant to the construction of a facility for spent-fuel storage. Furthermore, the use of preexisting documentation (augmented as necessary) will save money and time in the preparation of the proposal, the accompanying environmental documents, and safety analysis reports, as well as NRC findings regarding site characteristics. Eleven potential candidate sites in the preferred region met the above consideration and had ample acreage (1100 acres) for the potential MRS application.

The potential candidate sites were evaluated with regard to licensability, land availability, transportation characteristics, infrastructure, environmental characteristics, socioeconomic impacts, institutional structure, cost, and schedule. The characteristics of each candidate site were described to evaluate whether that site can meet the factors necessary for a 10 CFR Part 72* license from the Nuclear Regulatory Commission. To evaluate land availability, all known plans for the site under consideration were described to determine the current and planned land uses for the site and adjacent property. An assessment of transportation characteristics evaluated the ease and safety of access to inter-state highway networks and Class A rail lines. Known plans for transportation infrastructure improvements, or advisable improvements, were also described. Descriptions of the sewer system, utilities, housing, etc., were used to evaluate the sufficiency of the local infrastructure to handle an MRS facility and to determine where improvements may be necessary. Environmental characteristics were evaluated using baseline information to describe the local ecological structure and to determine potential impacts, including any known impacts the meteorological, geologic, or geographic conditions of the site could have on the safety of the facility.

The capacity of local economies and governments to accommodate the socioeconomic impacts of an MRS facility were evaluated, and the potential requirements for impact assistance will be assessed. Local government structure and the jurisdictional responsibilities for environmental, construction, and operating permits were described, and the impact on the MRS facility was evaluated. Finally, site characteristics that affect the cost of construction or affect the construction and permitting schedules were described and their impacts considered.

The Act includes a provision that MRS facilities developed pursuant to Section 141 may not be constructed in a State with a candidate site approved for repository-site characterization. This restriction was respected.

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*10 CFR Part 72, "Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation."

The DOE reviewed this evaluation and identified the three candidate sites most suited for consideration in the proposal by the Secretary to Congress. A report has been prepared to document the identification of the three candidate sites (Screening and Identification of Sites for a Proposed Monitored Retrievable Storage Facility, RW-0023, April 1985). Appropriate government entities were notified, and a public announcement identifying the candidate sites was made.

The site descriptions and evaluation are being prepared for inclusion in the proposal to Congress.

Assessment of Environmental Effects

The Act requires that an environmental assessment (EA) based on available information accompany the MRS proposal to Congress. This EA will include an analysis of the relative advantages and disadvantages of all proposed alternative combinations of sites and facility designs and will be based on available information regarding alternative technologies for the storage of spent fuel and high-level waste. Appropriate design-related data are being developed by an architect-engineer. Site-related data will be gathered from existing sources (e.g., previous environmental reports and impact statements; NRC findings and evaluations; and Federal, State, and local records). The EA will be published and released for information purposes several weeks before the proposal is submitted to Congress.

If Congress authorizes an MRS facility, a draft and final environmental impact statement (EIS) will be prepared. In accordance with the Act, these environmental documents will not consider the need for the facility but will comply with all other requirements of the National Environmental Policy Act, including the provision of opportunities for public participation.

Interactions with States, Affected Indian Tribes, and the Public

The Act (Section 141(h)) provides that any authorized MRS facility will be subject to the provisions of Sections 115; 116(a), (b), and (d); 117; and 118. Section 115 provides the specific mechanisms for Congress to override a "notice of disapproval." Sections 116 and 118 require the DOE to notify States and affected Indian tribes if they have potentially acceptable sites and provide for the submittal of a "notice of disapproval" by a State governor or legislature. Specific guidance for consultation and cooperation is provided in Section 117.

The preparation and release of information concerning the need for an MRS facility and the impacts associated with the facility are critical to the development of public understanding during the Congressional decision process. The DOE recognizes its responsibility to provide complete and timely information to meet these needs and proposes to approach this responsibility in several ways. Briefing materials on policy and special issues will be prepared for public distribution. Information briefings for the candidate host State (Tennessee) and local governments will be held to help their representatives and constituencies to have sufficient understanding for independent judgments on the acceptability of an MRS facility in their State. The DOE will consult with the State and local governments to define the briefing agendas that will meet their information needs. For example, it is expected that an MRS candidate State will have different information needs than other interested States. Briefings emphasizing different subject areas may be advisable and will be conducted if needed.

The participation of the government of the candidate host State is particularly important to an efficient and effective MRS program. The DOE feels that the use of a grant for this purpose is appropriate. A grant will be awarded to Tennessee specifically to facilitate its participation in preproposal interactions. Funding for this grant will be drawn from the Nuclear Waste Fund.

For a repository, Sections 116(b) and 118(a) of the Act provide that a State or affected Indian tribe will have an opportunity to file a notice of disapproval within 60 days of the presidential recommendation of a repository site to Congress. Although there is no equivalent provision for an MRS site, Section 141(h) provides that the opportunity for submitting a notice of disapproval is to be available after Congressional authorization, inasmuch as Section 141(h) applies to an authorized facility. Furthermore, the DOE believes that as a result of the public involvement process described above, the candidate host State (Tennessee) will have full opportunity to make its views about the MRS facility known during the Congressional deliberations on the DOE proposal. The DOE expects this issue to be addressed during authorization actions by Congress. In addition, the DOE will include in its proposal to Congress the views of the State of Tennessee insofar as they are made known.

Additional Information

In addition to the facility designs and the EA, Section 141 of the Act requires that the proposal include additional information. First, a "program for the siting, construction, and operation of such facilities" should be included. Second, a "plan for the funding of the construction and operation of such facilities" should be included. This plan will "provide that the costs of such activities shall be borne by the generators and owners of the high-level radioactive waste and spent nuclear fuel to be stored in such facilities." Third, a "plan for integrating facilities constructed pursuant to this section with other storage and disposal facilities authorized in this Act" should be included. These plans will be part of the MRS program plan in the proposal.

The funding plan will show expenditure requirements for the program and the recommended revenue source or sources. The funding requirements will be based on the other plans, the facility designs, the operational-cost estimates prepared by the architect-engineer, and analyses of operational costs for the integral MRS facility.

The integration plan will depend on the results of the need-and-feasibility study. It will provide detailed plans as to how and when an MRS facility is to be incorporated into the overall waste-management system. These plans are being developed in parallel with the facility designs and in cooperation with the repository and transportation planning efforts. In addition, safety assessments and a plan for licensing the MRS facility will be prepared.

As previously indicated, all of the above activities will contribute to, and be the basis for, the proposal to be submitted to Congress. Liaison with the Nuclear Regulatory Commission and the Environmental Protection Agency will be maintained throughout the development of the proposal documents. The formal comments from these agencies are to accompany the proposal when it is submitted to Congress.

Cost

An MRS facility would have an estimated capital cost of approximately $800 million to $1.2 billion, depending on the storage capacity. Annual operating costs have been estimated to be $30 to $40 million.

3.2.1.6 Schedule

The estimated time to deploy an integral MRS facility is 8 to 11 years after Congressional authorization. The currently estimated schedule for an MRS facility, if authorized, would allow the DOE to start operations by the end of fiscal year 1996. Implementation of MRS according to this schedule will provide assurance that the DOE's acceptance of spent fuel in 1998 and subsequent years will be at sufficient rates to meet obligations. Table 3-3 shows the currently projected timing of major milestones in the development of an MRS facility.

Table 3-3. Major Milestonee After Congressional Authorization To Deploy an MRS Facility[a]

Milestone	Date
Consultation-and-cooperation agreements completed	Early 1987
License application submitted to the NRC	Early 1989
Design verification and definitive design completed	Early 1990
License issued by the NRC	Summer 1991
Construction begun	Summer 1991
Testing of "hot" systems completed	Early 1996
Pilot-scale operation begun	Early 1996
Production operation begun	Fall 1996

[a]Assuming that Congressional authorization is received by the fall of 1986.

The estimated schedule is based on the use of sealed concrete casks for storage, with the submittal of a site-specific proposal to Congress in January 1986. The timing of the Congressional decision with regard to an MRS facility establishes the remainder of the schedule.

If Congress approves the construction of the MRS facility, a notice of intent to prepare an environmental impact statement (EIS) will be issued. The DOE will consult with the State of Tennessee in accordance with the MRS siting plan, to ensure that its needs and concerns are considered. Public comments on the draft EIS will be addressed during the preparation of the final EIS.

The definitive design of the facility would begin after the Congressional decision and would be completed 36 months later. When the design of safety-related facilities and equipment is completed, a safety analysis report would be prepared. At that time a license application would be submitted to the Nuclear Regulatory Commission. During the NRC review of the license application, the DOE would respond to NRC questions and, as required, provide any additional explanation and technical analysis necessary to support the position taken in the license application.

The issuance of the NRC license is projected to occur by mid 1991. Construction would start immediately on notification of granting of the license and is scheduled for completion at the end of fiscal year 1995. Design-verification activities supporting operational capability validation would continue throughout construction. These activities would include extensive testing of operating conditions. This testing would validate operator training and operational procedures before the completion of construction and would allow early operation at full capacity. After the completion of construction, a 3-month period of systems testing involving all MRS facility operations would commence, concluding by 1996. Pilot-scale operations involving all components of the waste-management system up to shipment to the repository would then commence, and the facility would start operating at production levels 9 months later, by the fall of 1996. Waste retrieval from temporary storage for shipment to the first repository would start in January 1998, at a rate compatible with the repository receipt rate.

This schedule is believed to be sufficiently flexible to accommodate some delays. Appreciable delays in critical events would delay the facility.

Detailed plans and schedules for the implementation of an integral MRS facility, including operation and decontamination, will be part of the proposal to Congress.

3.2.2 INTERIM STORAGE

Although the Act requires the Federal Government to ultimately provide a permanent repository for spent fuel and high-level waste, approximately 16 years will have elapsed between the passage of the Act and the availability of alternative storage or disposal options. With existing storage technology, spent-fuel inventories at nearly half of the U.S. commercial nuclear power plants will exceed the projected capabilities for onsite spent-fuel storage by 1998, with some reaching their storage limit in the mid-1980s. The Act addresses this problem by providing for research to expand existing onsite storage and by providing the Federal interim storage (FIS) needed before utilities can implement programs for expanding onsite storage.

Specifically, the Act provides that--

1. Reactor operators have the primary responsibility for the storage of their fuel and the effective use of the storage that exists or may be added.

2. The Federal Government has the responsibility to encourage and expedite the efficient use and expansion of onsite storage.

3. If these efforts prove insufficient and the Nuclear Regulatory Commission finds that the lack of spent-fuel storage is a threat to continued orderly reactor operation and that the owner cannot reasonably provide storage through the use of high-density storage for spent-fuel rods, rod compaction, transshipment to another facility owned by the same owner, the construction of additional storage capacity, or other technology approved by the Commission, then the Federal Government must provide not more than 1900 metric tons of interim storage capacity for spent fuel.

3.2.2.1 Background and Status

The DOE has published a report annually over the last several years analyzing in detail the current spent-fuel-storage situation in the United States. The most recent report, Spent Fuel Storage Requirements (DOE/RL 84-1, August 1984) describes in detail projected spent-fuel discharges over the next two decades, current reactor storage capacities, and the potential for increasing these capacities through existing, licensable technologies--namely, by reracking pools to the maximum extent practicable and through transshipments. A recent analysis shows that the storage needs of some utilities could exceed their capacities as early as 1986. The August 1984 report shows that, even if all utilities are able to rerack and transship to the maximum extent practicable, there will be storage problems from 1986 on unless new technologies that are not currently fully developed, licensed, or demonstrated in the United States are made available for utility use.

Some utilities, faced with increasing amounts of spent fuel to be stored, have developed and obtained licenses for various methods of extending their onsite-storage capabilities. These include the reracking of spent-fuel storage pools to obtain greater storage densities and transshipping excess spent fuel to the sites of newer reactors within their systems where unused storage capacity exists. However, these methods are not available to all utilities or are insufficient to provide all the capacity needed. Reracking is ultimately limited by the dimensions of the spent-fuel pools and may also be limited by seismic and structural constraints. Transshipment is available as an option only to some utilities and is further limited in many of those cases by institutional considerations.

Despite efforts to resolve their storage problems, nine nuclear power **plants owned** by five utilities are projected to require additional storage **capacity** for up to 270 metric tons of spent fuel within the next 5 years. **Further** increases in requirements for additional storage are projected for the **years that** follow. From information supplied by nuclear utilities, projec-**tions of the** additional storage requirements for spent fuel that has been, and **will be**, discharged from commercial reactors are shown in Figure 3-11. For **comparison**, the figure also shows the projected total spent-fuel inventories **for the same** period.

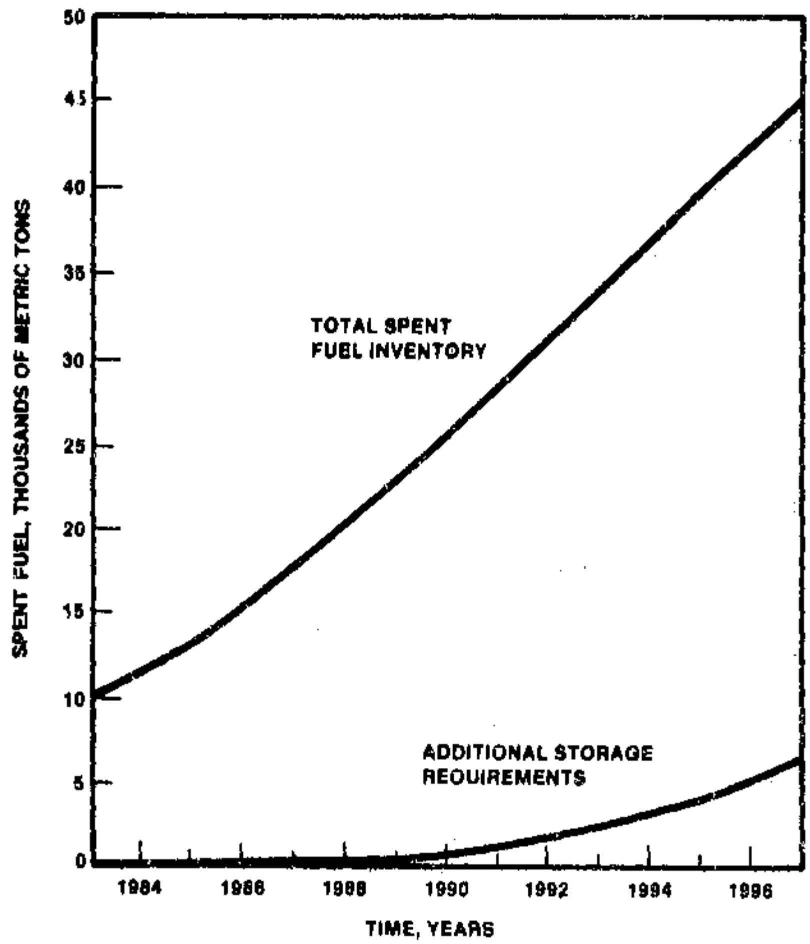

Figure 3-11. Projections for additional spent-fuel-storage requirements and for total spent-fuel inventories.

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To prevent potential forced shutdowns of nuclear power plants, the util-**ities must** have additional licensed options available for increasing their **spent-fuel**-storage capabilities.

Fulfillment of the Act's requirements, particularly the DOE's respon-**sibility** to encourage and expedite efficient use of onsite storage capacity, involves a series of Federal actions in cooperation with the utilities. First is the identification of technologies that utilities consider promising for solving their storage problems in a timely fashion. Cooperative efforts are then required to define and understand impediments to the licensing and implementation of these technologies. The final resolution of issues and the accumulation of data required for NRC licensing will be accomplished through cooperative demonstrations at both reactor and Federal sites and through federally sponsored generic research.

In the event that these impediments cannot be overcome soon enough, the DOE must be in a position to accept up to 1900 metric tons of spent fuel from those utilities that are in dire need despite their diligent pursuit of licensed alternatives to increase at-reactor storage capacity. The major conclusion here is that, if the impediments alluded to above can be resolved soon enough, there should be no demand for Federal storage. The DOE is therefore reluctant to expend funds to deploy Federal capacity before a clear indication of need because the Act requires that these expenditures be fully recovered by fees charged to customers and there may, in fact, be no customers. Yet, if demand arises, it will likely be on short notice, and the DOE is required to accept fuel once a utility has been certified eligible by the Nuclear Regulatory Commission and has entered into a contract with the DOE and the DOE has completed the design, licensing (if applicable), and construction of a facility for Federal interim storage within a 2.5-year period.

Federal responsibilities are being discharged through the support of generic research and development activities and participation in cooperative programs with the utilities to develop and demonstrate licensable techniques for increasing the effective capacity at reactors. In addition, the planning for the provision of Federal interim storage, if needed, is continually being evaluated.

3.2.2.2 Mission and Objectives of the Spent-Fuel Storage Program

The objectives of the DOE's program efforts in this area are to use all means directed or available through the Act or other authority to encourage and expedite the most efficient use of existing storage facilities and the addition of new capacity in a timely fashion. The primary means for accomplishing this under the Act are as follows:

1. Participating in cooperative demonstration programs with the private sector to develop dry-storage technologies that the Nuclear Regulatory Commission can generically approve (Section 218(a)).

2. Assisting the operators of commercial reactors with the demonstration of spent-fuel storage casks, caissons, or silos at their sites (Section 218(a)).

3. Providing consultative and technical assistance on a cost-shared basis for the design and documentation for NRC licensing (Section 218(b)(2)).

4. Performing generic research and development to supplement utility-sponsored work (Section 218(b)).

5. Establishing cost-shared research and development programs at Federal facilities for not more than 300 metric tons of spent fuel to collect necessary licensing data (Section 218(c)(1)).

6. Participating in cooperative programs with the private sector to encourage the development of spent-fuel-rod consolidation in an existing reactor storage pool (Section 218(a)).

3.2.2.3 Strategy and Approach

The technical approach of the spent-fuel-storage program is based on a strategy that depends on pursuing cooperative activities in which the private sector has expressed a high degree of interest. This ensures that the storage concepts developed will be those that most appropriately address the needs of the utilities. The generic research-and-development activities are designed to support the technology-development and licensing activities by minimizing technical risks and potential licensing delays for the technologies chosen as having the most potential for enhancing and expanding the at-reactor storage capacity.

A logic diagram for this approach is shown in Figure 3-12.

As shown in Figure 3-12, the adequacy of the technology data base for satisfying onsite-storage requirements depends on the successful implementation of the following several major activities:

1. Cooperative DOE/utility programs for licensed and unlicensed demonstrations.

2. Generic research and development to support those demonstrations.

3. International cooperation in the exchange and dissemination of technologies and data.

Each of these major activities will primarily contribute to the adequacy of the technology data base required to expand onsite-storage capacity. If this technology is inadequate and transshipment is available, then onsite-storage requirements will also be satisfied. If neither of the above is available and the Nuclear Regulatory Commission certifies a requirement for Federal interim storage in accordance with 10 CFR Parts 1 and 53, "Criteria and Procedures for Determining the Adequacy of Available Spent Nuclear Fuel Storage Capacity," then the plan for providing Federal interim storage will be activated.

Therefore, the primary focus of the program is to provide the technical information required by the utilities to allow them to license and deploy technologies to solve their own interim spent-fuel-storage problems. This information is developed by carrying out tests and demonstrations of spent-fuel-storage technologies in cooperation with the utilities, supplemented as needed with generic research-and-development activities to provide the requisite technical bases. In addition, pertinent information obtained from external sources--such as the Federal Republic of Germany, other foreign countries, and other DOE programs--is incorporated to minimize, insofar as possible, the resource requirements for providing this assistance to the utilities.

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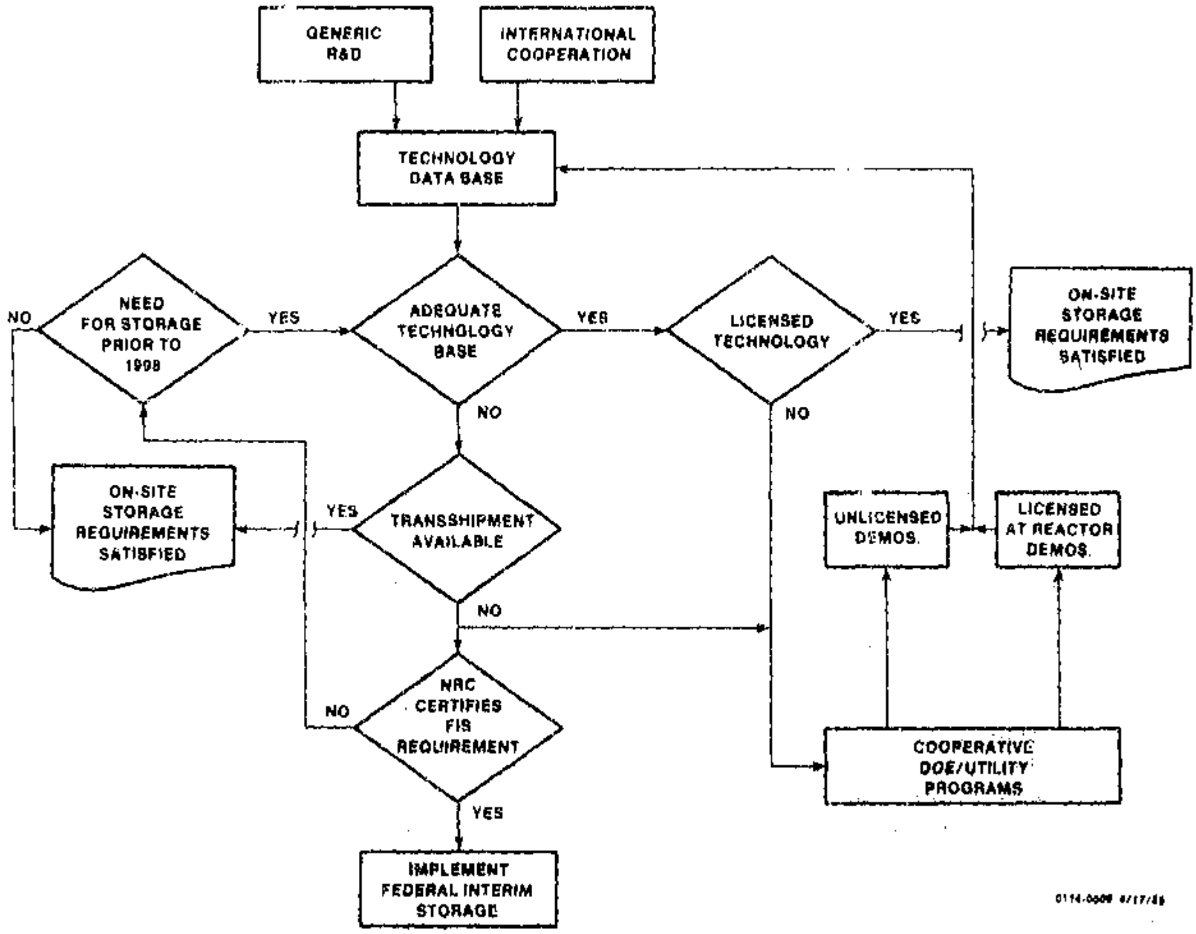


Figure 3-12. Logic for the spent-fuel-storage development program.

3.2.2.4 Program Plan and Status

The plan for meeting DOE's obligations under the Act covers cooperative licensed demonstrations of dry-storage and rod-consolidation technologies with utilities, conducting spent-fuel research and development (R&D) to expedite utility licensing efforts for these new technologies, and planning for Federal interim storage as needed. The objective of these cooperative R&D activities is to establish one or more technologies that the Nuclear Regulatory Commission may, by rule, approve for use at the sites of commercial nuclear power reactors without the need for additional site-specific approvals. These activities include participation in cooperative demonstrations of dry-storage and rod-consolidation technologies at reactor sites and the development of the technical bases needed to license those new technologies for spent-fuel storage.

The demonstrations will exercise NRC licensing processes for dry storage under 10 CFR Part 72 and rod consolidation under 10 CFR Part 50. The results of these demonstrations will contribute to generic rulemaking by the Nuclear Regulatory Commission. In addition, the data and experience obtained through these demonstrations, including supporting dry-storage R&D testing at Federal sites, will be useful to other utilities in determining performance characteristics, storage economics, and the ability of these systems to be licensed. The utilities will then have a sufficient technology base to meet their own interim requirements for spent-fuel storage.

3.2.2.4.1 Dry Storage

Dry-storage systems provide an alternative for additional spent-fuel storage at nuclear power plants that cannot accommodate reracking or rod consolidation because of the economic, seismic, or structural limitations of their spent-fuel pools. Systems for dry storage include casks, drywells, silos, and vaults. These systems are passive, modular, and low in maintenance. The modular aspect offers the economic advantage of adding storage in small increments, thereby avoiding large initial capital outlays.

The DOE has approximately 20 years of experience with dry-storage technologies. Drywell, silo, and vault storage systems have been demonstrated at the DOE's facilities in Nevada. The dry storage of reactor spent fuel, however, has never been licensed in the United States. To address this, the DOE entered into an interagency agreement with the Tennessee Valley Authority (TVA) in 1982 to demonstrate the licensed storage of spent fuel from a boiling-water reactor (BWR) in a prototype dry-storage cask called CASTOR, which is designed to store 16 BWR fuel assemblies. This demonstration will exercise the licensing process as required by 10 CFR Part 72. A license application will be submitted to the Nuclear Regulatory Commission in 1985. The cask will be loaded with fuel after the approval of the license application, which could be in 1986 or 1987. Fuel will be stored at conservative conditions for about 2 years, at which time the fuel will be returned to the storage pool.

Another cask, the REA 2023, was originally designed and fabricated for the DOE as part of the DOE/TVA cooperative program and was to be part of the aforementioned licensed demonstration at the Browns Ferry nuclear plant. However, it now appears that certifying that cask for a licensed demonstration will be too difficult because the original designer and fabricator are no longer in existence as the entity with which the DOE contracted. As a result, this cask will be used for unlicensed demonstrations at a Federal facility.

In addition, a solicitation for cooperative agreement proposals for dry-storage demonstrations was issued in May 1983. Proposals were received and cooperative agreements negotiated with the Virginia Electric Power Company (VEPCO) and the Carolina Power & Light Company (CP&L). These agreements were signed in March 1984. The agreement with the Virginia Electric Power Company provides for the licensed testing of spent fuel in five casks under conservative conditions at the Surry power plant. In addition, Surry fuel will be shipped to a Federal site (the Idaho National Engineering Laboratory (INEL)) for an unlicensed test in four casks supplied by the Virginia Electric Power Company. The Federal-site tests will demonstrate dry storage at higher temperatures using different cover gases, including air, and may involve consolidated fuel. The agreement with Carolina Power & Light provides for licensed demonstrations of dry storage in horizontal, modular concrete silos at the site of the H. B. Robinson plant. The fuel will be sealed in canisters filled with an inert gas. These dry-storage demonstrations will expand the data base available for the licensing of dry-storage concepts and will build on previous demonstrations, such as the one with the Tennessee Valley Authority. The 10 CFR Part 72 licensing process, cask-performance characteristics, and the cost effectiveness of dry-storage technology will be assessed by these demonstrations.

The DOE expects that, after these demonstrations are completed, an adequate data base will have been assembled to allow the licensing of the dry-storage processes tested at the Federal sites.

The schedule for completing both the rod-consolidation and the dry-storage demonstrations is summarized in Figure 3-13.

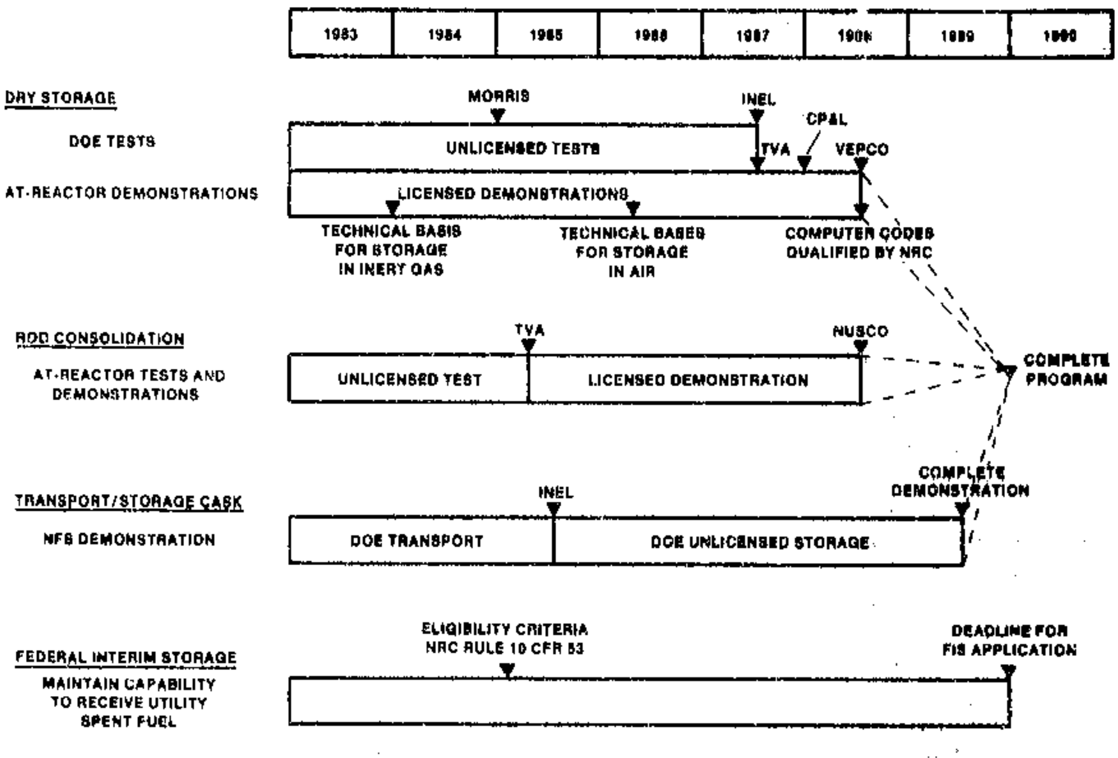


Figure 3-13. Schedule for the spent-fuel storage program.

3.2.2.4.2 Consolidation of Spent-Fuel Rods

Rod consolidation involves the dismantling of the fuel assembly and rearranging the spent-fuel rods into a more compact array. It represents a cost-effective method for significantly increasing the capacity of storage pools that have sufficient structural strength to safely support the added weight and for reducing the number of shipments to disposal or storage facilities.

The DOE began its research on rod consolidation in 1980, when it contracted for the design and fabrication of rod-consolidation equipment for spent fuel from pressurized-water reactors. In 1981, the DOE successfully completed a cold demonstration of this equipment with a dummy assembly. This equipment was then modified to handle BWR spent fuel for use in an interagency cooperative demonstration program with the Tennessee Valley Authority. This demonstration, to be completed by late 1985, involves the disassembly and consolidation of 12 BWR assemblies stored in the Browns Ferry storage pool. A final report of this demonstration will be issued in 1985.

In May 1983, the DOE issued a solicitation for cooperative agreement proposals for licensed in-pool rod consolidation. One proposal was received, and negotiations are under way, with an agreement expected by the summer of 1985. The actual schedule will depend on the negotiated scope of work. This new agreement will supplement the rod-consolidation demonstration with the Tennessee Valley Authority.

An objective of these cooperative programs is to make use of, and to demonstrate the process of, amending a license granted under 10 CFR Part 50 to permit the wet storage of consolidated fuel. The DOE expects that, after the completion of these cooperative programs, an adequate data base will have been assembled to allow the licensing of rod consolidation for commercial use. It is expected that, where physically possible, significant quantities of spent fuel will be consolidated and that this could result in a substantial increase in the storage capacity available at some reactor sites.

3.2.2.4.3 Federal Interim Storage

The DOE expects the increased efficiency of onsite spent-fuel storage that is expected to result from the successful completion of the fuel-rod consolidation and dry-storage demonstrations discussed in the preceding section to be sufficient to preclude the need for Federal interim storage. However, to comply with the Act and as a prudent backup in case unexpected problems arise during the rod-consolidation and dry-storage demonstrations, the DOE developed an initial deployment plan to provide Federal interim storage if any utility requests it and the Nuclear Regulatory Commission determines that the utility is eligible under 10 CFR Parts 1 and 53. The initial deployment plan was updated and published in January 1985. It provides a generic overview of the activities that must be undertaken to deploy an FIS facility, including institutional and transportation issues.

The specific site and type of storage to be used will not be determined until there are clear indications that Federal interim storage will be required. This will allow the DOE to tailor the site and the method selected to provide the best solution available at the time the need is identified.

The DOE has identified several storage techniques for consideration:

1. Metal storage casks.

2. Drywells (caissons below grade).

3. Silos (concrete caissons above grade).

4. Existing water pools at Federal sites.

Techniques 1, 2, and 3 provide passively cooled, dry-storage facilities that can be deployed in modules; they are currently being developed as described in the preceding section on spent-fuel research. The last option, the use of existing Federal water pools, is a currently authorized operating storage method requiring no further development. Since there is no firm indication when Federal interim storage will be required, if ever, there is no fixed time table for its deployment.

The Act requires that, if Federal interim storage is established, it must be handled as a stand-alone, full-cost-recovery program separate from the permanent-disposal program established by the Act. The Act establishes a separate fund (the Interim Storage Fund) that is to be activated to receive the fees charged to recipients of FIS services and from which the costs of establishing and operating the FIS program are to be paid. The Act also requires the DOE to establish and update annually a schedule of the fees that will be charged for Federal interim storage if it is required and to publish them in the Federal Register. The DOE is carrying out these requirements as specified.

The funding plan for Federal interim storage has been developed to distribute the costs of the service equitably among all users on a pro rata basis. Furthermore, the payment structure has been designed as a three-step process to provide the resources required for the FIS program when they are needed. The first step is an initial payment due at contract signing to cover preoperational costs--including capital, development, and administrative costs--and impact aid. Excess funds from this payment will be refunded with interest if additional contracts are signed, resulting in a lower unit cost for the service. The second step is a final payment, due soon after each waste shipment is made, to cover any outstanding adjustments in the initial payment as well as projected storage-module costs and operating and decommissioning costs. Transportation costs will also be billed to the utility as soon as they are known. Finally, at the conclusion of the FIS program, a reconciliation of all costs and revenues, including the interest earned on advance payments, will be made to determine what adjustments are needed to ensure that each user of Federal interim storage has provided his pro rata share of costs.

3.3 TRANSPORTATION

3.3.1 THE TRANSPORTATION SYSTEM

The ability to transport radioactive waste safely and economically is critical to the implementation of the Act. This ability is contingent on the availability of the necessary equipment and a stable, supportive institutional environment. The Act directs the DOE to take title to the spent fuel from the utilities at the reactor site and to be responsible for all aspects of its transportation to storage facilities or repositories. Furthermore, the Act requires that these transportation activities be performed by private industry to the maximum extent possible.

In addition to the shipment of civilian waste, the DOE has the responsibility for transporting high-level waste from defense activities to repositories. Currently, all DOE shipments of radioactive materials, including defense wastes, are made in accordance with the applicable regulations of the Department of Transportation (DOT) and NRC packaging standards as required by DOE policy. Although the framework governing the shipments of defense waste to a civilian repository has yet to be decided, the DOT regulations and NRC packaging standards will continue to apply under any procedures.

3.3.2 MISSION AND OBJECTIVES

In planning, designing, developing, and operating the transportation system that can support the fulfillment of its responsibilities, the DOE is faced with two major tasks that are parallel and complementary. One is providing for the full institutional development of the transportation system. This includes working with Congress; other Federal agencies; States, interested and affected Indian tribes, and local governments; industry and the utilities; and the public to address concerns about waste transportation and to prevent or resolve to the extent possible the institutional issues that could become impediments to the safe, efficient functioning of the system. The other task is providing for the technical or physical development of the transportation system. This includes defining the technical requirements of the system and working with industry and other interested parties to ensure that the various components are available when needed.

This section of the Mission Plan provides an overview of the program policies and plans to complete both of these tasks. Because the transportation of waste is a focal point of interest to all States and localities through which shipments will pass, the task of institutional development is discussed first. The information provided here will be amplified by two supplementary documents, the transportation institutional plan and the transportation business plan, both of which are being developed and are scheduled for release in draft form in the fall of 1985. Eventually, as both documents require updating and revision, the option of combining them into a single interrelated transportation plan may prove advisable.

3.3.3 THE INSTITUTIONAL DEVELOPMENT OF THE TRANSPORTATION SYSTEM

Adequate types and quantities of equipment will not be the sole determinant of the DOE's ability to transport nuclear materials under the provisions of the Act: stable regulations and regulatory bodies and a supportive institutional environment will be equally important. By its very nature, the shipment of radioactive material is a high-visibility activity that elicits interest and concern beyond the immediate vicinity of a repository or a storage site. Individuals who live along potential transportation routes--as well as the State, tribal, and local officials representing them--have expressed concerns about the safety of shipments. The DOE is committed to addressing and resolving their concerns to the extent possible.

Wide-ranging and potentially conflicting jurisdictional responsibilities, authorities, and interests must be recognized and addressed. Current Federal regulations for the shipment of hazardous and radioactive material are designed to protect the public health and safety and the quality of the environment. Commercial spent fuel and high-level waste will be transported in accordance with all applicable DOT and NRC regulations. Strict regulatory compliance has been and will continue to be the foundation for the DOE's planning to ensure safety in the transportation of radioactive waste.

Many States have adopted the Federal regulations for the transportation of hazardous materials. (The governing regulations, 49 CFR Parts 100-199, have been promulgated by the Department of Transportation under the authority of the Hazardous Materials Transportation Act.) However, in recent years some States and local jurisdictions have enacted regulations that have been determined to be or are potentially inconsistent with the Federal regulations established to promote a national transportation policy. These inconsistencies must be resolved to ensure that waste shipments can be made in an efficient manner; at the same time, the concerns of States, Indian tribes, and local populations about safety and emergency response must be adequately addressed. The DOE sees its role in this regard as twofold. First, as an agency with substantial experience and expertise in the field of radioactive-materials transportation, the DOE will take an active role in working with State, tribal, and local officials to identify and resolve public concerns. Second, the DOE will work with other Federal agencies to determine what changes, if any, should be made to the existing Federal regulations to make them more responsive to public or intergovernmental concerns without affecting national welfare and security.

In accordance with the requirements of the Act, the OCRWM will continually assess the effects of its transportation plans and activities on all affected parties. This will include generic analyses of the safety, environmental impacts, and costs of transportation for various storage and repository siting options. Such analyses are included in the draft environmental assessments issued for the nine potentially acceptable sites for the first repository. Moreover, as the site-selection process narrows, the effects of all transportation activities will be analyzed more specifically. The findings of transportation-specific environmental analyses will be included in the environmental impact statement.

3.3.3.1 Institutional Planning

The DOE recognizes that institutional concerns are complex and often interrelated--and that they will influence technical decisions and strategies. Issues are characterized by uncertainty and will frequently change in relative importance as some are resolved and others surface during the evolution of the transportation system. Divergent views complicate resolution, and national interests must be balanced against State, tribal, and local interests. In an effort to foster an institutional climate conducive to issue resolution and prevention, the OCRWM has initiated opportunities for dialogue with a wide range of interested groups. These interactions have led to the identification of a number of issues and the preparation of a series of discussion papers. These papers, which are intended to serve as focal points for the exchange of views and information, will become more detailed as common ground for agreement grows. Focused discussions should increase the knowledge and sensitivity of all parties involved and help ensure broad understanding and support for final decisions.

3.3.3.1.1 Institutional Issues

Seven issues of identified concern are briefly discussed below. As comments are received on the discussion papers, new iterations will be released for further public consideration. The DOE hopes that this will elicit a wide range of opinion concerning the various transportation issues. Other issues for which discussion papers are being developed or will be developed include inspection and the enforcement of regulations, cask safety, the transportation of defense waste, training, regulatory preemption and inconsistency, infrastructure improvement, occupational safety, and funding mechanisms.

The Routing of Waste Shipments to Repositories

This issue is a primary concern. Under existing procedures, the designated motor carrier of spent fuel is permitted to select from routes identified as "preferred" by the Department of Transportation or the States. A preferred route is (1) an interstate system highway, including beltways around major cities, or (2) an alternative route selected by a State routing agency in consultation with other affected States and local jurisdictions and in accordance with the DOT guidelines. The designation of alternative routes is assigned to the States because a State has more knowledge of local conditions than do Federal authorities, and it also has a broader perspective of overall routing requirements than do local authorities. At the request of the State, the DOE will assist, as practicable, in the identification and evaluation of alternative routes in accordance with DOT guidelines.

Once the carrier has selected the route for a specific shipment, the route plan is provided to the driver of the transporting vehicle. After the shipment has been completed, the carrier submits a report of the actual route taken, including any variance from the preshipment plan, to the shipper, who files the report with the Department of Transportation.

The DOE will consider a more formal program of routing assistance to the States in the future. An integral component of the projected process will be a coordinated effort with the DOT, the States, and Indian tribes to identify the factors--both generic and specific--that should determine routing selections. The routes selected must comply with all applicable regulations. Through a cooperatively determined weighting scheme, a set of the most important factors for evaluating specific routes will be established. Approved preferred routes will be provided to the carrier and monitored by the DOE when waste transportation begins.

In enforcing compliance with the routing requirements, the Department of Transportation and the States have primary authority. However, there are a number of ways in which the DOE currently supports routing-compliance efforts and, as the shipper of record for the transportation of spent fuel to repositories, the DOE will continue these practices. Designated carriers will be notified of the approved State-preferred routes and instructed that these routes are to be used. The carrier will be required to meet all safety and routing requirements and will be informed that failure to comply will result in appropriate sanctions, including potential suspension (41 CFR 109-40.103.2). Federal and State reports of carrier performance, DOT records of actual routes traveled, and DOE tracking of shipments will provide mechanisms by which operations can be monitored.

For rail shipments, there are fewer routing alternatives than for highway shipments. Route selection will consider the classification of the track and the specific conditions that exist at the time. The DOE intends, however, to work with the railroads, the States and Indian tribes, and the Department of Transportation to identify the benefits and detriments of available rail routes for waste shipments. As the shipper of record, the DOE intends to ensure adequate control over such factors as interchange points and secondary carriers.

The Mode of Transportation

The mode of transportation to be used in shipping waste to repositories is another issue of high interest. The DOE believes it is prudent to maintain the capability to ship by both rail and highway and is evaluating the capability of each option to meet its requirements. At this time, approximately two-thirds of the operating reactors have rail sidings. In addition to rail and highway, the OCRWM will continue to evaluate the feasibility of water transportation in terms of both safety and cost. More-complete information on the barge option is required to allow for comparisons with the road and rail modes, which are well documented.

A mixture of modes appears to offer the best assurance of operational efficiency. For example, if one mode is affected by labor or weather problems, an alternative mode could be used. In addition, competition between modes will enhance the cost effectiveness of waste transportation. Which mix of shipment modes will be most efficient will depend on factors that must be addressed over the next several years; examples are the deregulation of carriers, the design and the location of the repositories, decisions on the functions of a facility for monitored retrievable storage, the costs and risks of each mode, and the development of new equipment, such as transportable storage casks. The selection of sites for waste-management and disposal facilities will signal decisions on which of the available modes and what mix of modes would be the safest and the most efficient. The selection of modes will trigger site-specific analyses of such related factors as facility and equipment compatibility and methods of waste pickup and delivery.

Prenotification of Shipments

Some State and local organizations have expressed strong preferences that they be notified in advance of each shipment to a repository. The DOE's current practice is to provide State officials with generic prenotification. The basis for the State preference appears to be the belief that shipment-specific prenotifications would be beneficial to developing and maintaining an emergency-response and safeguards capability at the local level.

Pursuant to Section 117(c) of the Act, the Secretary of Energy is required to seek to enter into a consultation-and-cooperation agreement with a State or an Indian tribe that has a site approved for characterization or, if requested, with a State or an Indian tribe that has a potentially acceptable site for a repository. Any such agreement is required to include procedures under which the Secretary will prenotify the State or the Indian tribe of any spent-fuel shipments entering its boundaries for disposal at the repository. The DOE fully recognizes the desire of the States to be prepared to handle all aspects of the spent-fuel shipments crossing their borders. To support this objective, the DOE is working with the regulatory agencies to review existing procedures and to determine the changes--if any--that are required for shipments under the Act. An example of this cooperative Federal effort is the joint DOT/DOE study in progress on prenotification. The outcome of this study and ongoing technical analyses of the optimum methods for tracking shipments will influence the regulations governing notification procedures. In shipping to repositories, the DOE will comply with the regulations that are in effect at the time of transport.

Emergency-Response Capability

An issue of concern to many is the adequacy of emergency-response capability, for which the States and local jurisdictions have primary responsibility. The DOE strongly supports the need to take whatever steps are necessary to ensure that adequate emergency-response capabilities exist along the designated routes. Accordingly, the DOE stands ready to support the States in emergency-response planning and to assist in emergency-response activities, including training. The DOE believes this support provides the appropriate level of Federal assistance under current conditions.

The DOE has long played a central role in preparing for potential emergencies. The DOE provides support to the Federal Emergency Management Agency (FEMA), which has been established to coordinate overall Federal emergency-response activities. FEMA has designated the DOE the cognizant Federal agency for the development of emergency-response plans for the DOE's nuclear facilities and materials in transit. The DOE is an active participant in the Federal Radiological Preparedness Coordinating Committee, which recently published Guidance for Developing State and Local Radiological Emergency Response Plans and Preparedness for Transportation Accidents (FEMA-REP-5, March 1983).

The DOE has also long provided direct support to State and local agencies for radiological monitoring and assessment at an accident scene. Its personnel will respond to requests from NRC licensees; Federal, State, and local authorities; and private persons or companies, including carriers. Assistance can be obtained from any one of eight DOE regional centers, which can respond to radiological incidents on a 24-hour basis. Requests for aid are handled directly through the DOE's regional centers or through an emergency clearing house called CHEMTREC (Chemical Transportation Emergency Center), which is sponsored and funded by the chemical industry. The DOE, when requested, will field the radiation-assistance teams appropriate to the problem.

In the case of host States for facilities developed under the Act, the DOE will negotiate written agreements that will address assistance and funding for emergency-response preparations. In other States, funding or assistance in lieu of funding (e.g., training courses and equipment) will continue to be available through FEMA or other Federal agencies. Examples of the type of assistance already provided by the Federal Government are the emergency-response workshops for first responders sponsored by the DOE at various locations in the country each year as part of its compliance training program. Detailed information about the coordinated Federal emergency-response effort is given in the Federal Radiological Emergency Response Plan. In addition to existing support, the OCRWM will evaluate approaches for further assistance to the States in reinforcing their emergency-response capabilities.

Safeguards

Another concern of State and local governments and the public is the need for safeguarding shipments of spent fuel and high-level wastes to prevent theft, diversion, or sabotage. Since 1979, the Nuclear Regulatory Commission has had interim rules in effect for the protection of licensed spent-fuel shipments. Similar physical protection requirements have been approved and implemented by the DOE for existing program shipments. However, the Commission is considering whether its rules should be revised, because recently completed research has demonstrated that the health consequences of successful sabotage of a spent-fuel shipment would be much smaller than the consequence estimates that prompted the issuance of the interim rules. Also in progress is an NRC-sponsored study to determine what, if any, physical protection requirements should apply for shipments of high-level waste, particularly shipments with dose rates comparable to those of spent-fuel shipments. Requirements, if needed, will be developed by the Nuclear Regulatory Commission and put into force before wastes are shipped to a repository. The OCRWM will comply with whatever NRC shipment-protection requirements are in force at the time when wastes are transported.

Liability

Many questions have arisen concerning the liability for nuclear accidents arising out of activities conducted under the Act. The Price-Anderson Act, which is the legal mechanism for dealing with liability concerns, provides a comprehensive system of financial protection with many procedural advantages to the public.

The DOE has executed approximately 70 contracts with the owners and generators of spent fuel and high-level waste. In these contracts, the DOE agrees to take title to the material and provide transportation to, and disposal in, a repository. These contracts also specify that the DOE will include an indemnity agreement based on the Price-Anderson Act in any contract for the operation of a repository. The indemnity agreement will apply to nuclear accidents that occur at a contract location or in the course of transportation to or from a contract location. Furthermore, the disposal contracts state that the indemnity provision will continue beyond the term of the disposal contracts. The transportation of spent fuel from reactors will also be covered by the Price-Anderson system administered by the Nuclear Regulatory Commission for commercial reactors. Since the DOE's indemnity agreements provide coverage only insofar as coverage is not already provided by the financial protection required by the Commission, liability coverage for nuclear incidents occurring in the course of transportation from a commercial reactor will be covered by the NRC-administered system.

The Price-Anderson Act provides "omnibus" coverage; that is, it covers any person liable for personal injury or property damage under applicable law with respect to a nuclear incident. Therefore, indemnification is not limited to the parties who have entered into an indemnity agreement with the DOE: it is available also to suppliers, subcontractors, and transporters; to States and local governments; and to the generators and former owners of spent fuel. All transportation modes are covered. Even for a terrorist act that causes a dispersal of nuclear material, liability is covered as long as the act occurs in the course of transportation to or from a covered facility.

Once liability has been determined, $630 million (as of March 1985--the amount increases as new reactors come on line) would be readily available through the nuclear insurance pools under the NRC-administered system. If the DOE system were to apply, after a determination of liability, $500 million would be readily available to claimants for any one accident and would not be subject to the availability of appropriated funds. Recognizing the need to provide for the remote contingency that claims may exceed the limit, the Price-Anderson Act specifically provides that "in the event of a nuclear incident involving damages in excess of that amount of aggregate liability, the Congress will review the particular incident and will take whatever action is deemed necessary and appropriate to protect the public from the consequences of a disaster of such magnitude."

Use of Overweight Equipment

State and local officials are also concerned about the potential use of overweight equipment for shipping and the effect of such equipment on highways. The DOE has a policy and record of full compliance with all Federal and State limitations on vehicle weight and size. In general, these limitations are intended to protect the nation's highway system from damage. However, considering the safety objective of minimizing the number of spent-fuel shipments, the DOE, in supporting designs for future casks, will balance the benefit of reducing shipments against the possible road damage caused by overweight vehicles.

The DOE is investigating the potential of larger casks and will consider their use if additional impacts to roads can be minimized. The use of any overweight or oversized equipment will be subject to review and comment by appropriate State officials. Also, the DOE recognizes the State as the permit-issuing authority for shipments requiring overweight or oversize equipment over the national highway system.

3.3.3.1.2 The Transportation Institutional Plan

As a tool for coordinating institutional activities and for articulating policies and positions on issues, the OCRWM is developing a transportation institutional plan. As envisioned, the plan will identify the institutions that are affected by the development of a transportation system, provide guidance in establishing an interactive communications network, and suggest plans, including schedules, for the final resolution of transportation-related issues. Much of the general, preliminary work of developing the plan, including the determination of its contents, has been accomplished, and many of the prescribed activities have been initiated. The development of, and the interaction on, the discussion papers described above constitute part of the process for developing the institutional plan. This process has been and will continue to be helpful in defining the issues and identifying information and policy needs. As overall programmatic decisions are made on such factors as repository siting, the timing and siting of the MRS facilities, the waste-acceptance schedule, and disposal of both defense and civilian waste, the DOE strategies for transportation can be defined more precisely. Final positions on issues, determinations of risks and costs, and realistic schedules will then become available for inclusion in the plan. The OCRWM currently projects that a draft version of the institutional plan will be available in the fall of 1985. As conditions change and strategies evolve, it will be necessary to release periodic updates of this planning document. The details of coordination and communication between the OCRWM and the other elements of the projected institutional network will be specified in the institutional plan itself, but a brief discussion of currently projected strategies and activities is given below.

The OCRWM has identified three major institutional categories as desirable components for a communications network: intergovernmental (Federal, State, and tribal); industry and the utilities; and the general public. At the Federal level, the DOE will strengthen its coordination with other Federal agencies (e.g., the DOT, the NRC, and the FEMA) to avoid duplication of effort and to identify and resolve, as early as possible, any regulatory issues or deficiencies that could impede the transportation mission. A number of steps in this area have already been taken. A procedural agreement on packaging certification between the DOE and the Nuclear Regulatory Commission has been completed. A memorandum of understanding is being worked out between DOE and DOT program elements; in addition, the two Departments are cosponsoring a joint study of prenotification of hazardous material shipments. As noted in the preceding discussion of issues, the DOE is a participant in the emergency-preparedness activities of the FEMA. The DOE intends to maintain active and regular communication with the affected Federal agencies.

A forum for addressing the concerns of State and local officials is provided for in the consultation-and-cooperation procedures established by the Act for host States and affected Indian tribes. In addition, the OCRWM is investigating the potential for informal cooperative agreements with access and corridor States. Established contacts within Governors' offices, other State agencies (e.g., the legislature and public utility commissions), the governments of Indian tribes and State and regional organizations will be a primary element of the DOE's institutional network. Communication on a regular basis will serve to acquaint the DOE with regional concerns and interests regarding transportation as well as to inform the States and Indian tribes of Federal policies and plans. In addition to formal liaison, the OCRWM will conduct workshops, prepare discussion papers, and correspond with affected parties, including local governments and individuals, regarding transportation issues and other matters of concern. Finally, the OCRWM will assist States and Indian tribes in interpreting generic and route-specific transportation analyses and will, to the extent practicable, incorporate State-supported options in future efforts. Throughout the process of cask development and subsequent system operation, the OCRWM will maintain continuing liaison with the utilities to promote appropriate use of Waste Fund money and consideration of ratepayer interests. In addition, the OCRWM will work with business interests in developing the transportation system to ensure the proper balance of DOE oversight and management with the maximum use of industry, as directed by the Act.

To reinforce effective communication, the OCRWM will develop resources on waste transportation for use by State, tribal, and local officials; industry and utilities; the news media; and interested members of the public. These resources will include informational documents, technical reports, newsletters, films, public speakers knowledgeable about the DOE's waste-management program, and issue-oriented workshops. By providing adequate information, the

OCRWM seeks to inform citizens and to clarify misunderstandings on the safety of waste transportation. By encouraging comment on these resources, the DOE further seeks to promote constructive dialogue and to involve the public in as many aspects of the program as possible.

3.3.4 THE TECHNICAL DEVELOPMENT OF THE TRANSPORTATION SYSTEM

In its future role as the primary shipper of spent fuel and high-level waste to repositories and storage facilities, the DOE must ensure the availability of a supporting waste-transportation system. The technical development of the system must be accomplished on time and with maximum participation by the private sector. The system components to be developed include casks and related equipment; specialized onsite services at reactors, at destinations, and possibly at truck or rail fleet maintenance facilities; and the actual transportation procedures.

To assist in establishing the system, the OCRWM is producing a transportation business plan, which will be a summary document of expected business relationships, responsibilities, and strategies. It will provide information on contracting procedures, equipment requirements, budget information, and other areas of interest to the business of developing the transportation capability. A preliminary business document, the Transportation Business Plan: Strategy Options Document, was released in November 1984 to elicit comments from industry and other elements of the private sector regarding a number of potential business strategies. The comments received are being considered carefully and, where appropriate, will be reflected in the draft business plan scheduled for release in the summer or fall of 1985. This document will contain more-precise information than can be included in the Mission Plan and therefore should be consulted for details on cask production, procurement, and the like.

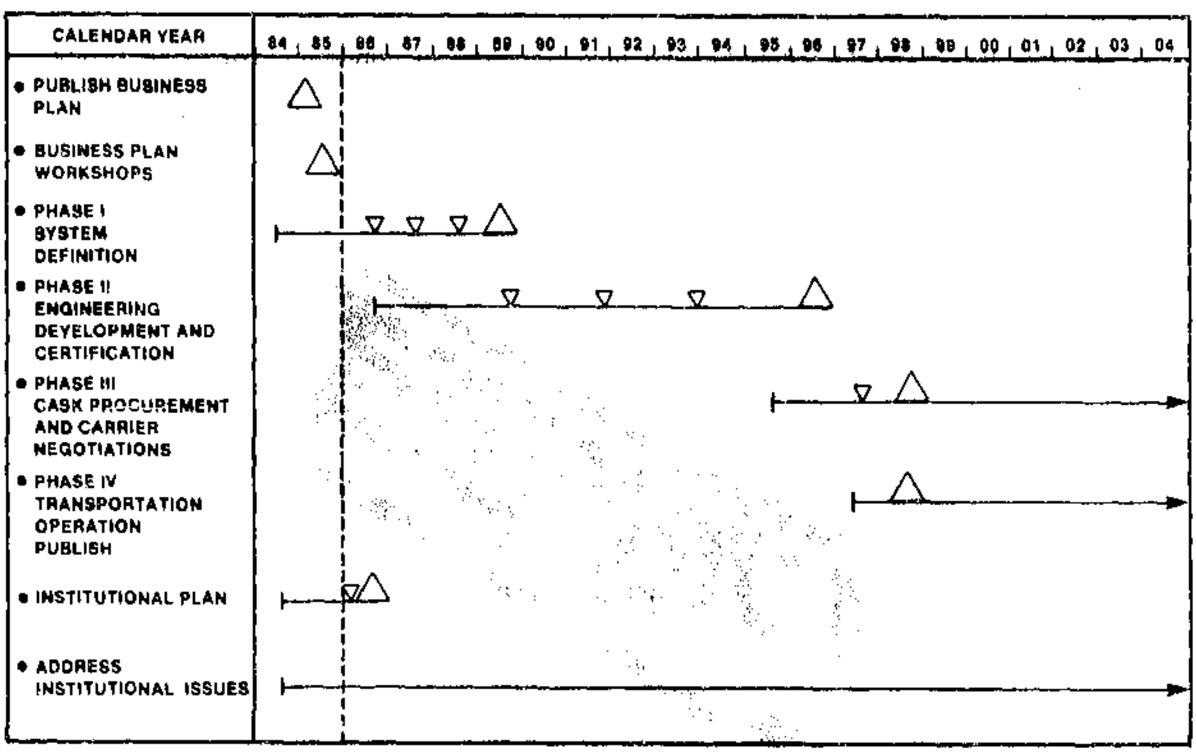
The scope of the hardware-development activity associated with establishing the transportation system will be delineated by a number of assumptions. With regard to long-range shipments to repositories, the DOE has signed contracts with the utility owners to begin accepting spent fuel no later than January 31, 1998. At the time of acceptance, the title to the spent fuel will transfer to the DOE, and shipment will begin to repositories or other designated Federal facilities, such as an MRS facility. In addition, the DOE will accept defense waste for disposal in the civilian repository system.

The DOE plans to rely on all surface modes of transportation (truck, rail, and barge) for shipment, and intermodal transport will be used where practical. Generally a practice of shipping the oldest fuel first will be followed. All spent fuel will have been aged at least 5 years. The spent fuel will be shipped in compliance with all DOT regulations in casks that have been certified by the Nuclear Regulatory Commission in accordance with 10 CFR Part 71. Estimates of the number of annual shipments vary widely, depending on assumptions about the shipment modes, cask capacities, and the function of an MRS facility. If an MRS facility is approved by Congress as an integral part of the waste-management system, approximately 100 truck and 10 train shipments to the MRS facility and 2 cross-country train shipments to the repository per month would permit an annual transfer of 3000 MTU of spent fuel. Depending on the cask design, the number of shipments could be reduced significantly, perhaps by a factor of 2.

3.3.4.1 Technical Planning

The current strategy for the development and operation of the transportation system assumes that the DOE would be an active participant with industry throughout the entire process. Technical development will follow a multiphased approach designed to (1) allow for the optimum use of research and development, (2) avoid premature commitment of resources, (3) encourage private-sector approaches to meet program needs, and (4) provide a framework for evaluating progress in the acquisition of the transportation system. Figure 3-14 shows the major activities and estimated schedules to meet long-term transportation requirements.

The details of the multiphased approach will be included in the transportation business plan. The plan will help the DOE in its interactions and communications with the private sector on contracting plans, funding availability,



A new-generation truck cask
B new-generation rail cask
C other advanced concepts (e.g., integrated cask/car)
D multipurpose casks, if recommended by results of PRDA studies
E mini-fleet available
F draft for review

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Figure 3-14. Major activities and estimated schedules to meet long-term transportation requirements.

and equipment requirements. In addition to information on the timing and the scope of major procurement actions, the plan will include plans for cask development, procurement, and ownership and for service procurement. The strategy outlined in the business plan will evolve through an iterative process as the technical requirements of the program become more definitive. This strategy is described briefly below.

3.3.4.2 System Definition

During the system-definition phase, which is now in progress, requirements for the overall transportation system will be defined in terms of the needs, capabilities, schedules, costs, and operating constraints. The DOE is developing information about long-term shipments, such as the size, weight, and other characteristics of waste forms; the quantities, timing, and destinations of shipments; and handling constraints at origin, en route, and at destination points. Activities include estimating the number and types of casks that will be needed to serve storage and disposal facilities, defining the interface characteristics of casks, establishing the key features desired in modifications of existing designs or in a new generation of shipping casks, identifying the physical interface requirements at the various reactor sites, and continuing any required safety or development research.

The DOE will invite industry to develop design concepts for both truck and rail/barge casks. Figures 3-15 and 3-16 are examples of the types of casks that are expected to be developed. Performance and design specifica-

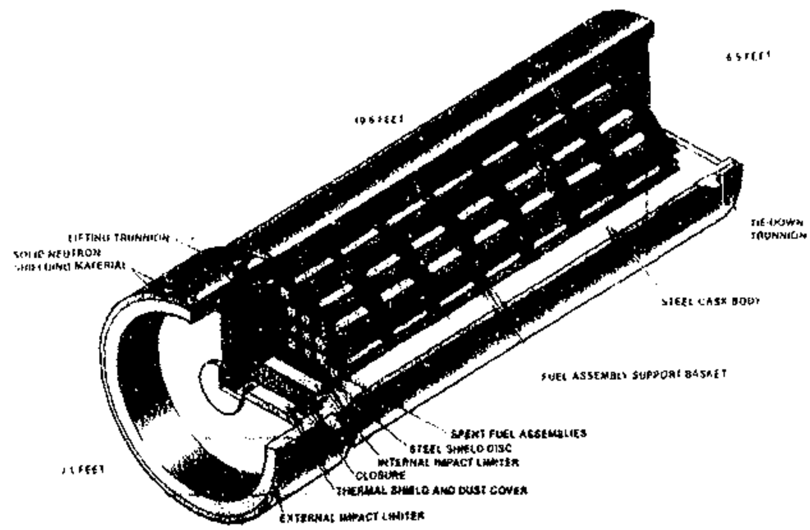

Figure 3-15. Illustration of a 100-ton reference spent-fuel transportation cask for shipment by rail or barge.

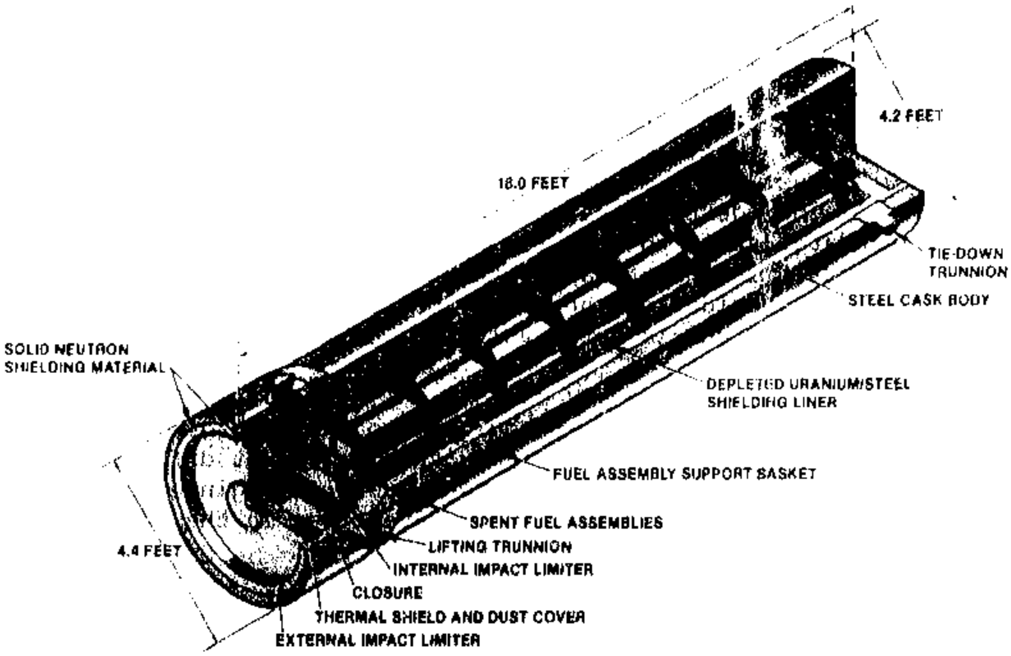

Figure 3-16. Illustration of a 40-ton reference spent-fuel transportation cask for shipment by truck.

tions are expected to be sufficiently advanced to permit the DOE to issue a request for proposals (RFP) by early 1986. Potential concepts from this RFP will result in a new generation of the traditional reusable (transportation only) casks. Future RFPs will look to more advanced multipurpose casks. Multipurpose casks could be used for storage, transportation, and disposal. Studies that will help to define the feasibility of the various cask concepts are under way.

The new casks can be designed to carry a significantly higher payload than the casks now in use. This is possible because the fuel to be shipped will be aged at least 5 years. The casks in current use are designed to ship fuel that has been out of the reactor for only a few months and therefore emits much more heat. In existing spent-fuel casks, the cylinder and the lid are made of thick stainless-steel shells, which envelop shielding materials like lead and depleted uranium. Current truck casks, which weigh approximately 25 tons, can carry only one assembly of fuel from a pressurized-water reactor (PWR) or two assemblies of fuel from a boiling-water reactor (BWR). Existing rail casks, which weigh about 100 tons and have a much greater capacity than truck casks, transport 7 PWR assemblies or 18 BWR assemblies. It is projected that the new designs could more than double the capacity of the current casks.

3.3.4.3 Engineering Development and Certification

The engineering development and certification phase for a particular cask follows the establishment of feasibility for a cask concept and the release of development specifications. The DOE will invite industry proposals for the engineering design and development, certification, prototype fabrication, and testing of the cask. Contracts will be awarded on the basis of the best combination of cost, schedule, and technical features. The industry contractor, if directed, will test scale models and fabricate and test prototypes. Prototype testing will include the verification of operational capability, integration and standardization to meet reactor and repository compatibility requirements, and verification of safety features. To obtain objective evaluations, the OCRWM is considering the option of the cask tested by an independent testing contractor who is not involved in cask development or by the national laboratories.

Considerable flexibility must be built into the packaging system to accommodate many reactors and facilities with significant differences in handling capabilities and waste forms. Consequently, engineering development of a family of casks will be appropriate. Categories in the cask family could include the following:

1. Truck casks (25-40 tons).

2. Rail/barge casks (100-ton range).

3. Dual-purpose casks for transportation and storage.

4. Multipurpose "universal" casks for transportation, storage, and disposal.

5. Advanced-concept casks for shipment by rail from the MRS facility.

The OCRWM expects that some standardization of critical interfaces is needed to minimize licensing requirements and to allow for efficient operations at a repository or storage facility. Advanced techniques (e.g., robotic handling) being developed today will allow a cask to be handled either manually or by automated remote systems. These handling techniques require some degree of standardization.

Since the responsibility for certifying a cask design will rest with the industry contractor developing it, certification activities are included in this phase. Each new cask system that is used for the transportation of spent fuel and commercial high-level waste to a repository will receive an NRC certificate of compliance before use. To receive this certification, the cask must be able to pass a series of four sequential tests: a free drop from 30 feet onto an unyielding surface, a puncture drop from 40 inches, exposure to a fire of 1475°F for 30 minutes, and immersion in water for 8 hours. During this entire phase of engineering development and certification, the DOE will consult with regulatory agencies on potential changes to the regulations that could affect cask development.

3.3.4.4 Cask-Fleet Procurement and Carrier Negotiations

During the phase of cask-fleet procurement and carrier negotiations, procurement activities for repository and storage-facility operations will be conducted, the fabrication of production cask units will be started, and operating-personnel training programs will be developed. This phase will also include the operation of prototype units for the purpose of evaluating equipment, contractual relationships, scheduling, and handling of casks. The OCRWM will be responsible for directing the operation of prototype units and for procuring production casks for repository and storage-facility operations. This phase, when completed, will confirm the technical and economic adequacy of the operating systems.

3.3.4.5 Transportation Operations

Phase 4, transportation operations, will include all tasks needed to complete required shipments (i.e., cask procurement, personnel training, maintenance, transportation operations, and traffic management) and to plan for the future development and improvement of transportation capabilities. As the shipper of record for spent fuel and high-level waste, the DOE will take the lead role in directing these activities.

3.3.5 TRANSPORTATION OPERATIONAL MANAGEMENT SYSTEM

The management structure and operational procedures that will be employed to carry out the transportation responsibilities of the DOE depend in large measure on the determination of what components and facilities are integral to the waste-management system and on the approach to be taken in contracting for transportation hardware and services. As decisions are made in these two areas, more definitive plans will be developed for the management of the transportation operations.

The DOE's well-established current transportation-management system and wealth of experience in shipping radioactive materials will provide important input into determining the approach to managing the transportation required by the Nuclear Waste Policy Act. In addition, the experience and capabilities of private industry in managing the transportation of thousands of shipments of radioactive and other hazardous materials will be factored into the operation and the management of the system. As in all elements of the waste-management program, the DOE will employ improved methods of quality control and quantity assurance as well as cost control in the operation of the transportation system.

3.4 SYSTEMS INTEGRATION

3.4.1 INTRODUCTION

As described in the preceding sections, the waste-management system proposed in this Mission Plan may consist of several components, including two repositories, a facility for monitored retrievable storage (MRS), near-term at-reactor storage by the utilities, potential Federal interim storage (FIS), and a transportation system. The combination of these components into an integrated system will require the application of systems engineering and integration techniques similar to those used in other major technical programs.

3.4.2 OBJECTIVES AND APPROACH

The objective of systems integration is to ensure that the above-listed components are integrated into a waste-management system that is efficient, safe, and on schedule. To achieve this objective, the systems-integration effort will--

1. Identify and baseline the requirements of the total system and maintain a current description of the waste-management system that meets those requirements, including the system components, functions, and critical interfaces.

2. Enhance communication among the parties responsible for various systems components and functions in order to ensure compatibility and the coordination of interfaces.

3. Develop and maintain the capability to fully assess alternative systems concepts and to determine how a change in one part of the system will affect the rest of the system.

4. Conduct well-planned and well-coordinated systems studies and recommend to the OCRWM Director improvements to the design of the waste-management system, as appropriate.

5. Support the development and testing of equipment or processes that have the potential to improve the waste-management system.

3.4.3 BACKGROUND

The management of waste from its acceptance at the source (e.g., a reactor site) to emplacement in a repository will involve major investments in facilities, equipment, construction, and operations. Figure 3-17 illustrates the various functions and facilities that could possibly be included in an integrated waste-management system. The operations include wet and dry storage at the reactor; truck, rail, or even barge transportation; near-term interim storage at a Federal site; the consolidation and packaging of spent fuel; and ultimate final disposal in a geologic repository. Each of these operations involves health, safety, and licensing issues and poses potential interface challenges.

In order to have a totally integrated waste-management system, it is necessary to consider the packaging and storage activities that are conducted by the utilities and other waste generators before the transfer of the waste to the Federal Government. These activities will influence what equipment the Federal Government will need to provide to transport the waste and what packaging or repackaging operations may be necessary at Federal facilities. Therefore, the waste-management system is defined to include the waste generators, distinguishing between the portion of the integrated system for which the waste generators are responsible and those for which the Federal Government is responsible. The discussions that follow are concerned mainly with the Federal portion of the integrated waste-management system.

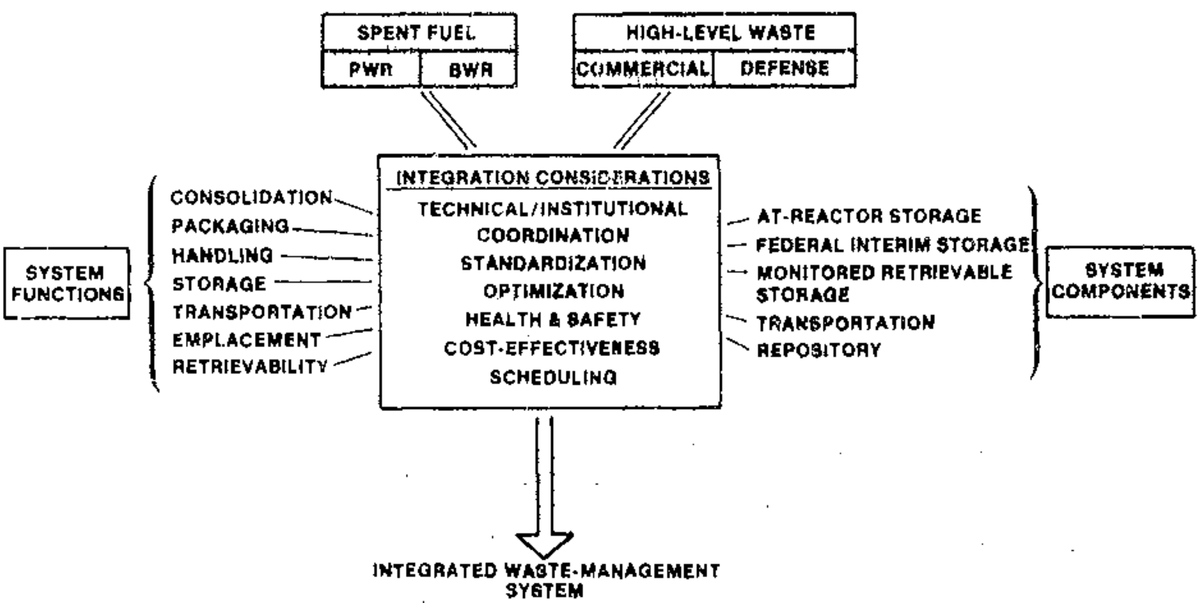

Figure 3-17. System integration considerations.

3.4.4 SYSTEM COMPONENTS

As indicated on the right side of Figure 3-17, the waste-management system may consist of several components. The first component is the spent-fuel storage facilities at the reactor sites.

The Act clearly makes the utilities responsible for the near-term management and storage of spent fuel. Nonetheless, this storage must be considered in a total waste-management system because the fuel must be packaged for transportation to Federal facilities.

Federal interim storage will only become a reality if a certified need arises, as discussed in Section 3.2.2. Interim storage if required, will not significantly affect the design and the operation of the whole waste-management program, because the maximum amount of spent fuel that would be stored is 1900 MTU.

As discussed in Chapter 2 of Part I, the DOE will propose to Congress that an MRS facility be an integral part of the system. As described in Section 3.2.1, its primary function will be the control, receipt, and packaging of waste for disposal. The repository (see Section 3.1) will emplace the waste packages in a geologic formation. The last component of the waste-management system is transportation, which is discussed in Section 3.3.

3.4.5 SYSTEM FUNCTIONS

The left side of Figure 3-17 shows the system functions that must be accommodated in the integrated waste-management system. Current plans call for spent-fuel assemblies to be disassembled and the spent-fuel rods to be consolidated before storage at an MRS facility or emplacement in the repository.

Several packaging operations may be necessary in the waste system, including packaging for storage at the reactor site, for transportation, for temporary storage at an MRS facility, and for emplacement in the repository. The coordination and standardization of waste-package designs, to the extent feasible, will therefore be considered.

The handling of the fuel assemblies, canisters, containers, and casks will require both remote and contact handling capabilities, using cranes and various jigs, grapples, and other handling devices. The design of these devices must be coordinated at all facilities to ensure compatibility with all handling operations. The use of robots will be considered where appropriate.

Waste may be stored at two locations in the waste system: at the reactor site and at an MRS facility. Temporary lag storage may also be necessary at the repository if fuel is shipped directly from reactors to the repository. Storage methods and equipment should be coordinated to the extent feasible.

The transportation of wastes may be by truck, rail, or barge. This function interfaces with all system components and with many States and localities not hosting one of the system facilities. The coordination of all aspects of transportation-equipment design and system operations is essential in the integrated system.

Emplacement in a repository is the final function of the waste-management system. It must be coordinated with other system functions such that the emplacement can be performed safely and efficiently.

3.4.6 STRATEGY AND PLANNED ACTIVITIES

Each component of the system could be optimized individually. However, the optimum waste-management system may not be just the sum of its separately optimized parts. Rather, it must be considered in its entirety to ensure the integration of the parts into a system that meets all requirements and is optimized as a whole.

As noted in the center of Figure 3-17, there are several factors that must be considered in the design of an integrated waste-management system; they include the technical alternatives related to the design of hardware and facilities and institutional issues related to licensing, ownership of equipment, division of responsibilities, emergency response, and liability. Coordination with the utilities, the Federal Government, States and Indian tribes, and the industry is necessary in designing and implementing an integrated waste-management system. Other considerations include the standardization of waste canisters and handling equipment to the extent feasible, the optimization of the whole system to the extent feasible, assurance of compliance with health and safety regulations, minimizing the cost to the ratepayer, and the scheduling of all systems activities such that required milestones are met and the waste system is implemented on time.

The strategy for ensuring that a safe, reliable, efficient, and cost-effective waste-management system is designed and implemented is as follows:

1. Prepare and implement a systems-engineering process that identifies (a) the systems-engineering procedures necessary for developing and designing the system, (b) the organizational responsibilities for implementing the procedures, (c) the required documentation, and (d) the procedures for controlling changes or revisions to the system.

2. Identify the technical and institutional requirements that the integrated waste-management system must meet and maintain a current description of the integrated system that meets those requirements efficiently, safely, cost effectively, and on time.

3. Identify and evaluate alternative systems concepts that offer the potential for reducing risk, increasing flexibility, lowering costs, and enhancing the ability to meet desired schedules.

4. Assess the effects of proposed changes in one part of the system on the design and operation of the whole system. Ensure that all system components and functions are properly interfaced and coordinated.

5. Where needed, design and test innovative components and equipment that appear to offer significant potential for improvements to the whole waste-management system.

The DOE is developing a systems engineering management plan directed at satisfying the strategy outlined above. This plan will identify and document the procedures and responsibilities necessary for the engineering of a major, complex system. These procedures are essentially the application of OMB Circular A-109, "Major Systems Acquisitions," and DOE Order 5700, "Major Systems Acquisitions." A system requirements and description document is also in preparation. This document will define the overall requirements of the waste-management system and describe the current design of the integrated waste system that meets those requirements. It is unlikely that the overall system requirements will change. However, the description of the total system that fulfills those requirements may change as the designs of its components are further defined. As the system design changes, this document will be updated to reflect the new approved systems concept. It will also be controlled as a baseline document for the program. Key officials representing each part of the OCRWM program will participate in the development and updating of the document to ensure continuing coordination among program participants.

For the assessment of alternative approaches, three activities have been initiated. First, the DOE issued a competitive solicitation called a Program Research and Development Announcement (PRDA) in 1984. Its objective was to invite utilities and industry to identify and develop technical and institutional alternatives for the near-term and long-term handling, packaging, shipping, and storing of spent fuel in ways that could facilitate or minimize handling and packaging for final disposal. Thus, the expenditures of time, effort, and costs throughout the back end of the fuel cycle could be minimized while possibly providing near-term benefits to the utilities in safely and efficiently solving storage problems. Concepts for standardization that could lead to additional economies were to be considered to the maximum extent practicable. Emphasis was placed on waste packaging and handling in an integrated system and on determining how an improvement in one part of the system will affect the total system in terms of cost, safety, and licensing.

The PRDA was issued on March 15, 1984, and proposals were received on May 15, 1984. The proposals covered a variety of ideas. Some were innovative, while others were for improvements to existing concepts.

Six contracts were awarded. These contractors are studying several unique systems ideas, including multipurpose casks and canisters, centralized and regional packaging facilities, and compact, portable dry rod-consolidation equipment.

Second, in addition to the studies initiated under the competitive solicitation discussed above, additional supplementary studies are being identified and will be conducted as necessary. These studies will concentrate on ideas that are not being addressed by the PRDA studies but appear to offer potential benefit to the integration of the system. Studies have been initiated to assess the benefits of rod consolidation to the whole waste-management system, to determine the effect of extending the burnup of fuel on the waste-management system, and to define strategies for waste acceptance. Other studies will be initiated as deemed appropriate. Various techniques of decision analysis, such as probabilistic analysis, are being investigated and will be used as appropriate. Value-engineering techniques will be considered as a method of cost control in the design and construction of the various components of the system.

Third, a systems computer model has been developed for use in cost and logistics sensitivity analyses. Along with other subsystem models, this model will be used to study how changes in one part of the waste-management system will affect the cost and logistics of the system as a whole. The cost data for these analyses will be obtained from various DOE programs and will be kept current. A peer review of the model is being conducted by a select group of industry experts. Their comments will be valuable for improving the model for future use.

After the systems studies, new, innovative equipment may be designed and tested. An example of such equipment could be the rod-consolidation equipment for use at an MRS facility or a repository.

All systems-integration studies and analyses will be monitored by DOE officials representing each program area to ensure that the unique features of these programs are properly integrated. Periodic progress reviews will be conducted. Industry representatives are invited to participate in these reviews. Representatives of the Edison Electric Institute and the Electric Power Research Institute have participated in past reviews and have offered valuable comments and suggestions.

3.4.7 COORDINATION AND INTEGRATION OF RESULTS WITH OTHER PROGRAMS

While systems studies are being conducted, existing design efforts in the various program areas (repository, monitored retrievable storage, and transportation) will continue. As the results of such studies indicate that changes should be made, such changes will be incorporated, with the approval of all affected parties. The systems requirements and description document will be updated as necessary to reflect the currently approved systems description. It will be used by the various program areas to redirect, if necessary, current design efforts. Figure 3-18 is an illustration of the systems-integration program logic.

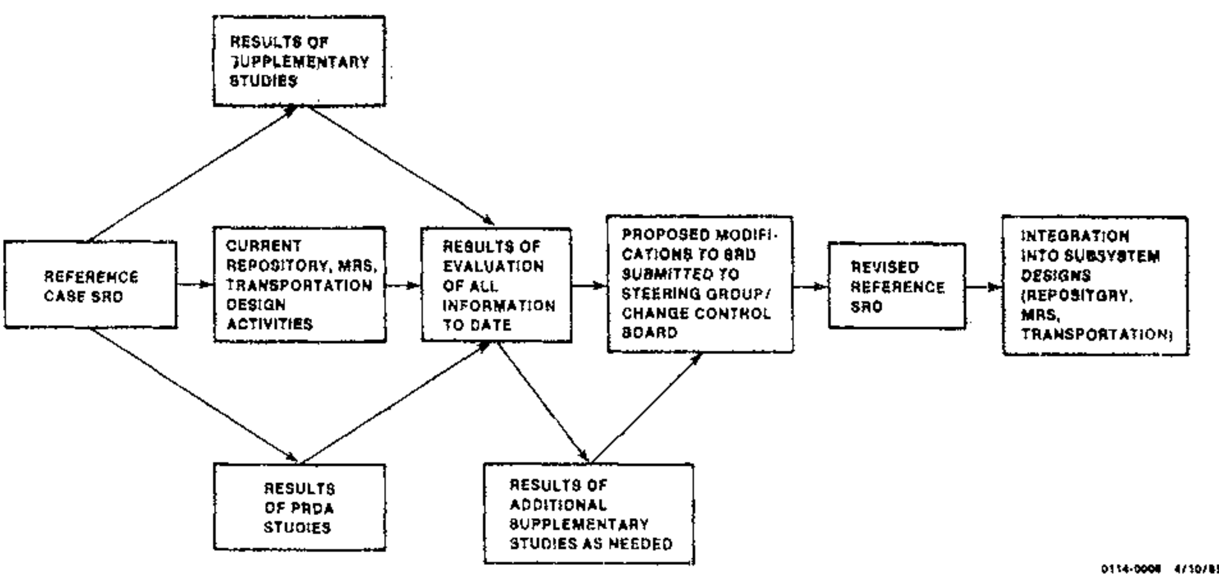

Figure 3-18. The logic for the systems-integration program.

Figure 3-19 presents the near-term schedule for systems-integration activities and shows how they will contribute to key activities of other program areas (repository, monitored retrievable storage, and transportation). A key date in Figure 3-19 is late 1985, by which time the results of the PRDA studies, the results of the supplementary studies, and the results of sensitivity analyses will have been brought together to produce a series of integrated analyses of the back end of the nuclear fuel cycle, incorporating new concepts, as appropriate. The results of these analyses will be incorporated, as appropriate, in modifications of the reference system design. This information will be available well before the DOE is scheduled to begin license-application designs for the repository and the waste package and before final designs for transportation casks are developed.

Progress made in developing the information base for transportation will be available and incorporated into proposed modifications to the system requirements and description document. In parallel, some results of the storage research and development program will also be available. While the DOE's report on monitored retrievable storage will have been submitted to the Congress, appropriate design changes could be submitted as an amendment to the report.

It is expected that some reactors will begin to have storage-capacity problems by about 1990. By that time, however, the total system should be well enough defined to allow the DOE to provide guidance to the utilities that is fully compatible with the integrated waste-management system.

In practice, the discrete lines of Figure 3-19 are symbolic in that there is, and will continue to be, an interchange of knowledge and information among the several program areas. In the short term, the accumulating information under the PRDA and supporting studies will be available continually for the advanced conceptual design of the waste package, for the conceptual design of the repository, and for use in preparing the MRS report to Congress. For the longer term, beyond 1985, systems analyses will continue, drawing as required on the private sector and on DOE contractors, in order to improve the overall effectiveness of the system. The revised system requirements and description document will serve to organize and control the total waste-management system, not only through the timeframe of Figure 3-19, but also through the design and construction of the ultimate system components.

3.4.8 THE WASTE-MANAGEMENT SYSTEMS UNDER CONSIDERATION

This section discusses the two concepts for a total waste-management system that were presented in Chapter 2 of Part I. Either concept would fulfill the requirements and the intent of the Act and would be integrated into an efficient, safe, and timely waste-management system, to the extent practicable. However, the DOE believes that one system offers significant advantages over the other.

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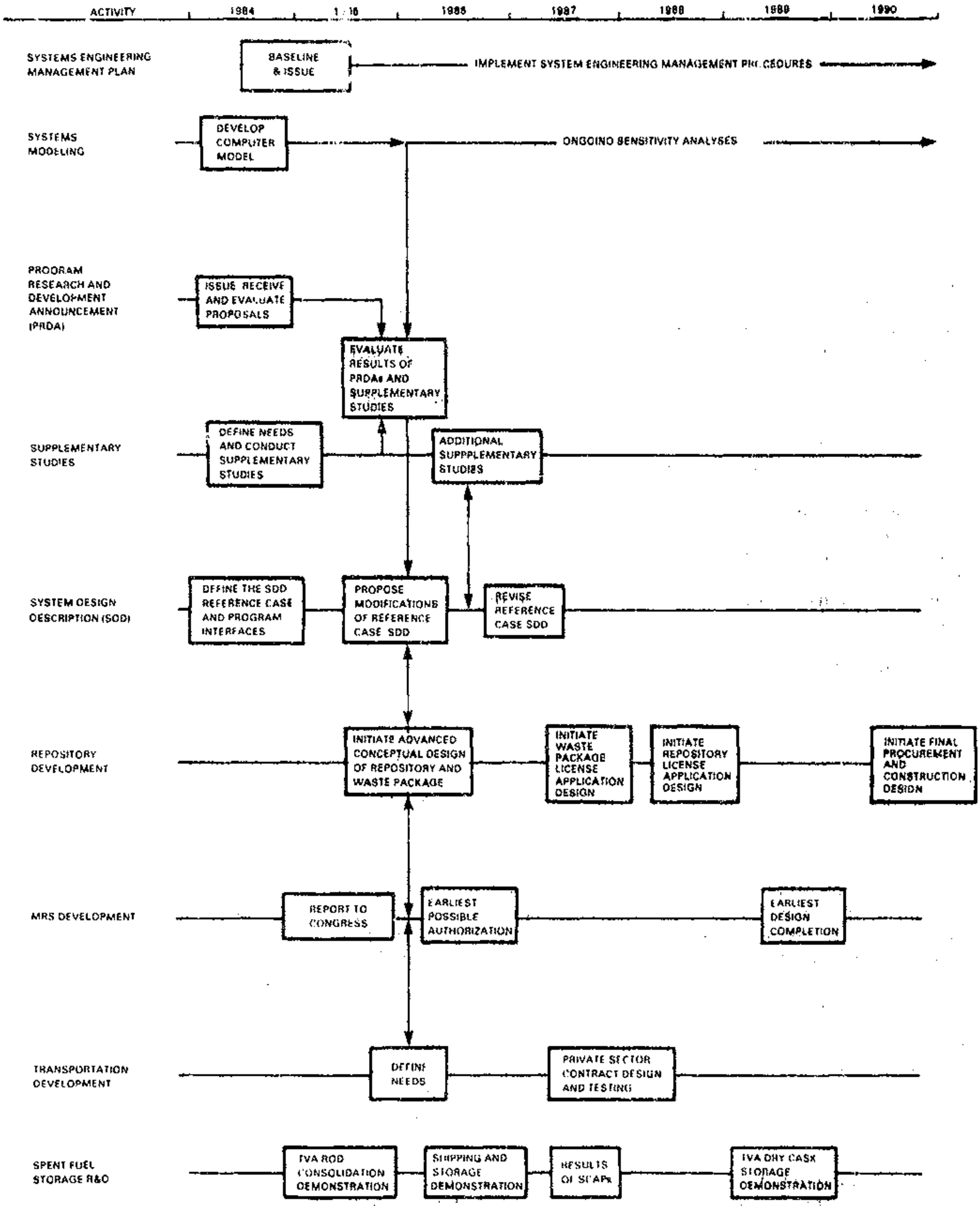

Figure 3-19. Systems-integration schedule and interfaces with other program activities.

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3.4.8.1 The Authorized System

The principal components of the authorized integrated waste-management system are the waste generators (primarily reactors), the geologic repositories, and the transportation system that links these components with each other. The packaging and handling operations associated with each of these components must also be integrated for the efficient operation of the entire system.

The spent fuel that will be accepted by the system for geologic disposal may be either intact assemblies of various types or canisters of consolidated spent-fuel rods. The spent fuel will be shipped directly to the repository from storage pools at reactor sites. Solidified high-level waste will also be shipped directly to the repository from the sites at which it is generated. Shipments will be made by rail, truck, or barge, using specially designed shielded transportation casks that comply with applicable safety regulations.

The surface facility of the repository will consolidate and package spent fuel from commercial reactors before permanent disposal.

The acceptance of waste will begin with the initiation of repository operations. The first geologic repository is to begin limited operation (phase 1) by no later than January 31, 1998. The system will be designed to eventually receive spent fuel at or near the projected rate of commercial spent-fuel generation. The second repository would start operating about 8 years later.

Generators of Spent Fuel

Nuclear power utilities will continue to store spent fuel at their commercial nuclear reactor sites until the Federal waste-management system is available to accept the fuel. The spent fuel stored at various reactor sites will differ in its physical, thermal, and radiation characteristics because of differences in fuel-assembly designs, the burnup in the reactor, the storage techniques used by each utility, and the duration of at-reactor storage.

It is expected that most of the spent fuel that is accepted into the Federal system will come directly from reactor storage pools. However, because of the possibility of limited storage-pool capacity at some reactors, some utilities may pursue the option of storing spent fuel outside their pools in licensed dry-storage casks until the fuel is transferred to the Federal Government. As discussed in Section 3.2.2, the DOE is cooperating with utilities in demonstrations of licensed dry storage, and it is expected that licensed casks would be available to industry within the next few years. The utilities are also investigating rod-consolidation procedures, which represent another method to significantly increase the capacity of some storage pools. Therefore, the spent fuel will be accepted into the Federal part of the system either in the form of intact fuel assemblies or canisters of consolidated rods.

The utilities will be responsible for loading their spent fuel into licensed transportation casks provided by the DOE. The DOE will then accept title to the spent fuel at the reactor site and transport it to the repository.

Generators of High-Level Waste

Liquid commercial high-level radioactive waste is a residual product of the reprocessing of spent fuel for the recovery of useful materials. Only a small amount of commercial high-level waste currently exists. This waste is stored in tanks at a closed commercial plant located at West Valley, New York. After being solidified and prepared for transportation, the waste will be shipped from the West Valley site to the repository.

Defense high-level waste is being generated at several DOE facilities, such as those located near Savannah River, South Carolina; Richland, Washington; and Idaho Falls, Idaho. This waste will be solidified at the generation sites into a waste form acceptable for permanent isolation and then shipped directly to the repository.

Geologic Repository

The geologic repository is designed to provide for the permanent disposal of spent fuel and high-level waste. At the repository, the waste will be emplaced in a suitable host rock at depths of 1000 to 3500 feet below the surface, depending on the rock. The repository will be licensed by the Nuclear Regulatory Commiesion.

When fully operational, the repository will be capable of receiving and emplacing the equivalent of about 3000 to 3400 MTU per year.

As illustrated in Figure 3-1, the repository will consist of both surface and underground facilities. It will be equipped to receive, handle, and emplace underground all of the spent fuel and high-level waste. The main operations performed in the surface facilities of the repository will consist of (1) receiving and inspecting the waste, (2) consolidating and packaging spent fuel, and (3) overpacking high-level-waste canisters, if necessary, with disposal containers.

The underground facilities will consist of access shafts or ramps, corridors, and waste-emplacement rooms. The waste will be lowered underground and emplaced into boreholes drilled into the floors or the walls of the emplacement rooms. The waste will be fully retrievable until it has been demonstrated that the repository is performing within the guidelines set by NRC regulations. The underground facility and shafts will then be closed and sealed, and the surface facilities will be decontaminated and decommissioned.

Current plans call for a second repository to be in operation in the year 2006.

Transportation

The transportation system will have the capability to transport waste from the waste generators to the repository. All waste will be shipped in licensed casks designed specifically for that purpose. The DOE will assume responsibility for transportation. Depending on the circumstances, waste will be shipped by rail, truck or barge.

Shipments will consist of both consolidated and unconsolidated spent fuel as well as solidified high-level waste. The private sector will be relied on to the maximum extent possible for cask development and transportation operations. Any functions performed by the private sector will be conducted in accordance with the appropriate licensing requirement .

The casks for each transportation mode will be designed to accommodate alternative waste forms and canistered waste configurations. Conceptual diagrams of transportation casks are shown in Figures 3-15 and 3-16.

3.4.8.2 The Improved-Performance System

The improved-performance system includes an MRS facility as an integral part of the waste-management system. In this system, all or most of the spent fuel will be shipped directly from reactor sites to the MRS facility. However, spent fuel from reactors located close to a repository but an appreciable distance from the MRS facility may be shipped directly to the repository. Solidified high-level waste could be shipped directly to the repository from the sites at which it is generated or to the MRS facility, where it may be combined with other wastes for shipment to the repository.

The MRS facility will consolidate and package spent fuel from commercial reactors before shipment to the geologic repository for permanent disposal. In addition, the MRS facility will provide temporary storage for waste received by the DOE and awaiting shipment to the repository. The length of time for which spent fuel will be stored at the MRS facility will depend on repository operating factors, such as the time of startup, waste-acceptance rates, and thermal design limits. Shipments from the MRS facility to the repository may be made in unit trains or barges to minimize the number of shipments.

The flow of waste from the waste generators to an MRS facility and a repository is illustrated in Figure 3-20. The MRS facility will have a finite lifetime. After all the waste has been emplaced in the repository, the MRS facility will be placed in caretaker status, capable of receiving waste from the repository in the unlikely event that the retrieval of the waste is necessary. After the retrievability period, the MRS facility will be decommissioned and removed from the site. The improved-performance concept is illustrated in Figure 3-21.

In the improved-performance system, the acceptance of waste could begin with the start of MRS facility operations as early as 1996. The system will be designed to receive spent fuel at or near the projected rate of commercial spent-fuel generation by 1998.

The difference in functions and charecteristics of each of the components of the improved-performance system from those described previously for the authorized system are described below.

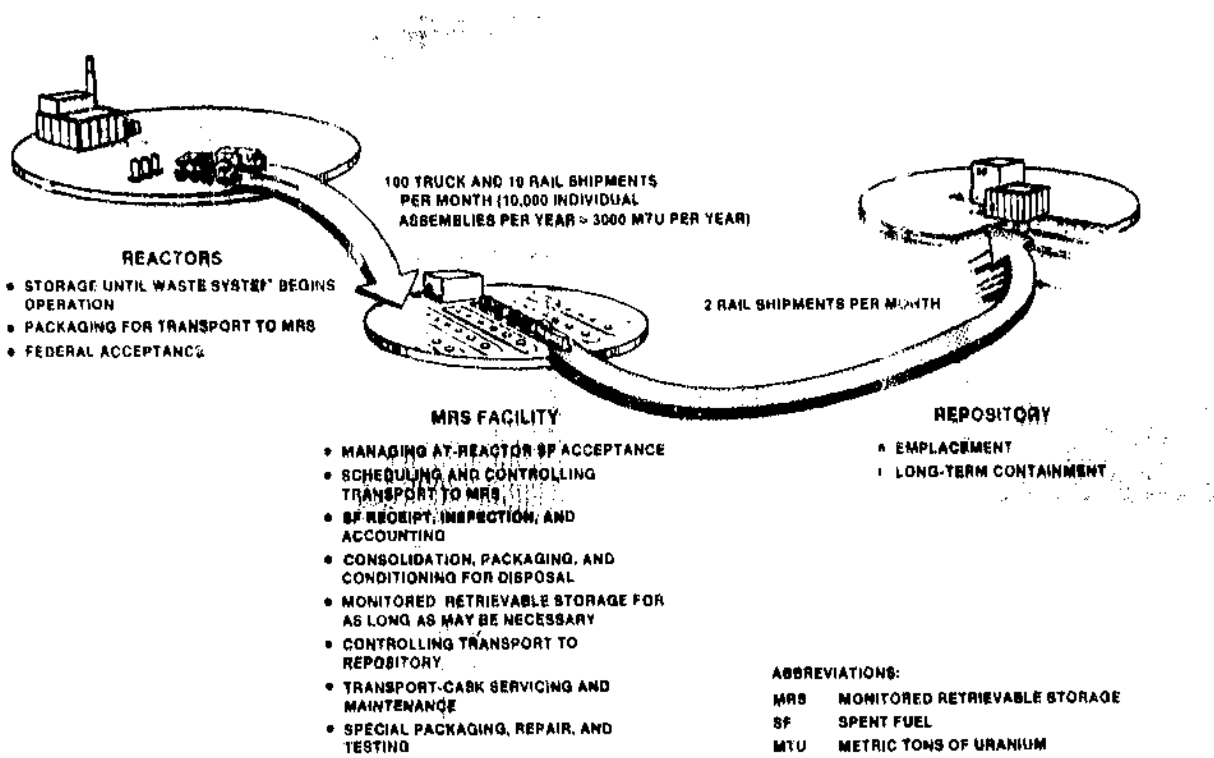

Figure 3-20. Distribution of waste-management functions within an "integrated" system.

Generators of Spent Fuel

In the authorized system, the utilities must store the spent fuel until the repository is operational. The receipt rate will depend on the rate at which the repository can emplace the waste. In the improved-performance system, the receipt rate from utilities is not limited by the emplacement rate, because the fuel goes to the MRS facility for packaging and temporary storage, if necessary.

Generators of High-Level Waste

In the improved-performance system, commercial and defense high-level waste will be handled in exactly the same way as described for the authorized system except that the transportation routing may be via the MRS facility so that the high-level waste shipments to a repository can be combined with a spent-fuel shipment.

Monitored Retrievable Storage

In the improved-performance system, the MRS facility is an integral part and will perform most if not all of the packaging operations previously described for the surface facility of the repository. In particular, the MRS

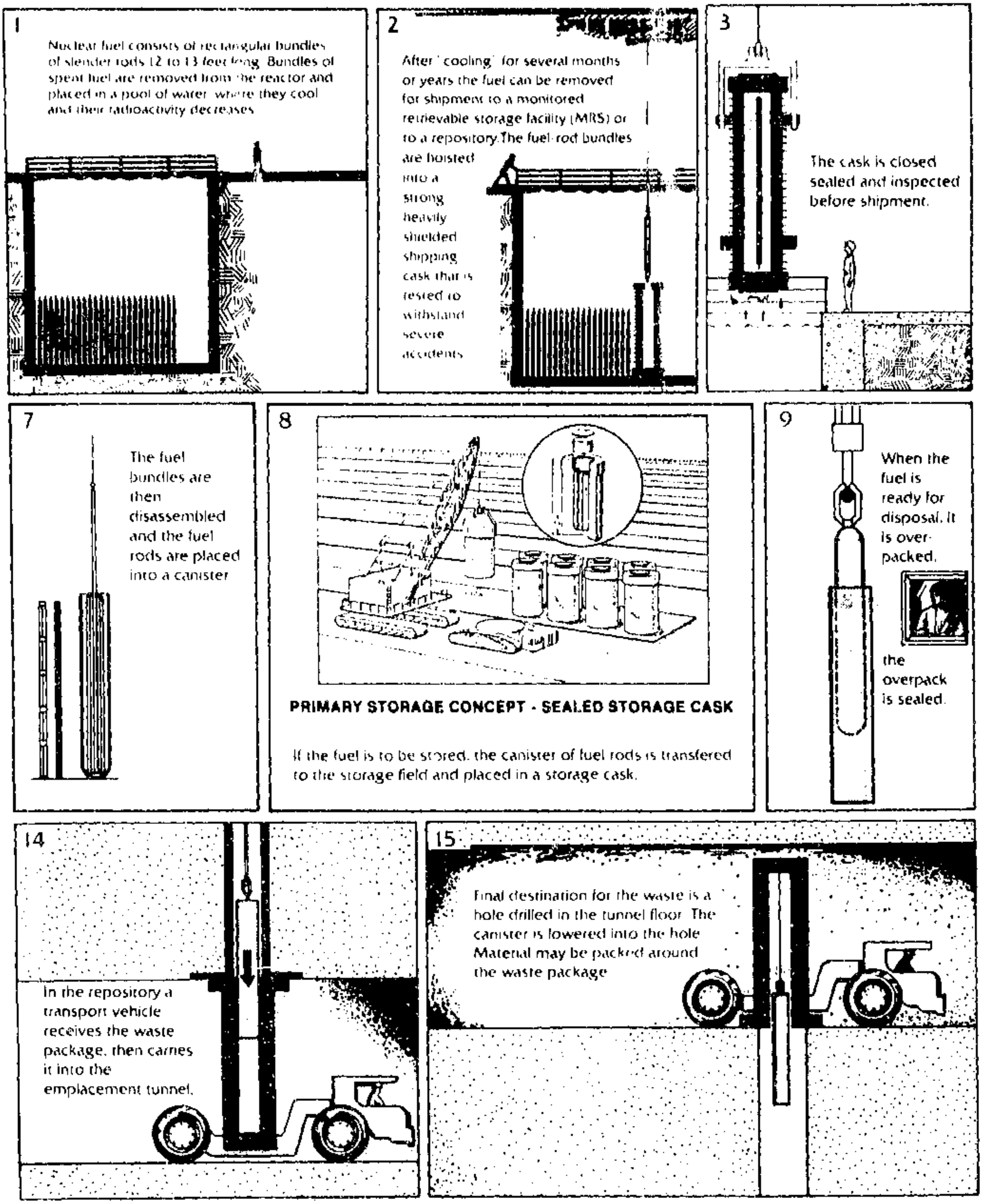

Figure 3-21. Illustration of the improved-performance-system concept.

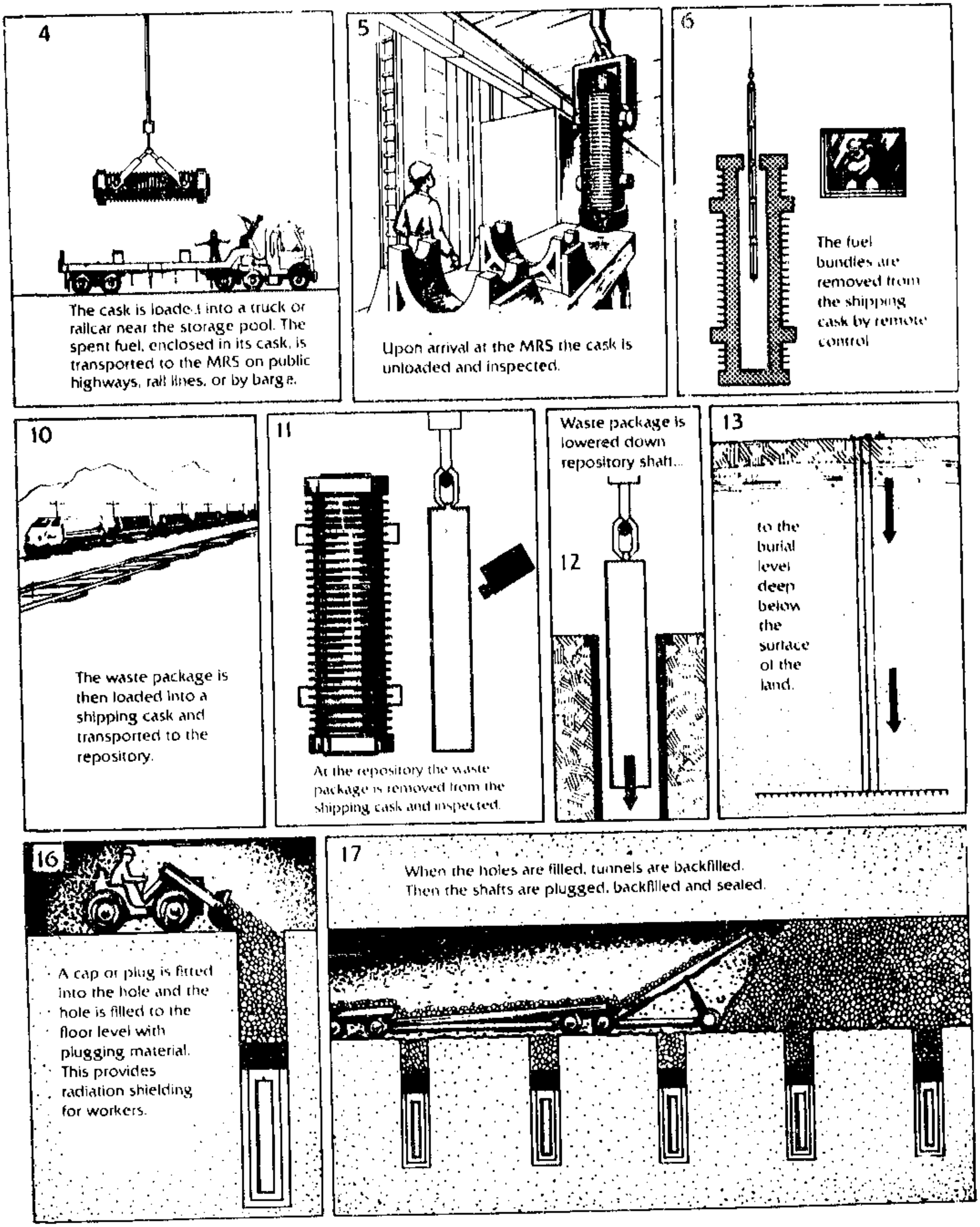

Figure 3-21. Illustration of the improved-performance-system concept (continued).

facility will (1) receive spent fuel from most or possibly all reactors; (2) consolidate and package the fuel, including overpacking with disposal containers for permanent disposal in a repository, unless further studies show that overpacking should be done at the repository; and (3) temporarily store the fuel pending shipment to the repository. The MRS facility will be licensed by the Nuclear Regulatory Commission. The design storage capacity of the facility will be limited.

The MRS facility will be located centrally with respect to the reactors to be serviced. It will be designed to receive spent fuel at a rate of about 3000 MTU per year. On arrival at an MRS facility, spent-fuel assemblies will be removed from the shipping cask. Each fuel assembly (unless already consolidated) will then be dismantled, and the fuel rods will be consolidated and loaded into canisters. These canisters will be capped, filled with an inert gas, welded shut, inspected, and readied for further handling or packaging operations. The hardware remaining from the disassembly operation will be compacted and loaded into similar canisters.

Canisters that are to be stored at the MRS facility will be removed from a hot cell in which remote fuel-handling operations are performed and then stored in dry storage casks or possibly dry wells. Figure 3-7 (see Section 3.2.1) illustrates a concept of the MRS facility and dry-cask storage. Vault storage at the MRS is being evaluated.

The spent-fuel canisters will be loaded into licensed transportation casks and shipped from the MRS facility to the geologic repository. It is assumed that dedicated trains will be used. The MRS facility may also repair damaged containers received from the repository. As already mentioned, the lifetime of the MRS facility will be limited to the period necessary to support the emplacement of waste in the repository and the specific period during which the waste is to be retrievable from the repository.

Geologic Repository

With the MRS as an integral part of the waste-management system, the main operations performed in the surface facilities of the repository would be reduced to (1) receiving waste and (2) inspecting the waste containers received for emplacement. Additional operations that may be performed in the surface facilities are (1) the installation of spent-fuel disposal canisters if necessary and if not done at the MRS facility; (2) overpacking of high-level-waste canisters with disposal containers, if necessary and if not done elsewhere, (3) repair of any damaged waste containers that are received if not sent back to the MRS facility for repairs, and (4) possibly packaging for disposal the fuel received from nearby reactors. The interface between the MRS facility and the second repository cannot be defined at this time, because it will primarily depend on the locations of the MRS facility, the second repository, and the reactors being served. The necessity for a second MRS facility will be evaluated when the site of the second repository is selected.

Transportation

Spent fuel will be transported from reactors located in various parts of the country to either an MRS facility or a nearby repository, as well as between the MRS facility and the repository. Solidified high-level waste will be either transported directly to a repository from the sites at which it was produced or to the MRS facility for combination with other waste forms. Since the spent fuel will be consolidated at the MRS facility, packages of consolidated fuel can be shipped in unit trains, thereby minimizing the number of shipments to the repository.

Conclusion

The improved-performance integrated waste-management system will satisfy the requirements of the Act and appears to be a significant improvement over the authorized system. Further details of the system and plans for its implementation are being developed. This improved system can be implemented only if the Congress authorizes an MRS facility. The DOE plans to request such an authorization in January 1986. A more detailed discussion of the MRS facility is presented in Section 3.2.1 of this chapter.

Chapter 4

INSTITUTIONAL PLANS AND ACTIVITIES

The mission of the institutional program is to support the overall program goal of establishing a safe and environmentally acceptable system of facilities, equipment, and operations for handling, transporting, storing, and disposing of spent fuel and high-level waste.

To ensure full participation by States and affected Indian tribes in the implementation of the DOE's waste-management program, the Act sets forth one of the most comprehensive outreach and involvement plans ever mandated by Congress. The major features of the Act in this regard include extensive provisions for notifying affected parties of the DOE's planned activities and soliciting their comments; consulting and cooperating with States and affected Indian tribes and committing plans for such interactions to written agreements; assessing the effects of program activities on States, affected Indian tribes, and localities at frequent intervals throughout the program; and providing for a substantial commitment by the DOE to avoid, mitigate, or compensate for any negative impacts.

The DOE is committed to follow both the letter and the spirit of the law to ensure a full and timely flow of information about the program to all affected parties and to provide frequent opportunities, both formal and informal, for the fullest possible participation in the program. The achievement of this goal depends on developing and maintaining information and interaction programs that meet the needs and address the concerns of States and affected Indian tribes, local governments, affected citizens, the general public, and other interested parties.

The DOE's information and interaction programs will demonstrate its commitment to--

1. Conduct activities in an open environment.

2. Listen to and understand the concerns of interested parties.

3. Actively involve affected parties in the program.

4. Execute faithfully the intent of Congress as expressed through the Act.

5. Provide equitable treatment for all parties affected by the implementation of the Act.

Toward these ends, the DOE is developing an institutional program that has three related elements:

1. Outreach and participation: activities to ensure that accurate, understandable information about the program is communicated to interested parties and that affected parties are involved in the program.

2. Consultation and cooperation (C&C): activities associated with negotiating and implementing formal consultation-and-cooperation agreements that will establish the foundation for interaction with States and affected Indian tribes.

3. Socioeconomic analysis and impact mitigation: activities to ensure that affected parties are actively involved in the planning of efforts to assess the impacts of program activities and to eliminate, mitigate, or compensate for any negative impacts.

In carrying out the waste-management program, the DOE will also ensure close and frequent interaction with other Federal agencies with responsibilities under the Act.

4.1 OUTREACH AND PARTICIPATION

4.1.1 GOALS AND INTENTIONS

Successful implementation of the waste-management program requires an informed and involved public, especially in those States and communities that may host a facility or may be along transportation routes. The better the public is informed, the better able it will be to participate constructively in planning the program. Through close and frequent interaction, the concerns and interests of all affected parties can be identified and addressed in a cooperative manner. Toward these ends, the DOE will endeavor to--

1. Identify the changing information needs of Governors, State legislators, the governing bodies of interested and affected Indian tribes, local governments, industry and environmental groups, other interested organizations, and the general public as the waste-management system is defined, designed, and implemented.

2. Communicate accurate, understandable information about the program to these groups.

3. Encourage the active involvement of interested and affected parties in the program.

4. Interact with Congress to report on the status of the program and respond to requests to answer inquiries from constituents.

4.1.2 IMPLEMENTING PLANS

Outreach-and-participation goals will be realized through the following major activities:

1. Discussing information and interaction needs with States, interested and affected Indian tribes, local representatives, and other interested parties.

2. Developing facility-specific outreach-and-participation programs based on input received from interested parties.

3. Maintaining an efficient system for responding to information requests and other correspondence.

4. Conducting regular, meaningful briefings for interested parties, including the Congress.

5. Holding informal, interactive information meetings and workshops.

6. Publishing materials and developing and presenting educational programs about the program.

7. Staffing community information offices.

8. Conducting formal hearings and soliciting public comments.

9. Providing financial assistance to particular groups to facilitate their participation.

Discussions with Affected Parties

In the States that may host a repository or storage facility, DOE officials will hold discussions with State, tribal, and local representatives before site characterization to gain a firsthand understanding of major program issues, information needs, and desired opportunities for input into program decisions. For example, the DOE will work with these representatives to identify the types of program information they would like to receive during the characterization of a candidate site for a repository and the form in which they prefer to receive it (e.g., small meetings, fact sheets, progress reports, or briefings). The DOE will also ask these representatives to specify how they would like to provide comments on program activities (e.g., small meetings, workshops, hearings, written comments).

Facility-Specific Outreach-and-Participation Plans

The information received during informal discussions with affected parties will be used to design outreach-and-participation activities that meet the needs of parties affected by the potential siting of a repository or a storage facility. These activities will be detailed in a facility-specific outreach-and-participation plan that will be available to the public. The DOE will also ask these parties to comment, on an informal and continuing basis, on the effectiveness of these information and participation activities. For example, during the site-selection process for a repository, DOE officials will hold further discussions with affected parties to determine additional information and interaction needs during the construction and the operation of the repository.

Responding to Information Requests and Other Correspondence

In addition to its efforts to identify information needs through discussions with interested groups, the DOE will respond to requests for information from Congress, State and tribal officials, local citizens, representatives of interested groups, and the general public. To ensure prompt responses to requests for information, the DOE is developing a computer-based data storage and retrieval system to organize and track its responses to information requests.

The DOE will also analyze the information in the system to determine areas of particular public concern. The DOE will call on the expertise of such organizations as the National Governors' Association, the National Conference of State Legislatures, the National Congress of American Indians, the Western Interstate Energy Board, and the Southern Interstate Energy Board to facilitate the flow of information to the public and to respond to questions and concerns about the program. Such assessments will enable the DOE to improve the content of its briefings, meetings, and publications.

Briefings

As the DOE meets project milestones, it will brief Congress, State and tribal officials, local citizens and officials, representatives of other interested organizations, and the public. Tentative briefing schedules will be developed after discussions with affected parties and will be specified in facility-specific outreach and participation plans. The DOE will provide advance notice of such briefings to State, tribal, or local representatives and seek their recommendations on how to schedule and structure briefings in a way that best meets identified needs. The DOE will also respond to requeste for briefings on plans for administering the waste-management program.

Meetings and Workshops

To ensure that all interested parties have access to program plans and have an opportunity to shape these plans, the DOE will respond to requests for meetings by interested and affected parties and may initiate meetings as well. These meetings will be directed toward the following:

1. Establishing a sound working relationship between the DOE and the affected communities.

2. Providing information about how the DOE is attempting to address the concerns of States, Indian tribes, and local communities.

3. Providing program status reports and answering specific questions.

4. Identifying and resolving concerns about the program.

For example, the DOE will meet with State and tribal representatives interested in how radioactive waste can best be transported, as well as representatives of the States and other groups that may be affected by storage and handling facilities and by programs for the first and the second repositories. These meetings will be structured to encourage interaction between the DOE and State and tribal representatives.

To provide opportunities for intensive discussions of issues, the DOE will continue to hold working sessions on specific issues or problems with groups of affected officials or citizens. For example, several meetings have recently been devoted to the subject of transportation of spent fuel and high-level waste. The persons who attended these meetings have generally commented favorably on the usefulnees of such sessions.

Publications and Educational Programs

The DOE will inform interested parties on the nature and status of the program through the formal documents required by the Act; through technical reports, pamphlets, brochures, bulletins, and other publications; and through press releases and news conferences.

The DOE will participate in technical conferences and meetings through presentations, exhibits, and publications. The exhibits will describe the various aspects of waste management and will note the availability of both technical and nontechnical literature on the waste-management program.

The DOE will initiate efforts to involve universities and scientific and technical groups to present objective information about the management of spent fuel and high-level waste to local groups and others involved in public education.

A large number of special interest groups will be affected by the program. Such groups include nearby residents and landowners, local and national environmental organizations, local civic and citizen groups, public utilities, public utility commissions, rate-payer organizations, the mass media, chambers of commerce (local and national), and many others. The DOE will endeavor to maintain communications with all such individuals or groups who express an active interest in the program. Periodic bulletins will be mailed to those who wish to stay abreast of program developments and upcoming events.

Community Information Offices

Among those citizens most interested and affected by the waste-management program will be those living in areas under consideration for a repository or a storage facility. To provide a local source of information for these citizens, information offices may be established, when appropriate or upon request. Such offices have already been established in some of the States under consideration for the first repository. These offices will contain the outreach-and-participation plan for the facility, project documents, nontechnical explanations of those documents, and the names of DOE staff to contact for more-detailed information.

Formal Hearings and Public Comment

The DOE uses formal hearings to identify issues that should be addressed in key program documents such as the siting guidelines, environmental assessments, site-characterization plans, and the environmental impact statement, and to receive comments on draft documents. The DOE will design hearings in a manner to make it as easy as possible to participate in the public hearing and public comment process. For example, the DOE will work with State, tribal, and local representatives to ensure convenient hearing times and locations. The DOE will also release drafts of program documents for review, whenever practicable, and provide for informal comment periods.

Comments received through hearings and in the formal written-comment process will be considered as the document is prepared or revised. A separate "comment-response document" may be issued, as was done with the general siting guidelines (10 CFR Part 960), or an index to the treatment of comments may be included as part of the document. In both instances, a clear and complete description of the procedures employed for addressing the formal comments will be made available to any interested party. The DOE will encourage comments on documents outside of formal hearings.

Financial Assistance To Facilitate Participation

The DOE will continue to provide grants and other financial assistance, as appropriate, to States, affected Indian tribes, and others to facilitate effective public participation in the program. In addition, the DOE will seek ways to encourage the involvement of other interested parties through grants and other technical or financial assistance. Grants to national organizations (e.g., the National Conference of State Legislatures, the National Governors' Association, and the National Congress of American Indians) will support the dissemination of information to members of the various groups. The DOE will also seek ways to facilitate effective participation by units of general local government that may be affected by program activities.

4.2 CONSULTATION AND COOPERATION

4.2.1 GOALS AND INTENTIONS

As noted in the preceding section, the DOE is undertaking an active outreach-and-participation program for States, Indian tribes, and other affected parties. Some of these activities will be specified in formal consultation-and-cooperation (C&C) agreements with States and the governing bodies of affected Indian tribes, as required by Section 117 of the Act.

Consultation and cooperation between the DOE and States and affected Indian tribes, however, is a dynamic process that will not be limited to activities specified in agreements. The DOE has initiated a series of informal meetings with first-repository States and tribes as well as a series of discussions with second-repository parties. The DOE intends to continue to work hard to build smooth working relationships as well as trust and confidence.

Some of the key goals of establishing an effective C&C process are as follows:

1. To establish a timely and substantive two-way information flow between the DOE and States and affected Indian tribes.

2. To assist States and affected Indian tribes in building the capability to study, comment, and make recommendations on program plans.

3. To provide States and affected Indian tribes with frequent opportunities to express their concerns.

4. To encourage States and affected Indian tribes to use the consultation-and-cooperation process as a means of developing mutually satisfactory project-management and communication arrangements.

5. To ensure that the DOE addresses concerns raised.

6. To identify and agree on formal conflict-resolution mechanisms that can deal with the objections raised by States and affected Indian tribes.

Formal C&C agreements between the DOE and States and affected Indian tribes will specify information and participation activities that reflect these goals.

4.2.2 IMPLEMENTING PLANS

The provision of timely and complete information to States and Indian tribes on plans and decisions made during all stages of site selection and development is instrumental for ensuring full participation. As technical program information is obtained and shared, the concerns of States and Indian tribes will be solicited, and these concerns will be taken into account to the maximum extent feasible in carrying out programmatic responsibilities. If, however, conflicts do arise, the DOE will endeavor to negotiate them to fulfill its responsibilities to site and construct a facility on schedule. To initiate and complete agreements that formalize this C&C process as quickly as possible and to use the financial-assistance programs to make the participation of States and affected Indian tribes more effective are program priorities. Ongoing and planned activities are described below.

Consultation-and-Cooperation Agreements

To ensure that States and affected Indian tribes are actively involved in the program, a formal C&C process will be established through the written agreements provided for in Section 117(c) of the Act. High priority will be placed on concluding these agreements promptly. No formal C&C agreements have yet been signed with any States or affected Indian tribes, although negotiations have been initiated with the State of Washington and the Yakima Indian Nation.

Training will be provided to DOE personnel involved in the negotiation of C&C agreements to improve their sensitivity to issues of concern to States and affected Indian tribes and to increase the likelihood of reaching early agreement. The DOE will also be receptive to requests from States and affected Indian tribes for such training in preparation for negotiations as well. Mutually agreed-upon negotiation procedures will be established to help ensure that the negotiations are productive and that an agreement can be reached within a reasonable period of time.

Communications with the general public concerning the status of negotiations in progress will be determined mutually by the parties in negotiation. Once a C&C agreement is signed, it will be made readily available to the public, through such mechanisms as the community information offices.

The terms of C&C agreements will vary, depending on the specific needs and interests of the particular State or affected Indian tribe; no two agreements are likely to be identical. The DOE, however, will seek agreements that--

1. Specify procedures for consultation and cooperation among the affected parties. These procedures will need to be applicable throughout the entire facility-development process. Because it is not possible to prescribe at an early date detailed mechanisms for the handling of all possible future concerns, the C&C agreement should stipulate procedures for modifying and amending the original agreement.

2. Include, to the maximum extent practicable, reciprocal obligations between the parties. For example, both the DOE and the State or affected Indian tribe should keep the other informed of planned and continuing activities and agree to similar schedules for providing comments on reports prepared by the other.

3. Provide for meetings and briefings, advance notice of significant decisions, detailed review of documents, and accountability for consideration of comments.

4. Make technical information available at the earliest possible time and to the fullest extent possible. Certain data, however, such as proprietary data or data protected by patents, will be subject to all applicable laws governing release. Every effort will be made to release information of a policy nature, such as policy working papers or excerpts thereof, at the earliest possible time consistent with the program's internal predecisional policy-development requirements.

5. Provide formal procedures for conflict resolution. They should be reciprocal (i.e., contain procedures by which the State or affected Indian tribe as well as the DOE can seek resolution of disputes concerning the agreement). The procedures should encourage the resolution of disputes informally, early in the process. Should informal means fail, the conflict-resolution procedures defined in the C&C agreement will be used. Either party to the agreement may invoke the procedures defined in the C&C agreement. Schedules for each step of the process should be established.

6. Identify key events that trigger negotiations for financial assistance as a particular site advances through the site-selection process, in order to ensure an orderly financial-assistance program.

A formal, comprehensive written agreement does not by itself ensure an effective C&C process. Equally important is the spirit in which the parties negotiate and implement the agreement. The development of good working relationships before the negotiation of the C&C agreement will help establish a record of good faith and set the stage for constructive negotiations. The agreement itself is also likely to influence the nature of the relationships. To the extent that the agreement is perceived by both parties as responsive to their needs, further cooperation will be fostered.

Consultation-and-cooperation agreements are also discussed in Chapter 3 of Part II.

Financial Assistance

Financial assistance helps provide the means for States, affected Indian tribes, and local communities to participate in the waste management program, including the activities authorized in the C&C agreements. The financial assistance described here is intended to enable the States and affected Indian tribes to participate in the C&C activities detailed above. Financial assistance to support impact-assessment efforts and to mitigate impacts is described in Section 4.3, "Analysis and Mitigation of Socioeconomic Impacts."

To date, all six States considered for the first repository and three affected Indian tribes have been awarded grants for participation in the program. The awards have totaled $2.15 million in fiscal year 1983 and $4.59 million in fiscal year 1984. Grants also have been extended to the States involved in the crystalline-rock program to enable them to participate in the screening phase of the second-repository program. These DOE awards have totaled $930,400 in fiscal year 1983 and $2.06 million in fiscal year 1984. Grants enable States and affected Indian tribes to review and comment on program documents, such as the siting guidelines and the Mission Plan, and to participate in program meetings and workshops.

In general, grant proposals will be submitted by the State or affected Indian tribe to the appropriate DOE Project Office. The DOE will endeavor to process grant applications as quickly as possible consistent with applicable Federal procurement regulations.

4.3 ANALYSIS AND MITIGATION OF SOCIOECONOMIC IMPACTS

4.3.1 GOALS AND INTENTIONS

The Act provides for financial and technical assistance to mitigate the impacts of waste-disposal activities. Many of the activities that may be undertaken by the DOE as part of the waste-management program could lead to social and economic impacts on States, affected Indian tribes, and communities in the vicinity of facilities or along transportation corridors. It is of the utmost importance that the potential for such impacts be assessed in a thorough and timely manner, with adequate planning to avoid, minimize, or mitigate any negative impacts.

States, affected Indian tribes, and local communities will pursue parallel paths with the DOE in their assessment and planning efforts. For example, the DOE will conduct socioeconomic-impact assessments for the environmental assessments and the environmental impact statement. States and affected Indian tribes may conduct their own socioeconomic-impact assessments to develop and document their requests for mitigation grants in the repository program. The DOE will work closely with States, affected Indian tribes, and localities during this process to achieve a common understanding of the issues that need to be addressed, the impacts that will need to be mitigated, and the analytical tools that will need to be used. Some of these efforts will be specified in the C&C agreements described in Section 4.2.

The key goals for addressing socioeconomic impacts throughout the facility planning and development process are as follows:

1. To attain a thorough understanding of the social and economic impacts of the program.

2. To avoid, minimize, or mitigate social and economic impacts to the greatest extent possible.

3. To ensure that the assessment of impacts and plans for their mitigation are developed with understanding of, and sensitivity to, the concerns of States, affected Indian tribes, and local communities--and with the cooperation of affected groups.

4.3.2 IMPLEMENTING PLANS

The goals for addressing socioeconomic impacts will be implemented through the following major activities:

1. Conducting socioeconomic impact assessments and working with States, affected Indian tribes, and local communities to develop a common understanding of the factors and issues involved, and to identify appropriate mitigation measures.

2. Developing mechanisms for providing financial and technical support for States, affected Indian tribes, and local communities in their own assessment and mitigation efforts.

3. Providing financial and technical support for impact mitigation to appropriate States, affected Indian tribes, and local governments.

Socioeconomic Studies

Socioeconomic studies have been and will be conducted by the DOE for the environmental assessments and environmental impact statements. These socioeconomic analyses examine a variety of potential impacts--demographic, economic, community services, social, and fiscal--on host communities. The impacts of related transportation will also be analyzed. A large body of institutional knowledge and experience from other energy-development projects, nuclear facilities, and waste-disposal activities is available to assist in this effort. To ensure that future analyses will be thorough and comprehensive, and will accurately represent the study areas, teams of socioeconomic specialists will be involved in the development of all major program documents, such as the environmental impact statement.

The DOE will endeavor to involve affected parties in the development of socioeconomic-impact analyses. Interaction is also planned with potentially affected residents at briefings and at public hearings, and through other mechanisms that may be developed as part of the formal C&C agreements or the facility-specific outreach-and-participation plans. Residents will have an opportunity to provide information on socioeconomic conditions in their community and to consult with the DOE on plans for assessing socioeconomic impacts. The DOE will work with States, affected Indian tribes, and localities to identify socioeconomic issues regarding the transportation of wastes through State and local jurisdictions.

Impact-Assessment Grants for States and Affected Indian Tribes

The Act specifies mechanisms whereby the DOE can provide financial and technical assistance for impact mitigation to States, affected Indian tribes, and localities that are affected by the construction of a repository. The nature and the level of such assistance will be based, in large part, on the socioeconomic-impact reports that the States or affected Indian tribes will submit at the time one site is recommended for development as a repository, and on discussions and negotiations between the DOE and States, affected Indian tribes, and communities.

Financial and technical support will be made available to States and Indian tribes affected by repository activities for the development of impact reports. This support can assist States and affected Indian tribes in examining the potential effects of a repository on public health and safety, the environment, and on social and economic conditions. Procedures will be refined, published, and followed in order to distribute financial assistance in a timely and efficient manner.

Many socioeconomic impacts, such as increased demand for public services, will affect local governmental units directly. For this reason the DOE will encourage the participation of local governments in the development of these impact reports as early and as fully as possible. Where the Act does not provide for direct grants to units of local government, the DOE will encourage the State to allocate a portion of its grant to affected localities. All possible means of financial and technical assistance will be explored to ensure that local communitiee can effectively participate in the siting program.

Technical and Financial Support for Impact Mitigation

The DOE will work with States, affected Indian tribes, and localities to develop impact-mitigation plans in response to the siting of repository and storage facilities. These plans will address ways to augment community services, as well as ways to minimize disruptions and maximize the benefits of new economic activities related to program activities.

In addition to providing support to the development of mitigation plans, funding will be provided for impact-mitigation efforts after the construction of the repository has been authorized by the Nuclear Regulatory Commission. Impact-mitigation funds can be provided throughout the period when impacts are occurring. Funds could be used, for example, for improving community services to accommodate project-related population growth. In addition, States, affected Indian tribes, and units of general local government are entitled to receive grants equal to the taxes they would have received were the project conducted as a private business.

The Act also provides for impact assistance to local communities in which a facility for monitored retrievable storage (MRS) facility is located. Such assistance is limited by the Act to use for planning, construction, maintenance, and provision of public services related to the MRS facility.

Concern has been expressed by potentially affected communities that the need to improve community services will occur before impact-mitigation funds are distributed. To resolve these concerns, the DOE will endeavor to work with States, affected Indian tribes, and localities to identify mechanisms that ensure timely provision of mitigation funding within the authorizations provided by Act. This issue is discussed further in Chapter 3 of Part II.

4.4 PLANS FOR INTERACTION WITH OTHER FEDERAL AGENCIES

4.4.1 GOALS AND INTENTIONS

The management of the radioactive waste involves the participation of numerous agencies of the Federal Government. The Act assigns lead responsibility for developing and implementing a program to the DOE; however, it anticipates significant roles for the following other agencies:

1. The Nuclear Regulatory Commission.
2. The Environmental Protection Agency.
3. The Department of Transportation.
4. The Bureau of Indian Affairs.
5. The Bureau of Land Management.
6. The U.S. Geological Survey.
7. The U.S. Army Corps of Engineers.
8. The Advisory Council on Historic Preservation.

The DOE has identified milestones that require interactions with these Federal agencies and support program decisions in its Project Decision Schedule, which was issued in preliminary draft form in January 1985 (DOE/RW-0018). The DOE's goals in interacting with other Federal agencies are as follows:

1. To ensure compliance with other Federal statutes and regulations.

2. To ensure a thorough and timely flow of information.

3. To identify issues that will require common resolution as early as possible.

4. To develop agreements on operating principles to guide agency-to-agency interactions, where appropriate.

4.4.2 IMPLEMENTING PLANS

The Project Decision Schedule has been developed in consultation with participating Federal agencies. These agencies will be interacting in updating the schedule. For example, if a Federal agency believes it cannot comply with any deadline identified in the Project Decision Schedule, it will notify the DOE. The DOE will then work with the agency to establish a new, mutually agreeable milestone. The DOE will also consult with agencies when changes to the program activities require changes in the schedule.

In addition to the formal interactions required for the DOE to obtain from other agencies needed concurrences, licenses, approvals, permits, leases, and rights-of-way or other approaches, the DOE will interact with the agencies through meetings and workshops to exchange data, information, and views on issues of mutual concern. Such meetings have been held and will continue as needed. An example was the frequent interaction with the Nuclear Regulatory Commission on the repository siting guidelines (10 CFR Part 960). Agreements on repository operating principles have been reached with the Nuclear Regulatory Commission the Bureau of Land Management and the Corps of Engineers, and the U.S. Geological Survey; they will be considered with the other agencies that are involved.

4.5 SUMMARY

The DOE's institutional program for implementing the waste-management program envisions a comprehensive system of collaboration, consultation, and cooperation with States, interested and affected Indian tribes, and other affected parties. In the spirit of the Nuclear Waste Policy Act, the DOE will work individually and collectively with these groups to ensure high standards of performance and to place the highest priority on protecting public health and safety and the environment.

The active involvement of all interested parties is solicited to help build an institutional process that supports the national commitment to the safe disposal of spent fuel and high-level radioactive waste.

The processes described in this chapter will be reviewed periodically to determine whether they support the Act in a manner that best serves the public interest. As technical programs evolve, the institutional plans that implement those programs will be updated to reflect current activities.

Chapter 5

PROGRAM MANAGEMENT

This chapter provides an overview of the organization of the Office of Civilian Radioactive Waste Management (OCRWM) and the management system used for the program. Being a part of the Department of Energy (DOE), the OCRWM is using the DOE's management philosophy and management systems to the extent possible. However, to meet the unique challenges of the waste-management program, the OCRWM is developing a program-management system to supplement the DOE systems. The OCRWM system is being developed and implemented at this time and will be documented when it is complete.

The Civilian Radioactive Waste Management Program has a complex mission that demands exceptionally effective management. The characteristics of the program that define the management requirements include the following:

1. Objective. The program has a specific, predetermined objective established by the Nuclear Waste Policy Act of 1982 (the Act) and agreed to by the parties to the contracts between the DOE and the owners and generators of the waste (spent fuel and high-level waste). This objective is waste acceptance by the DOE by January 31, 1998.

2. Uniqueness. The program and its implementing legislation (the Act) are complex, first-of-a-kind, and controversial.

3. Duration and cost uncertainty. The life cycle of this program extends for nearly a century at an estimated cost of more than $23 billion in constant 1984 dollars, but with considerable inherent cost uncertainty due to the unique nature of the program.

4. Financing basis. The program must be financed on a full-cost-recovery basis by fees largely calculated and collected many years in advance of providing the disposal services. The fees are collected from electric utilities and other owners and generators of waste; general tax revenues are not used.

5. Quality-assurance requirements. The program must provide for the achievement and assurance of quality in order to protect the health and safety of the public and to meet other mission objectives in a timely and cost-effective manner.

6. Institutional requirements. The program has extensive, but essential, institutional requirements (e.g., consultation and cooperation with States and affected Indian tribes, public involvement, and coordination with other Federal agencies).

7. Management control. The program requires strong, centralized management because it is executed through a geographically dispersed network of Project Offices and contractors.

These features distinguish the DOE's waste-management program from most Federal or private-sector activities. They also impose special requirements for management organization and systems.

The first three sections of this chapter define program-management goals and objectives (Section 5.1), describe the program-management organization (Section 5.2), and discuss the program-management system (Section 5.3). The management of funds is covered in Section 5.4, which is followed by a discussion of the acquisition strategy (Section 5.5). The other topics covered in the remainder of the chapter are quality assurance (Section 5.6), safeguards and security (Section 5.7), peer review (Section 5.8), administrative support services (Section 5.9), and international activities (Section 5.10).

5.1 PROGRAM-MANAGEMENT GOALS AND OBJECTIVES

The overall program-management goal is to ensure the successful and cost-effective execution of the waste-management mission in accordance with the Nuclear Waste Policy Act of 1982.

The specific objectives of the management system designed to accomplish this goal are as follows:

1. <u>Effective program planning</u>. Define and support program planning procedures that will efficiently allocate time and resources to well-defined program objectives.

2. <u>Effective use of systems engineering</u>. Define and support systems engineering activities that will optimize the configuration of a waste-management system meeting programmatic, legal, health and safety, technical, and economic requirements.

3. <u>Effective program execution and monitoring</u>. Develop, implement, and enforce program-execution and program-monitoring procedures, including quality assurance, to achieve technical, cost, and schedule objectives.

4. <u>Effective cost control</u>. Define and support effective methods and adequate incentives to control expenditures and to minimize the costs of the program.

5. <u>Reliable estimates of costs and revenues</u>. Define and support activities to develop documented and defensible forecasts of total-system costs and evaluations of fee adequacy that will help to ensure that revenues will be adequate for the full recovery of all costs.

6. <u>Sound financial management</u>. Provide sound financial management and accountability for all revenues and expenditures in a manner that will instill and maintain public confidence in the administration of the nuclear waste funds.

7. Effective institutional and outreach programs. Define and support institutional and outreach activities that will promote understanding of the program and cooperation by States, affected Indian tribes, the general public, the industry and the utilities, and other Federal agencies.

5.2 PROGRAM-MANAGEMENT ORGANIZATION

The Act assigned to the DOE responsibility for the permanent disposal of spent fuel and high-level waste and created the Office of Civilian Radioactive Waste Management for this purpose. This Office is headed by a Director appointed by the President, by and with the advice and consent of the Senate. The Director is responsible for carrying out the functions of the Secretary of Energy under the Act and reports directly to the Secretary.

The OCRWM's management organization is consistent with the DOE's overall philosophy of program planning, guidance, and control by DOE Headquarters, with project execution being accomplished through the DOE Operations Offices and Project Offices established within the Operations Offices. Accordingly, Headquarters (i.e., OCRWM) provides policy guidance, program direction, and technical review, while the Project Offices and their contractors are responsible for the execution of projects and the day-to-day management of project performance. The sections that follow describe the OCRWM organization, the support received from other DOE offices, and the responsibilities of the Operations and Project Offices.

5.2.1 OCRWM ORGANIZATION

As shown in Figure 5-1, the OCRWM is organized by functional responsibility and staff responsibility. The three major functional components are (1) Resource Management; (2) Geologic Repositories; and (3) Storage and Transportation Systems. Policy, Integration and Outreach provides staff support.

The Director of the OCRWM recommends program policy to the Secretary of Energy and ensures that the activities of OCRWM components are properly focused, paced, and integrated. He also guides the Project Offices in implementing major program decisions.

5.2.1.1 Resource Management

The Office of Resource Management administers the Nuclear Waste Fund and the Interim Storage Fund, which are discussed in Section 5.4. This responsibility, carried out in coordination with the Assistant Secretary for Management and Administration, encompasses fee collections and payments; annual reviews to determine the adequacy of the fee collected from the owners of the waste; and contract-management activities. Other functions include the preparation of OCRWM budgets, financial management, and management information and data systems. The Office is also responsible for the development and maintenance of the OCRWM program-management system, the management of contracts

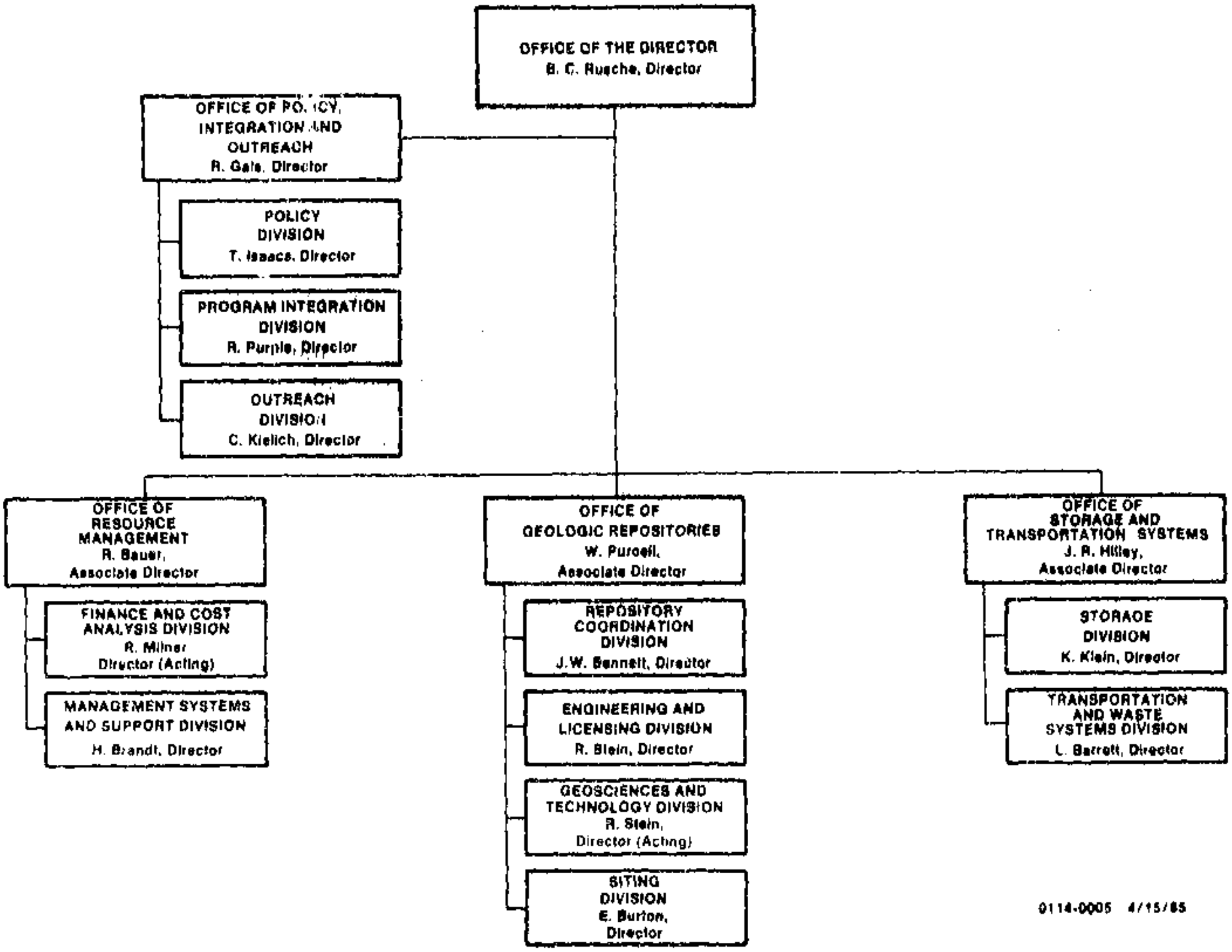

Figure 5-1. The Office of Civilian Radioactive Waste Management.

between the DOE and the owners of the waste, and the traditional management-support functions associated with subcabinet offices.

5.2.1.2 Geologic Repositories

The primary responsibility of the Office of Geologic Repositories is to site, design, construct, operate, close, and decommission geologic repositories for spent nuclear fuel and high-level waste. As described in more detail in Section 3.1 of Part I, this responsibility includes the screening and characterization of potential sites for geologic repositories; recommendation of sites; the design and development of repositories and waste packages; the preparation of documents to meet all regulatory, licensing, safety and health, environmental, and quality-assurance requirements; cooperating and consulting with States and affected Indian tribes; evaluating the need for and designing a test and evaluation facility; and managing the research and development of disposal technology for both repositories and alternative means of permanent disposal.

5.2.1.3 Storage and Transportation Systems

The Office of Storage and Transportation Systems implements all interim or long-term storage and transportation activities (see Sections 3.2 and 3.3 in Part I). A key responsibility of this Office is to develop an integrated approach that coordinates the entire system of repositories, waste preparation, handling, and transportation. The Office is also developing for submittal to Congress a proposal to construct facilities for monitored retrievable storage and to develop a Federal capability to provide interim storage for up to 1900 metric tons of spent nuclear fuel if utilities determined eligible by the Nuclear Regulatory Commission submit a request for such storage.

5.2.1.4 Policy, Integration and Outreach

The Office of Policy, Integration and Outreach has primary responsibility for providing central staff support to the OCRWM Director and Associate Directors in policy formulation, program planning, and the general oversight of program execution. The Office evaluates program accomplishments and ensures the integration of the activities performed by the OCRWM and the Operations Offices, including international activities. The Office has the responsibility to oversee the application of environmental, safety, health, and quality-assurance policies, standards, and regulations in the execution of the waste-management program. In addition, the Office independently monitors program interaction with external organizations to observe the effectiveness and quality of policy implementation. The Office also coordinates communications and public affairs and is responsible for the development and implementation of the OCRWM institutional relations policy.

5.2.2 SUPPORT FROM OTHER HEADQUARTERS OFFICES

Other organizations in the DOE provide essential support to the Civilian Radioactive Waste Management Program, and certain functions can be performed only by other DOE offices. The most important contributions are made by the Office of General Counsel; the Office of the Assistant Secretary for Management and Administration; the Office of the Assistant Secretary for Environment, Safety and Health; the Office of the Assistant Secretary for Congressional, Intergovernmental and Public Affairs; and the Energy Information Administration. In keeping with the full-cost-recovery basis for program execution, the OCRWM reimburses other DOE units for the support they provide.

The Office of General Counsel is the source of legal reviews and opinions on the interpretation of statutes, contracts, and other legal instruments relating to the funds. It also coordinates litigation with the Department of Justice.

As briefly explained below, four offices within the Office of the Assistant Secretary for Management and Administration provide support for the waste-management program: the Office of the Controller, the Procurement and Assistance Management Directorate, the Office of the Director of Administration, and the Office of Project and Facilities Management.

The Office of the Controller integrates the OCRWM budget into the DOE budget and coordinates it with the Office of Management and Budget; develops Fund-administration policies and procedures; and performs Headquarters accounting and administrative activities for the Nuclear Waste Fund. The Procurement and Assistance Management Directorate develops and administers internal procedures and controls for contracting activities; negotiates and executes contracts between the DOE and the utilities for the disposal or storage of radioactive wastes and for support services; and provides contract-administration oversight. The Office of the Director of Administration provides administrative support services to the OCRWM, prepares quarterly estimates of Headquarters support costs, and coordinates with the OCRWM in developing personnel-cost estimates. The Office of Project and Facilities Management provides departmental guidance for the implementation of project-management systems as well as independent assessments of program performance and cost estimates.

Within the Office of the Assistant Secretary for Environment, Safety and Health, the Office of Environmental Compliance provides expertise and environmental assistance and guidance, facilitating compliance with applicable Federal, State, and local regulations and laws.

The Office of the Assistant Secretary for Congressional, Intergovernmental and Public Affairs provides assistance in developing, managing, and coordinating relations with Congress; the news media; the governments of States, affected Indian tribes, and local jurisdictions; other Federal agencies; and the general public.

Under a memorandum of understanding, the Energy Information Administration (EIA) provides projections of spent-fuel discharges, nuclear power generation, and the revenues collected into the Nuclear Waste Fund. The EIA also collects all necessary data, validates all amounts owed by each utility or other owner of spent fuel existing prior to April 7, 1983, and verifies that the fees due on electricity generated by nuclear power are accurately reported by the utilities.

5.2.3 OPERATIONS OFFICES AND PROJECT OFFICES

Four of the DOE's Operations Offices are involved in the waste-management program and are assigned responsibility for major projects. The Operations Offices perform their waste-management work through Project Offices, which, in turn, rely on prime contractors. This arrangement is well suited for the Civilian Radioactive Waste Management Program because the work of its repository projects is focused on sites in various parts of the country, and the management of these projects can be best accomplished in the field.

The DOE Operations Offices that are involved in the waste-management program are the Albuquerque, Chicago, Nevada, and Richland Operations Offices. The latter three are responsible for evaluating the suitability of sites for geologic repositories in four different host rocks (basalt, salt, tuff, and crystalline rocks), designing repositories and waste packages that are compatible with a particular host rock, demonstrating the performance of the total system, and conducting all attendant regulatory and institutional activities. In addition to its involvement in the geologic-repository program, the Richland Operations Office is also responsible for performing studies related to monitored retrievable storage and for research and development in spent-fuel disposal. The Albuquerque Operations Office is responsible for transportation systems and for subseabed disposal (see Section 3.1). The OCRWM projects assigned to the Operations Offices are presented in Figure 5-2, which also shows the prime contractor for each project.

The DOE Operations Offices perform a variety of project management and administration functions. In addition to administering contracts, they

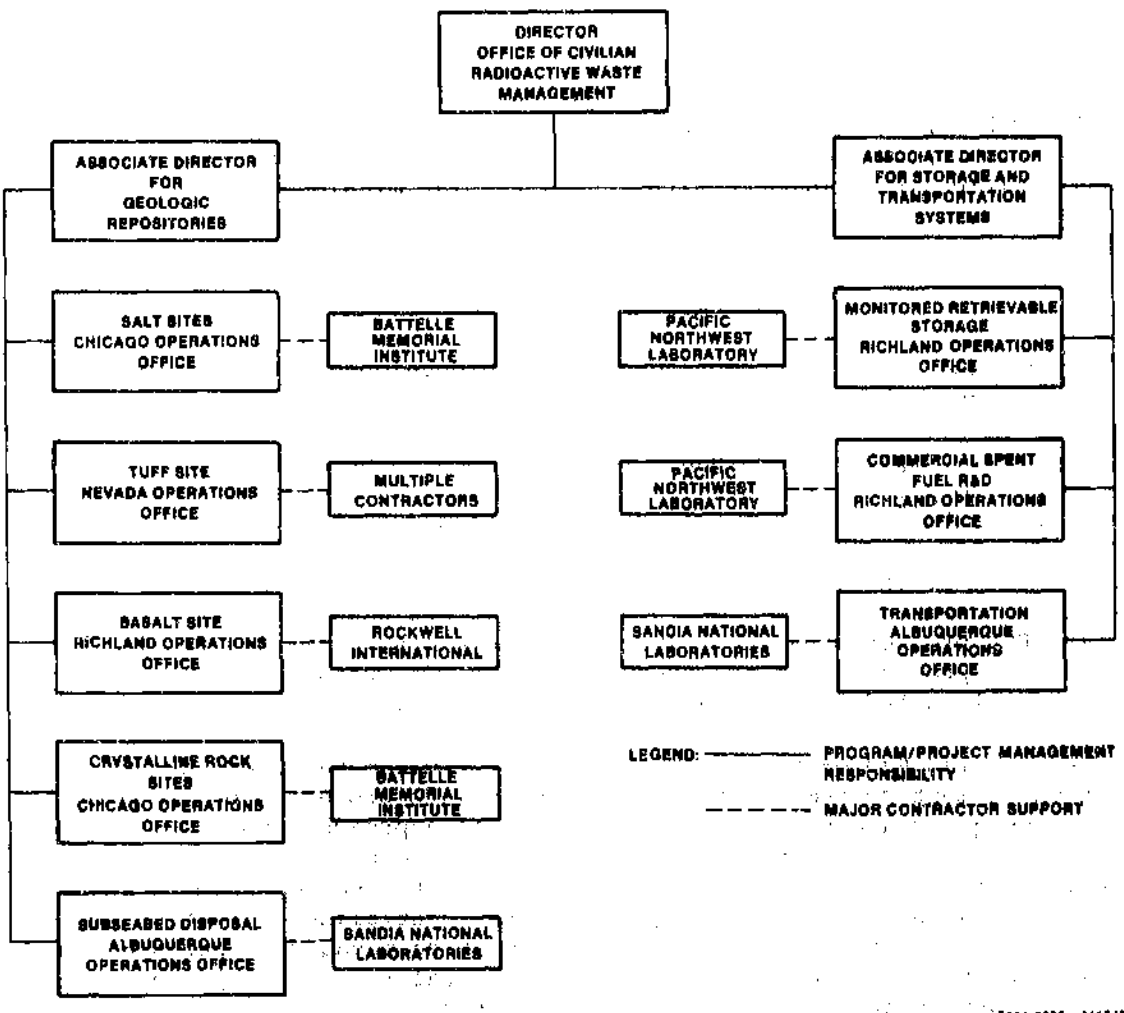

Figure 5-2. DOE Operations Offices and prime contractors responsible for major projects.

provide support services in accounting, budgeting, quality assurance, procurement, and the like.

OCRWM Project Offices are part of the above-mentioned DOE Operations Offices, but they report to the OCRWM Director and his designees for overall program policy guidance and for the technical direction and review of project performance. The Project Offices are responsible for providing detailed guidance and oversight to the prime contractors.

The prime contractors are responsible for the performance of the work under DOE direction. They also prepare detailed project plans, schedules, cost estimates, and budgets. Work that is not performed directly by the prime contractors is subcontracted to firms that have the technical expertise needed for specific tasks. Among the prime contractors and subcontractors are the national laboratories (e.g., Sandia National Laboratories, Lawrence Livermore National Laboratory). Under DOE direction, these contractors spend approximately 85 percent of the total Nuclear Waste Fund budget. (A more detailed discussion of the overall procurement approach for the program is presented in Section 5.5.)

All of the Project Offices must conform with existing DOE procedures and orders for project management, including the uniform guidance in DOE Order 5700.4A for DOE project-management systems. While working under this uniform guidance, each Operations Office has some autonomy to organize and manage its responsibilities in accordance with its particular mission.

5.3 PROGRAM-MANAGEMENT SYSTEM

The DOE and its predecessor agencies have developed an effective project-management system that has been used for a wide variety of projects. (A project is a specific, well-defined effort within a program.) The DOE project-management system provides guidance for the procurement of the goods and services needed to carry out a project, and it describes the data and control systems needed to ensure that the work is performed on time and cost effectively. The DOE's project-management system for major systems acquisition and other elements of the DOE project-management system are documented in a series of detailed directives (DOE Order 5700.4A) that are used internally within the DOE. The DOE project-management system was developed primarily for the management of projects that are executed by the DOE Operations Offices. It is therefore well suited for the management and control of the OCRWM projects.

The Civilian Radioactive Waste Management Program has used the DOE project-management system for the management of its projects, but some of the program's unique characteristics require special approaches to provide effective program-management control. For example, the mandate of full cost recovery and the OCRWM's commitment to control costs and to minimize adjustments to the waste-disposal fee require strong, centralized direction and control. In addition, the individual projects must be managed as parts of an integrated waste-management system, and the several repository projects are parallel efforts that must be closely coordinated.

Therefore, the overall management and control of the program are exercised by the OCRWM Director and his staff from Headquarters. Responsibility for the execution of the technical projects is delegated through the Associate Directors to the Project Office Managers, who manage the activities on a day-to-day basis. The management of detailed technical work and individual contractor tasks is best performed locally where DOE staff can monitor progress and deal with problems as they arise. However, progress on each individual project is reported to Headquarters on a regular basis to enable the OCRWM Director to control overall cost, schedule, and technical performance.

A major element of the DOE project-management system is the Field Work Package Proposal and Authorization System (WPAS). Within this system, DOE Headquarters organizations like the OCRWM have the responsibility for developing program plans for achieving their goals. The work required to execute a program is divided into a group of discrete elements in a work-breakdown structure. Within the OCRWM, the Associate Directors are responsible for providing overall guidance for the elements of the work-breakdown structure in their areas of technical responsibility, with the work in each element to be performed by the Project Offices and their supporting contractors.

The OCRWM is now developing a program-management system to meet the unique requirements of the Act and to comply with the existing DOE project management system. The OCRWM program management system (PMS) makes maximum use of existing and proved project-management mechanisms both to avoid repeating past mistakes and to ensure compliance with Federal regulations. Many elements of the OCRWM system are already in place, and current plans are to document and fully implement it during calendar year 1985.

The OCRWM program-management system will provide a set of management tools needed to ensure that the performance of individual projects is integrated into a program that develops and implements a total waste-management system and to document these management systems so that they can be uniformly and effectively used throughout the program. In summary, the OCRWM program-management system is a union of existing DOE management systems and additional systems needed to meet the unique needs of the program.

The OCRWM program-management system will be documented in a PMS manual. The PMS manual will provide a set of mutually supportive, interrelated policies and procedures designed to enable the OCRWM Director to plan and control the implementation of the program. A simplified illustration of the program-management system that shows the major management, control and reporting interfaces between Headquarters, the Operations Offices, and contractors is provided by Figure 5-3. Figure 5-4 shows more of the details of the program planning and control process; it also lists the major plans, reports, and systems that comprise the program-management system. The topics covered in the manual are summarized below.

Program Management Organization and Responsibilities. In this section, the management organization will be described in detail, including the assignment of functions, responsibilities, and authority for each level of management. This includes a summary of the responsibilities of the supporting Project Offices.

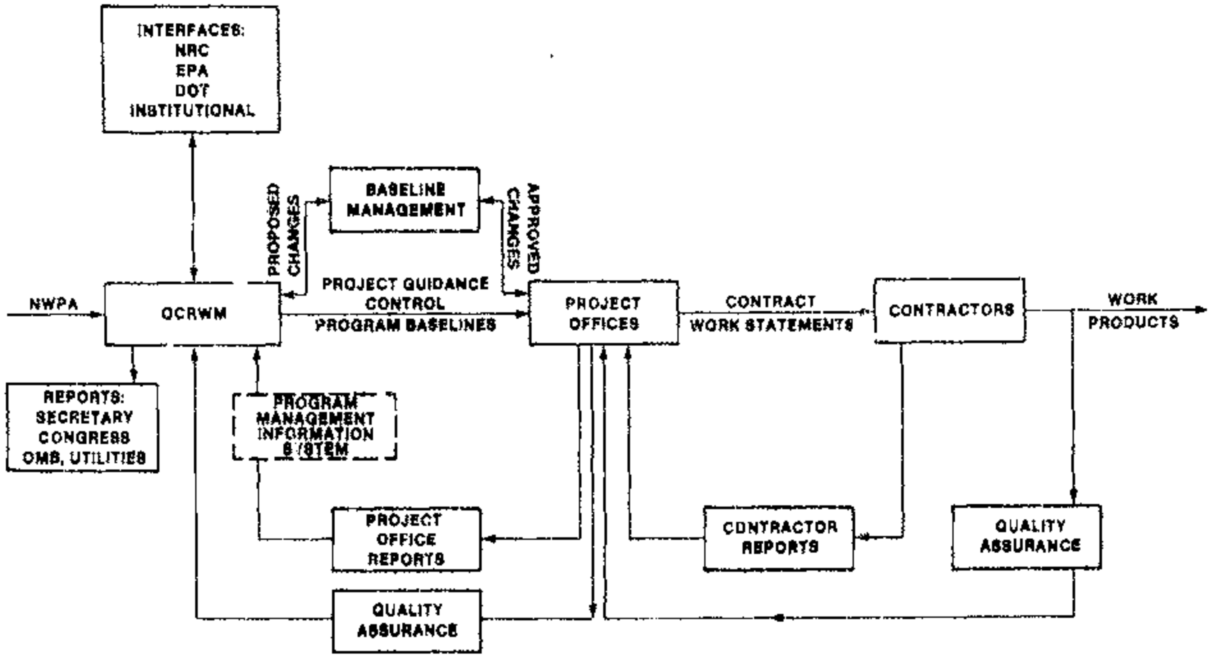

Figure 6-3. Overview of the management system for the Civilian Radioactive Waste Management Program.

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Program Documentation. This section will list and categorize the reports and other documentation needed for the orderly planning and management of the program. Documentation includes reports to the Congress, planning documents, program and project baselines, and the detailed procedures for managing and conducting program activities. The top-level technical requirements and a description of the waste-management system as a whole are specified in the prescribed system requirements and description document. Requirements for similar documents for each program element are specified as illustrated in Figure 5-5. Also included in this section is a summary of the procedures that control the systematic modification of management and technical documents.

Program Functional Management. This section will describe several distinct management functions that are necessary for effective program planning and implementation. These include an annual management-by-objectives plan at the Headquarters level to identify the major near-term milestones and responsibilities. A program-wide work-breakdown structure is required to ensure that all activities are identified and defined in a common framework and used for all appropriate management purposes. The systems-engineering process is specified in a systems engineering management plan. Additional sections cover procedures and mechanisms for Fund management, quality assurance, the acquisition strategy, safety assurance, and the conduct of internal coordinating groups.

Program Controls. This section will describe the procedures for establishing program cost and schedule baselines and for conducting management reviews of program performance and making changes, as necessary, in the program baselines that result from those reviews. Central to effective

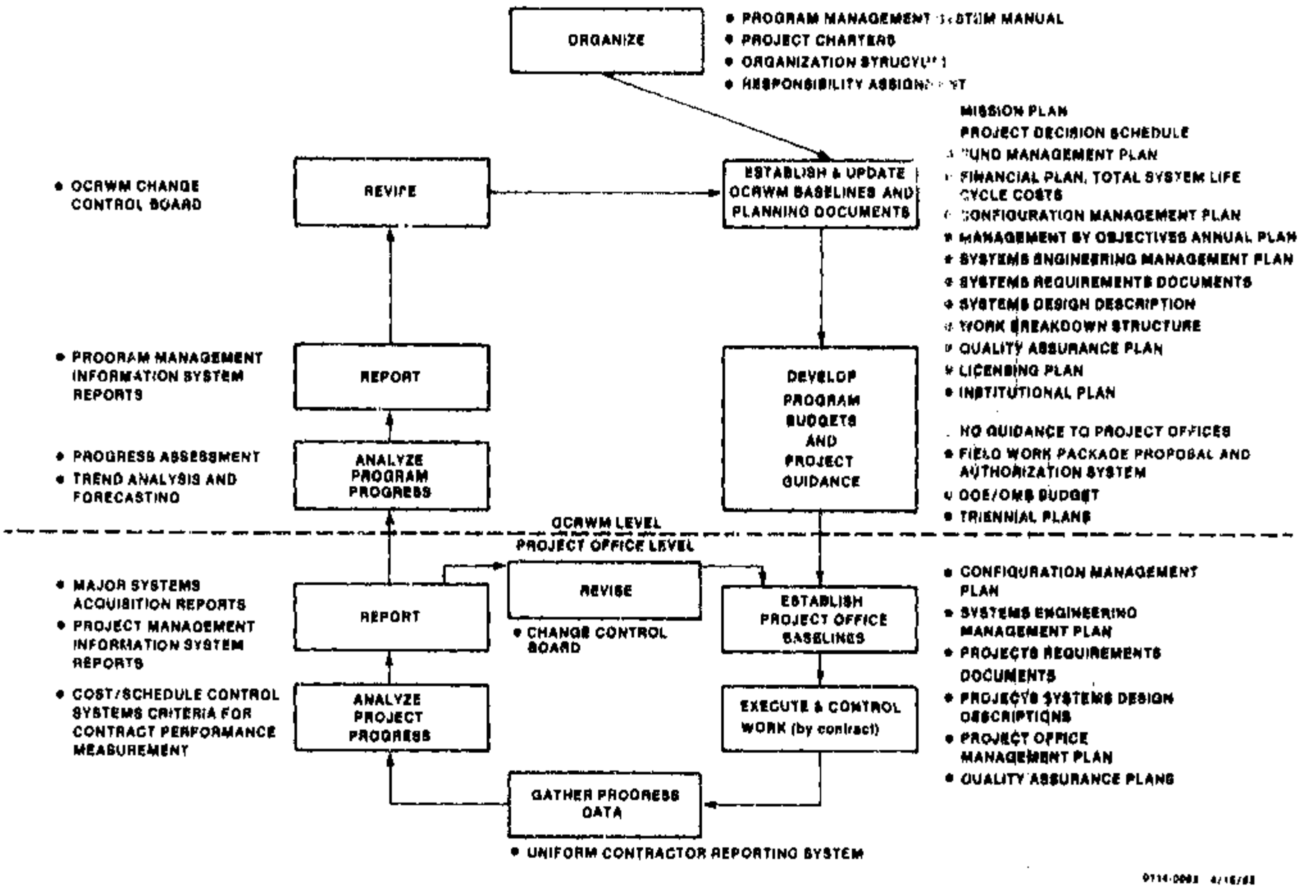

Figure 5-4. OCRWM program-management system: summary of processes and systems.

program control will be the OCRWM program-management information system (PMIS). The PMIS will provide the data and analytical capabilities needed to support the management-review and program-change procedures and mechanisms delineated in this section. This PMIS will make optimum use of data that are currently being collected by the Operations Offices. The analytical capability will be developed to project the effect of schedule changes on cost and program milestones.

Regulatory Compliance. In achieving its mission, the DOE will have to comply with applicable Federal laws and regulations. In addition, the DOE intends to comply with State and local laws and regulations consistent with its responsibilities under the Act. The program will be subject to frequent reviews, concurrences, and approvals by authorities outside the DOE. This section will describe the policies, procedures, and strategies needed to achieve compliance with the regulations and to receive the necessary approvals and concurrences.

Institutional Management Plan. A separate section will be devoted to the management of institutional affairs because of the exceptional importance of this activity in accomplishing the waste-management mission under the Act. This section will reference plans for public outreach and participation, procedures for conducting formal consultation-and-cooperation activities with

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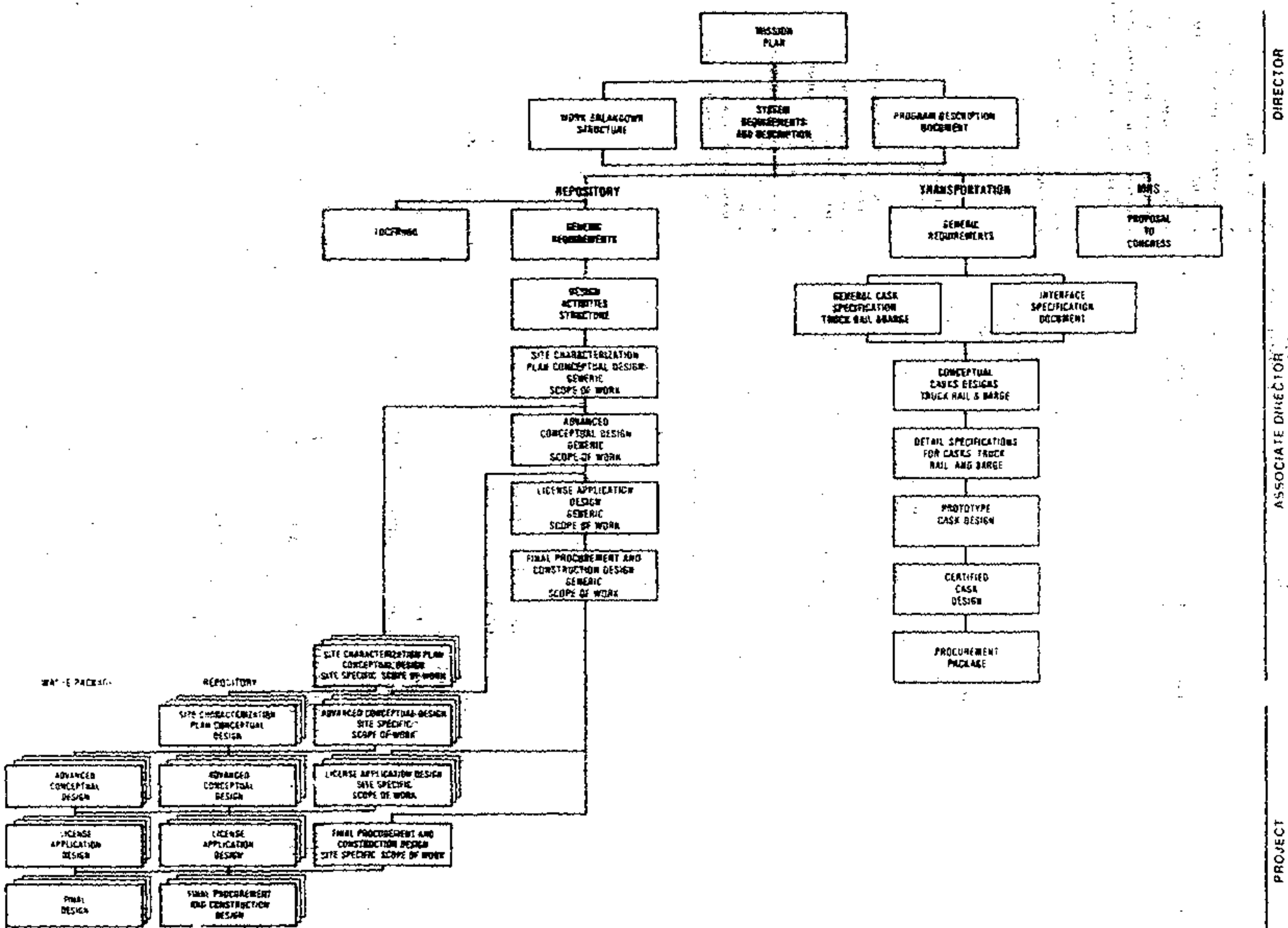

Figure 5-5. The major technical documents of the waste-management program.

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States and affected Indian tribes, an approach to the analysis and mitigation of socioeconomic impacts, procedures for interactions with other Federal agencies, and policies and procedures for integrating international activities in support of the program.

In summary, the program-management system, as set forth in the PMS manual, will be a centralized program-planning and program-control system. Its specific purpose will be to ensure a disciplined, systematic management approach that enables the OCRWM Director to plan, integrate, and control the decentralized execution of the individual projects that comprise the Civilian Radioactive Waste Management Program.

5.4 FUND MANAGEMENT

The Act stipulates that the cost of providing disposal and/or storage services is to be fully recovered by the Federal Government from the generators or owners of the waste. To implement this requirement, the Act establishes two special funds in the U.S. Treasury: the Interim Storage Fund and the Nuclear Waste Fund. The Act contains provisions covering the sources and the uses of these funds and requires formal contracts between the DOE and the electric utilities defining the rights and the obligations of the parties.

Federal interim storage of spent nuclear fuel is to be provided only for utilities that submit a request to, and are determined eligible by, the Nuclear Regulatory Commission. To date, no such requests have been made, and the Interim Storage Fund has not been activated.

The management of the funds for the Civilian Radioactive Waste Management Program is of special significance because the program is fully financed by fees collected by utilities from their ratepayers. It is complicated by the requirement that these fees, which are deposited into the Nuclear Waste Fund, be largely calculated and collected many years in advance of the provision of the services. Thus, the unusual financial provisions of the Act impose requirements on the OCRWM that transcend traditional financial management by the Federal Government.

Although the Civilian Radioactive Waste Management Program is essentially self-financed, the Nuclear Waste Fund is included in the budget of the U.S. Government. Therefore, the program is subject to Executive Branch and Congressional budgetary processes, and expenditures from the Fund require authorization and appropriation by the Congress. Federal accounting and reporting procedures must be observed, and the General Accounting Office is required to conduct an annual audit of the program for the Congress. In addition, the Secretary of the Treasury must submit an annual report to the Congress on the financial condition and operations of the Nuclear Waste Fund.

The financial provisions of the Act also impose some of the standards and constraints applicable to a private business. The program must generate revenues sufficient to cover estimated costs. Conversely, expenditures must be controlled within the limits imposed by the revenues generated. In the short term, the program must borrow if available funds do not cover current expenditures and, conversely, may invest and earn interest during periods when income temporarily exceeds its needs. The OCRWM has contracted with a certified public accounting firm for an independent annual financial audit to reassure the utilities, the public utility commissioners, and the electricity consumers who ultimately pay most of the fees that generally accepted accounting principles are observed and that the financial statements and presentations of the OCRWM fairly and accurately present the financial conditions and operations of the Nuclear Waste Fund.

A fund management plan is one of the plans required under the OCRWM program-management system. That plan describes how the individual tasks inherent in management of the Nuclear Waste Fund are performed and integrated to accomplish the financial management and cost-control objectives of the Mission Plan. The major tasks being performed in accordance with this plan include estimating the life-cycle cost of the program, projecting the nuclear electricity-generating capacity, and evaluating the sufficiency of the fees; managing contracts with the utilities, preparing and executing budgets, accounting and reporting, implementing cash-management policies and procedures, and collecting and verifying fees; and auditing of the Nuclear Waste Fund. The most recent revision of the Fund Management Plan was issued in August 1984 (DOE/S-0019/1).

5.5 ACQUISITION STRATEGY

The Civilian Radioactive Waste Management Program encompasses several major systems to be procured at a number of separate locations. Furthermore, some of its activities (e.g., siting, construction, operation, and closure and decommissioning) will extend over a long time--approximately a century. Therefore, it is neither practical to use a single procurement approach nor feasible to prepare detailed procurement plans for all of the specific elements of the program at this time. Instead, acquisition strategies and procurement plans will be prepared and approved as needed in accordance with established policies and procedures.

Most procurements will be subcontracted through prime contractors who will conduct assigned work under the direction of the OCRWM Project Offices. As a general rule, design and construction management will be performed under negotiated contracts that are awarded through competition. Whenever feasible, construction materials, equipment, and supplies will be obtained competitively by a construction manager, using fixed-price contracts.

Individual acquisition strategies and procurement or business plans will be required in advance of requests for significant funding for each major element of the work-breakdown structure and for major subprojects. Reviews of these advance plans and strategies will be coordinated between the OCRWM and Project Offices and documented either by the originating office or, if appropriate, by a DOE business strategy group. This documentation will include the purpose of the project, the status of the program, and, whenever applicable, the tradeoff analyses performed and the incentives provided for developing and selecting minimum-cost alternatives for achieving the objectives of the project. All procurement activities will be guided by the policies and procedures in the OCRWM PMS manual and in accordance with DOE Order 5700.4A, the DOE's project-management system.

For all cases, the method of contracting and performance will be reviewed by the lead DOE Operations Office manager, by OCRWM program-element managers, and, as appropriate, by the OCRWM Director to ensure that procurements are in compliance with DOE procedures and regulations and OCRWM policies.

5.6 QUALITY ASSURANCE

A major and continuing commitment of the OCRWM is to achieve and ensure quality in all essential aspects of the program. To this end an integrated system of plans and actions is being established to achieve and ensure quality at all levels of the program from Headquarters, through Project Offices, to the participating contractors. The overall OCRWM quality assurance (QA) program will be established and maintained for the development of mined geologic repositories and storage and transportation systems.

The objective of the OCRWM QA program is to set forth QA policy and requirements for a disciplined QA program. This QA program will consist of systematic actions that will ensure and provide demonstrable evidence that the health and safety of the public are protected and that other program goals, such as reliability and maintainability, are achieved in a cost-effective manner.

The OCRWM is committed to ensure that the structures, systems, and components important to safety and the barriers important to waste isolation, as well as supporting engineering and technological data, are subjected to appropriate QA methods and procedures during the siting, designing, licensing, constructing, and operating of waste-management facilities.

Quality-assurance requirements for the OCRWM program have their origin in, and comply with, DOE directives, NRC licensing regulations, and national consensus standards. The principal DOE and NRC quality requirements for the program are shown in Figure 5-6. Specifically, the QA program is consistent with the applicable QA criteria of DOE Order 5700.6A (Quality Assurance); the NRC's 10 CFR Part 50, Appendix B (Quality Assurance for Nuclear Power/Fuel Reprocessing Plants); and the national consensus standard ANSI/ASME NQA-1 (Quality Assurance Program Requirements for Nuclear Facilities), which has been developed by the American National Standards Institute and the American Society of Mechanical Engineers. The criteria cover the following QA program elements:

1. Organization
2. Quality-assurance program
3. Design control
4. Procurement-document control
5. Instructions, procedures, and drawings
6. Document control
7. Control of purchased material, equipment, and services
8. Identification of materials, parts, and components
9. Control of special processes
10. Inspection
11. Test control
12. Control of measuring and test equipment

13. Handling, storage, and shipping
14. Inspection, test, and operating status
15. Nonconforming materials, parts, or components
16. Corrective action
17. Quality assurance records
18. Audits

Quality requirements will be selectively and judiciously applied on the basis of how important the item or activity is to safety, waste isolation, and mission performance criteria.

The OCRWM will continue to take the initiative in instituting new or modified QA requirements and guidance beyond those existing for the design, construction, and operation of nuclear facilities by focusing on the activities unique to geologic repositories, such as data collection, site characterization, and computer-code development. The OCRWM will also continue to support the long-standing DOE policy of encouraging the adoption of needed requirements by the organizations that write national consensus standards.

A focal point for the OCRWM QA program is provided by the CRWM quality management policies and requirements (QMPR) document. This document sets forth generic requirements for quality planning and management and defines responsibilities for quality achievement and assurance. It provides for quality indoctrination and training of management and technical personnel; the performance of management overviews and audits; and the communication of quality information, including quality progress and problems. Actions to achieve and ensure quality are described in progressively greater detail in the QA plans and procedures prepared by Headquarters, Project Offices, and participating contractors.

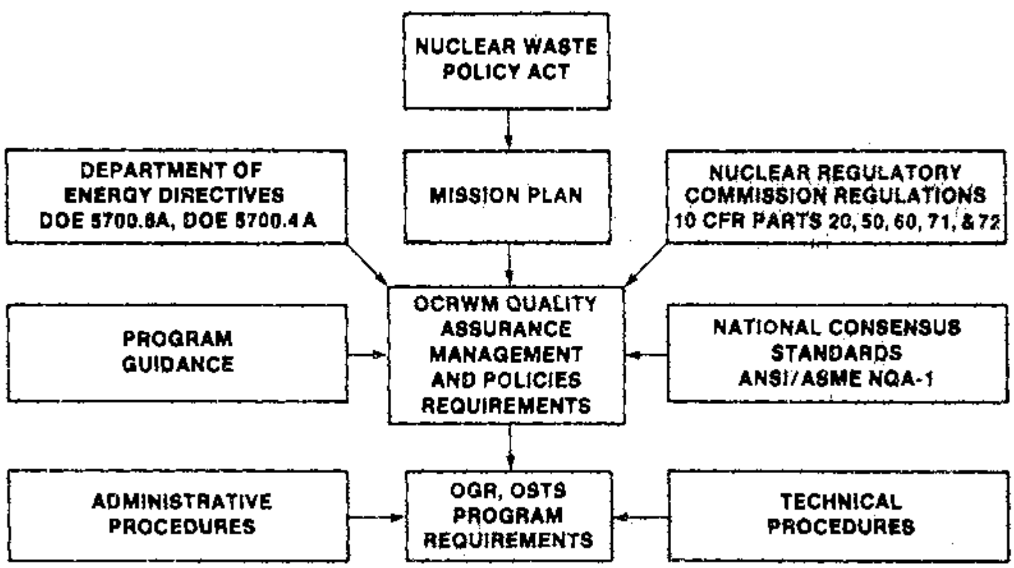

Figure 5-6. Generic quality requirements.

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The QMPR and the QA plans for Headquarters and Project Offices will be reviewed periodically and updated as necessary to incorporate major changes in policy, responsibilities, and requirements. Descriptions of the QA program will be incorporated into the site-characterization plans and other key documents.

Consistent with DOE policy, the achievement of quality is a primary responsibility of line management, and it will be independently verified by various methods by both the DOE and the contractors' line and QA organizations. For example, management overview and QA audits will be performed to ascertain the status and the adequacy of OCRWM and contractor management controls. Site-characterization, research, and design data will be subjected to technical, peer, or design reviews. Surveillance and inspection methods will be periodically used to monitor or accept work activities. All verification activities for the program will be planned, scheduled, and documented to provide objective evidence of procedural adequacy and compliance. The organizational relationships for the performance of quality overview and audits and the feedback of quality status and problems are shown in Figure 5-7.

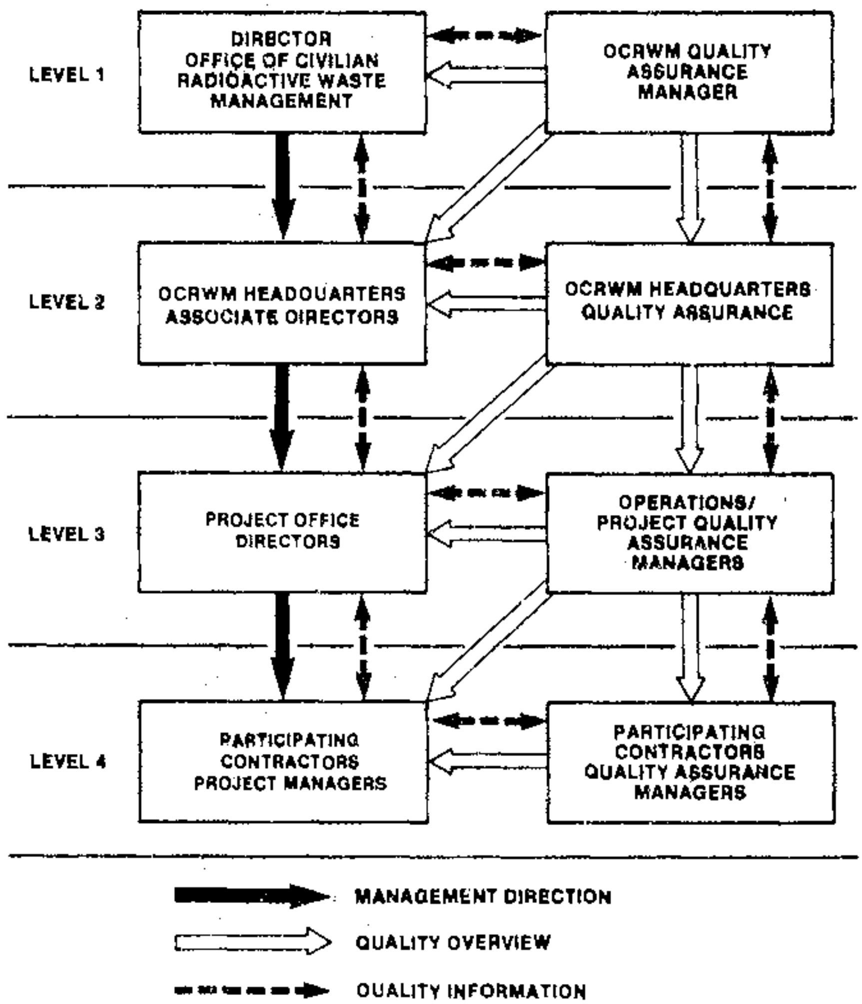

Figure 5-7. OCRWM program quality management direction, overview and information.

Pursuant to 10 CFR Part 60, during site characterization, the NRC staff is permitted to visit and inspect the site and observe excavations, borings, and in-situ tests as they are done.

The QA policies and requirements document for the program was issued in May 1985 under the title Quality Assurance Management Policies and Requirements. A QA plan for siting and site characterization was issued by the Office of Geologic Repositories in September 1984. Quality-assurance plans and implementing procedures are under development by the Project Offices and are scheduled to be in place before the submittal of the site-characterization plans. Similar QA plans and procedures are under development for storage and transportation systems.

5.7 SAFEGUARDS AND SECURITY

Special safeguards and security measures will be established and implemented for the handling, transportation, and storage of spent fuel and high-level waste. These measures will be defined in site-specific terms as needs are identified. In the interim, routine safeguards and security measures, including access control, will be executed in accordance with current DOE directives applied to DOE test facilities.

5.8 PEER-REVIEW PROCESS

Peer review is an important part of the process by which a repository is sited, constructed, and operated. Peer-review groups have already participated in the early stages of the process. For example, the DOE has assembled a group of independent experts, the Performance Assessment Review Group, to examine the performance-assessment plans of the repository projects. As the repository program continues, the OCRWM expects to assemble similar groups to examine other parts of the work. Other DOE organizations--for example, the Office of Environmental Compliance--also use independent experts in their review of work sponsored by the OCRWM; their peer reviews are significant contributions to the program.

The States in which a repository may be located also provide independent peer reviews; some of the funds distributed by the DOE as financial assistance to the States (see Chapter 4 in Part I and Chapter 3 in Part II) are used for that purpose. The States have already conducted peer reviews of the draft environmental assessments prepared for the nine potentially acceptable sites for the first repository; they will provide further reviews throughout the program.

Another source of independent peer review is the National Academy of Sciences. This organization has contributed a review of the draft environmental assessments and is expected to contribute further reviews in the future.

The ultimate peer review of the program will be provided by the Nuclear Regulatory Commission. Through its staff and consultants, the Commission will continuously review the DOE work, as it already has the siting guidelines and the draft environmental assessments.

5.9 ADMINISTRATIVE SUPPORT SERVICES

Administrative support is essential to the success of the program. The program cannot attain its objectives without adequate personnel, facilities, equipment, mail handling, travel, procurement, printing, records, and other support activities. There is no need for a detailed presentation of administrative services in the Mission Plan. However, it is important to emphasize that these services are being provided within the established DOE organizations. The success of the program will hinge on the continued priority support from the DOE's administrative offices.

5.10 INTERNATIONAL ACTIVITIES

It has long been DOE policy to cooperate with other nations in developing technology for the management of radioactive wastes.

The objectives of the OCRWM international activities are as follows:

1. To improve the performance of the OCRWM program by

    a. Conserving OCRWM resources through joint projects.

    b. Securing independent reviews and confirmation of OCRWM data and modeling concepts.

    c. Avoiding unwarranted duplication of research-and-development efforts.

    d. Promoting international consensus on issues related to radioactive-waste management.

2. To comply with U.S. foreign policy.

3. To fulfill the obligations of existing bilateral agreements and to consider other agreements that could augment the OCRWM program.

4. To comply with Section 223 of the Act.

It is OCRWM policy to ensure the proper management of international activities through coordination and integration, to ensure compliance with the requirements of the Act, to continue honoring existing commitments, and to complete cost-benefit evaluations before the initiation of new activities.

The OCRWM currently maintains active participation in international cooperation and information exchange through bilateral agreements, multinational activities, and international agency forums and programs. These activities are conducted under current bilateral agreements with Belgium, Canada, France, the Federal Republic of Germany, Japan, Sweden, Switzerland, the United Kingdom, and the Commission of European Communities. The OCRWM also cooperates through the International Atomic Energy Agency and the Nuclear Energy Agency of the Organization for Economic Cooperation and Development. The OCRWM is currently most active in joint projects with Canada, the Federal Republic of Germany, and the Nuclear Energy Agency. These projects include (1) an underground crystalline-rock research laboratory in Canada; (2) ongoing tests in the Asse salt mine in the Federal Republic of Germany; (3) the exchange of information with and tests of spent-fuel storage in, the Federal Republic of Germany; and (4) crystalline-rock tests in the Stripa mine in Sweden. Through the Nuclear Energy Agency, the OCRWM participates in the International Seabed Working Group, which coordinates research on the feasibility of waste disposal in clay formations beneath the ocean floor.

In accordance with Section 223 of the Act, the DOE and the Nuclear Regulatory Commission jointly offer cooperation and technical assistance in spent-fuel storage and disposal to countries that do not produce nuclear weapons. This includes assistance in the health, safety, and environmental regulation of storage and disposal activities. The Federal Register notice extending this offer was updated and reissued jointly by the DOE and the NRC on April 6, 1984 (Federal Register, Vol. 49, p. 13858) and April 5, 1985 (Federal Register, Vol. 50, p. 11137). Expressions of interest have been received from the Netherlands, Egypt, Brazil, Japan, the Republic of Korea, Taiwan, Mexico, and Indonesia. Other expressions of interest are expected. Briefings on the spent-fuel management program have been provided to Korea and Mexico, and a seminar on spent-fuel management was held in Egypt. These types of briefings will be continued in response to expressions of interest.

Part II

INFORMATION REQUIRED BY THE NUCLEAR WASTE POLICY ACT

Chapter 1

INFORMATION NEEDS

An identification of the primary scientific, engineering, and technical information, including any necessary demonstration of engineering or systems integration, with respect to the siting and construction of a test and evaluation facility and repositories.

--Nuclear Waste Policy Act, Section 301(a)(1)

INTRODUCTION

Although a geologic repository is a first-of-its-kind engineering project, many of its elements are similar to those of facilities that have been successfully built and operated. For example, the sinking of shafts and the excavation of underground disposal areas will resemble routine operations at deep mines throughout the world; many of the surface operations will resemble those of warehousing; and many of the waste-handling operations will resemble those successfully used by the nuclear industry and the DOE for years. Furthermore, the mission of the repository and the requirements for its performance are explicitly defined by regulations, including the DOE's siting guidelines ("General Guidelines for the Recommendation of Sites for the Nuclear Waste Repositories," 10 CFR Part 960). There is, therefore, a broad basis for determining the kinds of scientific, engineering, and environmental information that will be required for a repository.

Certain aspects associated with the design and performance of a geologic repository distinguish it, however, from more conventional engineering projects. For example, the design of the repository must account for the thermal stresses on the host rock induced by the heat-producing waste, an aspect unique to the repository as an underground construction project. Another distinguishing aspect is the reliance--over the long term--on the natural barriers of the site to provide waste isolation. This reliance requires a very thorough underground-exploration program in comparison with the siting of other underground engineering projects, such as hydroelectric power stations. These distinguishing aspects of the repository are reflected in the emphasis on the site.

Unresolved questions related to the performance of a repository are termed "issues." For each issue, the kinds of information needed to answer the question can be identified. This information will be collected during site characterization. This chapter lists and explains examples of the types of information needed to determine whether a repository can be sited, designed, constructed, operated, and closed in accordance with applicable regulations. The information needs listed here are not intended to be applicable to all sites. Each geohydrologic setting or site will have additional, specific information needs. These site-specific issues and information needs will be described in the site-characterization plans to be issued for the three sites approved by the President.

Much of the information listed here remains to be collected, analyzed, or verified. The activities through which these data-acquisition steps will be performed are described in Chapter 2, which presents plans, milestones, schedules, and budgets.

During site characterization, the DOE will collect detailed information on the geologic, hydrologic, and other characteristics that determine compliance with the siting guidelines. These guidelines (see Appendix B) include a postclosure system guideline, 10 CFR 960.4-1; postclosure technical guidelines for geohydrology, geochemistry, rock characteristics, climatic changes, erosion, dissolution, tectonics, human interference, and natural resources, 960.4-2-1 through 960.4-2-8; a preclosure system guideline for the ease and cost of siting, construction, operation, and closure, preclosure technical guidelines for surface characteristics, rock characteristics, hydrology, and tectonics, plans for collecting the detailed information required to demonstrate compliance with this set of guidelines will be presented in the site-specific site-characterization plans to be developed for each candidate site approved for characterization.

In parallel with site characterization, the DOE will collect information about other aspects of the site. This activity, referred to as site investigations, will be carried out in order to establish compliance with the guidelines that do not require characterization (e.g., demographic, socioeconomic, and ecological characteristics) and to comply with the requirements of the National Environmental Policy Act of 1969. The guidelines for which information will be collected during site investigations include 960.4-2-8-2 (technical guideline for site ownership and control); 960.5-1(a)(1) and 960.5-1(a)(2) (preclosure system guidelines for radiological safety and for environmental quality, socioeconomics, and transportation) and 960.5-2-1 through 960.5-2-7 (preclosure technical guidelines for population density and distribution, site ownership and control, meteorology, offsite installations and operations, environmental quality, socioeconomic impacts, and transportation). Plans for collecting the detailed information required to demonstrate compliance with this set of guidelines will be presented in the EIS implementation plan, which will be separate from the site-characterization plans.

The information required to site and construct a test and evaluation facility (TEF), if such a facility is deemed necessary, will be essentially the same as that for a repository. However, the information needed would be much less extensive because the TEF would be located at the repository site (see Chapter 4), would operate over a short time, and would be much smaller in scope. For these reasons, no separate information needs for a TEF are presented here.

Appendix III of the DOE's siting guidelines describes the level of information needed in each step of the site-selection process. Appendix IV of the guidelines identifies the types of information needed to nominate potential sites as being suitable for characterization.

HIERARCHY OF INFORMATION NEEDS

This chapter is organized in accordance with an issues hierarchy consisting of three levels of detail: key issues, issues, and information needs. The purpose of this hierarchy is to make apparent the logic of site studies and design activities and thereby ensure that no significant issues are overlooked or extraneous information collected. The hierarchical structure provides a convenient framework to distinguish broad questions of overall suitability (key issues) from more specific questions about natural systems or major design components (issues) and from requirements for additional data or analyses about particular natural conditions or design elements (information needs).

The <u>key issues</u> are derived directly from the system guidelines in the DOE's siting guidelines. The system guidelines define general requirements for the performance of the repository system; these requirements are based generally on the objectives of protecting public health and safety and the quality of the environment and specifically on the Environmental Protection Agency's standards for allowable releases of radioactive material (40 CFR Part 191). The key issues are treated in their order of importance (see discussion in Appendix B).

<u>Issues</u> are subordinate to key issues. Collectively, the issues grouped under a key issue indicate what questions must be answered to resolve the key issue. Most of the issues are related to the geologic, hydrologic, and geochemical characteristics of the repository site and other aspects of the natural environment; they are based on the qualifying conditions of the technical guidelines in 10 CFR Part 960. Some issues, however, are concerned with the waste package and engineered aspects of the repository itself; these issues are based on performance criteria and regulations that must be met to receive a license for a repository. It is noteworthy that many of the issues should not be especially difficult to resolve because the methods used to obtain the information, and the analysis and interpretation of the information, are straightforward and well established. However, some issues can be resolved only after in-situ testing at the proposed depth of the repository. To perform these tests it will be necessary to construct one or more exploratory shafts.

<u>Information needs</u> constitute the lowest level of the hierarchy. The technical information needed to resolve the issues is stated broadly at this level. Some information topics pertain to site suitability; others pertain to the information required to design cost-effective waste packages or surface and subsurface facilities. The DOE has intentionally duplicated certain information needs under two or more issues so that each issue and its associated information needs can be considered as a discrete package; thus, the interdependences among issues and information needs are not shown. The DOE places no particular programmatic significance on the number of information needs associated with an issue. Finally, the preceding discussion on the relative difficulty of resolving issues applies to acquiring the technical data as well. For example, data on meteorological conditions are routinely collected at nuclear power plants, and the use of these data in analyzing the safety of the plant and planning emergency responses is well established.

As mentioned, the issues are intended to apply to a repository sited and constructed in any host rock. Some of them are relatively unimportant in certain potential host rocks, an example being dissolution processes in any of the hard rocks. These limited-applicability cases are indicated in the narrative, as appropriate. Typically, the information needs cited here are generic and illustrative of the information required to resolve issues. Site-specific information needs will be identified in the forthcoming site-characterization plans or the EIS implementation plan. In addition, not all of the approximately 140 information needs listed in the following pages are of equal importance. Generally, the information needs required to resolve key issue 1 are more important than those required to resolve key issue 2, and so on. The information needs listed under each issue generally are in the order in which they would be collected or applied to that issue and thus are not in order of importance.

KEY ISSUE 1: Will the geologic repository, consisting of multiple natural and engineered barriers, isolate the radioactive waste from the accessible environment after closure in accordance with the requirements set forth in 10 CFR Part 60 and the proposed Environmental Protection Agency rule to be codified as 40 CFR Part 191?

Key issue 1 is derived directly from the postclosure system guideline (10 CFR 960.4-1), which defines the general long-term performance requirements for the repository system as a whole (i.e., the waste package, the engineered repository, and the natural system at the site). These performance requirements reflect the general objectives of protecting the health and safety of the public and the quality of the environment; they are based specifically on the safety standards proposed by the Environmental Protection Agency (EPA), to be codified as 40 Part CFR 191, Subpart B, and the criteria adopted by the NRC in 10 CFR Part 60, Subpart E.

Compliance with the system guideline must be demonstrated (1) to recommend a site for the development of a repository and (2) to obtain a construction authorization from the NRC. The demonstration of compliance will be based on the results of analyses that will evaluate the integrated performance of the total repository system. This performance assessment will use mathematical models (i.e., computer codes developed specially for repository modeling purposes), scientific data collected during site characterization and during the preceding field investigations at the site, data about the performance of the waste package in the particular host rock, and data about the repository itself, including such engineering specifications as the distance between waste-emplacement holes, the distance between drifts, and the shape and dimensions of each drift. Included in this assessment will be analyses of the following:

1. Interactions between various components of the repository system (e.g., the effects of the heat emitted by the waste on the surrounding host rock and the effects of the chemical constituents of the host rock on the materials of the waste package).

2. The effects exerted on the repository system by exploratory boreholes and shafts, and the construction of the underground facility.

3. The effects exerted on the performance of the repository system by conditions that are expected to occur over the long term (e.g., changes in geohydrologic conditions that can be projected from the history of the host rock during the Quaternary Period--the past 2 million years or so).

4. The effects exerted by potentially disruptive processes and events whose occurrence is not likely but is sufficiently credible to warrant analysis (e.g., extreme erosion, climatic change, or human intrusion).

Critical to the performance assessment will be the definition of three major boundaries that are related to the regulatory requirements for the repository: the boundaries of the engineered-barrier system, the disturbed zone, and the accessible environment. These boundaries can be precisely defined only after completing the site characterization and the designs of the repository and the waste package.

Derived from key issue 1 are nine issues--one that pertains specifically to the engineered barrier system and waste package, one that pertains largely to the repository, and seven that pertain mainly to the site. The latter are based on the postclosure technical guidelines (codified as 10 CFR 960.4-2).

ISSUE 1.1: Will the present and expected geohydrologic setting at a site be compatible with waste containment and isolation?

The geohydrologic setting will determine the quantity and the chemical composition of the water that comes into contact with waste packages. These conditions, together with the thermal and radiation fields produced by the waste packages, will control the corrosion of the waste containers. For the site to be compatible with the achievement of waste containment and isolation objectives, it must be possible to design and build a waste package that is compatible with the requirements of NRC regulation 10 CFR 60.113(a)(1)(ii) on the engineered-barrier system.

After the containment period, as the waste package begins to lose its integrity, some of the radioactive waste may be dissolved. This would create the potential for radionuclide transport out of the engineered barrier system. The hydrologic conditions at the site will affect isolation by determining the flow paths and flow times for the water containing the radionuclides. The geologic conditions along the flow path will affect the rate at which the radionuclides travel in relation to the water flow rate; these conditions can affect radionuclide transport through retardation by sorption, dispersion, precipitation of low-solubility phases, and other processes that slow the rate of radionuclide transport in relation to the rate of water flow.

The information needs for this issue include the following:

1.1.1 Knowledge of the present nature and distribution of aquifers and aquitards in the region (thousands of square miles) surrounding the site, including areas and modes of recharge and discharge, interrelationships of geohydrologic units, and influence of structure on the regional occurrence of aquifers.

1.1.2 Detailed descriptions of the lithology, stratigraphy, and structure (especially of structural features like fractures, faults, and folds) of the geologic deposits and formations in the vicinity of the site.

1.1.3 Geochemical characteristics of ground water in the region and near the site, including variations with depth.

1.1.4 Detailed knowledge of the potentiometric surface, present hydrologic properties (e.g., hydraulic conductivity and gradient), and distribution of the geologic deposits and formations in the vicinity of the site.

1.1.5 Estimates of, and bounds on, the present ground-water fluxes, flow directions, velocities, and travel times for the paths between the repository and the accessible environment.

1.1.6 Estimates of, and bounds on, effects of man-induced changes on the present hydrologic flow system at the site, including those caused by site characterization, repository construction, dam construction and operation, climate changes induced by human activity, and increased surface-water and ground-water withdrawal, as specified in State or local management plans.

1.1.7 Estimates of, and bounds on, the effects of natural phenomena that have reasonable potential for changing the present surface and subsurface hydrologic flow system, including climatic changes (both natural and those induced by human activities), tectonism, and dissolution.

Information need 1.1.5 is critical to the resolution of issue 1.1. The ground-water flow parameters and travel-time calculations for the undisturbed conditions are required to qualify the site. The ground-water fluxes, flow directions, and velocities at the potential repository horizon are needed to plan the construction and operation of the repository and to design the shaft and borehole seals. The post-waste-emplacement ground-water-flow conditions at the repository horizon need to be determined to ensure that borehole and shaft seals will function properly and to determine the conditions of water flow to which waste packages will be subjected.

The information gathered to address this issue will provide the baseline description of the geologic and hydrologic setting. This description will be used in designing the components of the engineered barrier system and establishing conditions for the testing of the barrier materials. Together with geochemical information, it will provide the basis for calculating the expected rates of radionuclide releases to the accessible environment.

ISSUE 1.2: Will the present and expected geochemical characteristics of the site be compatible with waste containment and isolation?

The geochemical characteristics of the repository site will control the chemical composition of the fluids available for the degradation of the waste package. These fluids will affect the lifetime of the containment barrier and the rate of radionuclide releases from the waste packages after the containment barrier is breached. The geochemical characteristics of the rock units along the water flow path from the repository to the accessible environment must be known to estimate the retardation of radionuclide transport in relation to water travel times.

The heat and radiation emitted by the waste may induce changes in the properties of the host rock, local water chemistry, and mineral composition along the water flow path from the repository to the accessible environment. Changes in water chemistry may alter the rates and mechanisms of waste-package degradation and the rate of radionuclide release from the engineered-barrier system. Changes in the mineral composition of the host rock may result in changes in water chemistry or in the amount of water that may come in contact with the waste packages--or in the mechanism by which these changes may take place. Changes in the mineral composition of the rock units along likely flow paths may alter the potential of the site for retarding radionuclide transport.

The retardation of radionuclide transport relative to water flow times depends on such processes as the precipitation of low-solubility phases, sorption onto minerals, the exchange of ions between dissolved species and the minerals along the flow path, and the dispersion of radionuclides into rock-matrix pores during flow through fractured rock. Some of these processes depend on the chemical speciation of the radionuclides in solution; it is therefore necessary to know the chemical stability of complex ions and colloidal species. Transport by particulate matter and colloids suspended in water must also be investigated. Kinetic factors may be involved in speciation, colloid stability, and precipitation. Finally, the relative importance of each of the transport and retardation processes must be determined so that the overall retardation properties along the path from the repository to the accessible environment can be estimated.

Both preemplacement and postemplacement geochemical conditions must be understood. The preemplacement geochemical conditions are needed to provide the baseline data from which the effects of waste emplacement will be estimated. Information on the present geochemical conditions will be used in evaluating the suitability of the site. The geochemical conditions that are expected after waste emplacement will determine whether the site is compatible with the long-term containment and isolation of the waste.

The information needs for this issue include the following:

1.2.1 Estimates of, and bounds on, the present geochemical conditions at the potential repository site, including water chemistry, the mineralogy and petrology of the proposed repository horizon, types and amounts of organic compounds present, and geochemical parameters along the water flow path from the repository to the accessible environment.

1.2.2 Estimates of, and bounds on, the geochemical stability of the host-rock minerals, changes in ground-water chemistry and mechanical stability of the host rock after repository construction and waste emplacement.

1.2.3 Estimates of, and bounds on, the processes that affect the retardation of radionuclide transport relative to the velocities of water flow along the path from the repository to the accessible environment.

ISSUE 1.3: Will the present and expected characteristics of the host rock and surrounding units be compatible with waste containment and isolation?

The physical and chemical properties of the host rock and surrounding rock units must all be compatible with a design and an operating plan that will allow construction, operation, and closure in accordance with containment and isolation criteria. The excavation of the repository and the effects of waste emplacement must not induce changes that would significantly affect the ability of the rock to contain and isolate the waste. If changes in the host rock occur, such as extensive fracturing, new pathways for radionuclide transport could be established, and the isolation capabilities of the rock could be impaired. Therefore, in addition to the scientific characterization of the site (e.g., determining the thermal and mechanical properties of the host rock), engineering analyses are also needed.

The major information needs for this issue include the following:

1.3.1 Descriptions of the structure, lithology, and stratigraphy of the host rock and surrounding rock units, including depth, thickness, and lateral extent.

1.3.2 Estimates of the mechanical properties and ambient stress conditions of the host rock and surrounding rock units.

1.3.3 Estimates of the thermal properties and ambient geothermal characteristics of the host rock and surrounding rock units.

1.3.4 The characteristics of the geologic and hydrologic setting and in-situ conditions of the repository.

1.3.5 The thermal characteristics of the waste package and the thermal-mechanical effects of the heat emitted by the waste on the properties of the host rock.

1.3.6 The underground layout and configuration (i.e., drift design, depth and areal extent of the underground development) and the waste-emplacement configuration.

1.3.7 Estimates of mining-induced effects on the hydrologic properties of the rock immediately surrounding repository openings.

1.3.8 Definition of the allowable changes in the host rock caused by the presence of the repository (e.g., temperature, stress).

1.3.9 Description of the sealing design for underground drifts, shafts, ramps, and boreholes.

1.3.10 Construction, operation, and closure plans for the repository.

ISSUE 1.4: Can the underground facility be placed at a depth such that surface erosion will not lead to releases greater than those allowed by regulations?

To prevent the waste from being uncovered, thereby causing a direct release of radionuclides to the surface, the repository must be at a depth greater than that which can be reached by surface erosion during the next million years. As specified in technical guideline 10 CFR 960.4-2-5, this depth must be at least 200 meters (650 feet) below the directly overlying ground surface. The rates and depths of erosion are controlled by the nature of the rocks and deposits that lie between the repository and the surface; by climatic conditions that affect precipitation, infiltration, evapotranspiration, and runoff; and by changes in the baseline of erosion through differential vertical movements of the earth's crust or by changes in sea level.

Erosion, like the processes and events covered in issues 1.5 through 1.7, is a potentially disruptive process that is not expected to adversely affect the long-term performance of the repository but is sufficiently credible to warrant analysis. In projecting the depth of continued erosion, the rates and depths of erosion in response to crustal movements and climate during the past million years need to be determined as the first step. The results must be coupled with estimates of the consequences of changes in crustal movement and climate during the next million years, to ensure that the repository is sufficiently deep.

The information needs for this issue include the following:

1.4.1 Descriptions of the stratigraphy of the soils, deposits, and rocks that lie above the repository horizon.

1.4.2 Past rates of erosion estimated by determining depths of entrenchment of geomorphic surfaces whose ages have been determined.

1.4.3 Determination of mechanisms of erosion through study of the soils, weathering processes, and geomorphic processes in the region.

1.4.4 Estimates of, and bounds on, future climatic and fluvial conditions as outlined in issue 1.5.

1.4.5 Estimates of, and bounds on, past and future geomorphic processes in the geologic setting, including effects of changes in climate and fluvial conditions as outlined in issue 1.5 and of changes in tectonic stability as outlined in issue 1.7.

1.4.6 Estimates of glacial erosion during the Quaternary Period.

ISSUE 1.5: Will future climatic conditions at the site lead to radionuclide releases greater than those allowed by regulations?

Phenomena that could cause significant climatic change in the future will be considered. One such mechanism for change is an increase in global atmospheric carbon dioxide. Variations in climate can result in changes in infiltration, which may affect the ground-water regime, as well as changes in runoff and streamflow, which will affect the rates of erosion. Cyclic climatic patterns occurred during the Quaternary Period and are expected to continue into the future. The prediction of future climates is based on the reconstruction of Quaternary climates. Areas covered by continental glaciers in the past can be presumed to be covered by comparable glaciers in the future and to be affected by glacial erosion, deposition, disruption of drainage, increased overburden and changes in the ground-water regime. Areas not directly affected by glaciers have been and will again be affected by the changes in climate that result from a glacial episode. These changes are global; they involve fluctuations in temperature, evaporation, precipitation, and runoff. These can lead to changes in sea level. Also of importance to future climates is the influence of human activity, such as the injection of particulates into the atmosphere and release of carbon dioxide.

Estimates of, and bounds on, future climatic conditions and their effects on the host rock and the hydrologic system will be developed.

The information needs for this issue include the following:

1.5.1 Estimates of the distribution of precipitation, including geographic occurrences, amounts, rates, and durations.

1.5.2 Estimates of the balance of precipitation, evapotranspiration, infiltration, and runoff.

1.5.3 Descriptions of any paleo-flood deposits, including their age, composition, particle size, and stratigraphy; and the width, depth, depth of scour, and gradient of the channels in which they occur.

1.5.4 Evidence of past ground-water levels in the geologic setting and the potential for future changes in ground-water level.

1.5.5 Descriptions of geomorphic features in the geologic setting, including size, slope, and elevation.

1.5.6 Rates and directions of streamflow in the drainage basin during the Quaternary Period.

1.5.7 Descriptions of soil horizons in the vicinity of the site, including fossil pollen where available.

1.5.8 Estimates of, and bounds on, contributions to climatic changes from man-related factors, such as releases of carbon dioxide and particulates.

ISSUE 1.6: Will any subsurface rock dissolution within the geologic setting of the site lead to radionuclide releases greater than those allowed by regulations?

Rock dissolution is of concern because it might expose waste packages to corrosive fluids or cause a hydraulic interconnection between the host rock and the immediately surrounding geohydrologic units. It is a slow, erosional process (a representative rate is 1 foot per 1000 years) of concern only to potential sites in salt or other evaporite formations. In such formations, zones of past or present dissolution are commonly evidenced by such features as breccia pipes, sinkholes, and depressions of varying size; reductions in the volume of the host rock or surrounding strata and consequent collapse or other deformation; or the absence of strata in a geologic section where their presence is expected. While dissolution is a potentially disruptive process, it is not expected to adversely affect the long-term performance of a repository at any of the potentially acceptable sites.

To estimate the rates of horizontal and vertical dissolution, it is necessary to obtain the following information:

1.6.1 Definition of the structural, hydrologic, geomorphic, and stratigraphic framework of the site vicinity.

1.6.2 Locations and characteristics of dissolution fronts or other dissolution features, if identified in the vicinity of the site.

1.6.3 Geochemical analysis of the ground water within the geologic setting.

1.6.4 Fracture and fault analysis of surface outcrops, drill cores, and data from geophysical surveys.

1.6.5 Estimates of future climatic conditions in the geologic setting.

1.6.6 Estimates of future tectonic activity in the geologic setting.

ISSUE 1.7: Will future tectonic processes or events within the geologic setting of a site lead to radionuclide releases greater than those allowed by regulations?

Tectonic processes include subsidence, uplift, tilting, folding, faulting, igneous activity, and seismic activity (earthquakes). Slow subsidence may be favorable because it generally increases the depth of burial of a site. However, some other tectonic processes and events may lead to a relative uplift of the site and to increased rates of erosion, which in the extreme, might exhume the repository.

Potential igneous activities include volcanism and intrusions that do not reach the surface. Igneous activity can cause faulting, tilting, and uplift. Uplift by itself or in combination with the magma body, can change, either favorably or adversely, the ground-water flow. Uplift can also lead to faster erosion, and the introduction of heat can cause hydrothermal activity. Possible impacts resulting from intrusions into the repository range from dispersion of radionuclides into the atmosphere to their encapsulation in highly impermeable igneous rock formations.

Some faults may provide barriers to ground-water flow; others may act as conduits of increased hydraulic conductivity that result in faster and shorter flow paths. Therefore, the presence of faults and the likelihood of future faulting and uplift must be evaluated in terms of their contributions to a tectonically induced, erosional breaching of a repository or adverse changes in the paths of ground-water flow, even though a significant disruption of the repository by tectonic processes is unlikely.

The following information constitutes a basis for estimates of, and bounds on, the rates, magnitudes, and locations of future tectonism and the effects on the local and regional ground-water-flow system:

1.7.1 Patterns of active and inactive tectonic features in the geologic setting--including igneous features, faults, folds, uplift, and subsidence--and their relation to the hydrologic system.

1.7.2 Ages of tectonic features to allow a time-space analysis of geometric information in a historical framework. This reveals tectonic changes that have occurred through time and permits the calculation of past and present rates of tectonic activity as a means of predicting future changes.

1.7.3 Records of historical earthquakes within the geologic setting, including locations, frequency, magnitude or intensity, and focal mechanisms when available.

1.7.4 Assessments of the correlations of earthquakes with tectonic features and processes.

1.7.5 Estimates of the geometry and origin of present stress systems within the earth's crust to relate tectonic processes to present tectonic conditions.

1.7.6 Assessments of past igneous activity in the geologic setting as an indicator of the potential for future igneous activity.

1.7.7 Estimates of changes in rock stress and potential fault creation and movement due to flooding and glaciation.

ISSUE 1.8: Will future human activities at or near the site adversely affect waste containment and isolation?

Much consideration has been given to activities by future generations that could inadvertently compromise the effectiveness of a geologic repository. Such intrusion into a repository could result from attempts to find or exploit natural resources or from changes in land use. For this reason, repositories will be sited in areas where future exploration for valuable natural resources is unlikely and where land ownership and control can be maintained. Furthermore, various measures will be used to warn future generations about the presence of the repository (e.g., the erection of durable monuments and markers).

The information needed to resolve this issue includes the following:

1.8.1 The general quantities, grades, and depths of occurrence of energy and mineral resources, including water. The potential for using underground spaces for the storage of fluids must also be assessed.

1.8.2 Estimates of the value of the natural resources compared with that contained in other areas of similar size in the geologic setting.

1.8.3 Assessments of whether geologic or geophysical exploration would be likely to discover a significant concentration of any naturally occurring material that is not widely available from other sources.

1.8.4 Descriptions of past and present drilling and mining operations in the geologic setting. The description of drilling practices will include drilling methods, frequency of drilling, and depth and spacing of drill holes.

1.8.5 Natural phenomena (e.g., atmospheric conditions, floods, glaciers, sandstorms) and human activities (e.g., construction of dams) that might degrade the surface markers and monuments designed to warn future generations of the existence of the repository.

1.8.6 Evaluation of potential for changes in land use over the long term of interest to waste isolation.

This information will be used to estimate or to bound the potential effects of future human activities (in the vicinity of the repository) on the rates and concentrations of radionuclide releases to the accessible environment.

ISSUE 1.9: (1) Will the waste packages meet the performance objectives of waste containment for the 300 to 1000 years after permanent closure of the repository, and (2) will the engineered-barrier system meet the performance objectives of an acceptable rate for radionuclide releases after the containment is breached?

After closure of the repository, the waste package and other engineered barriers must accomplish two functions. First, the waste package must provide substantially complete containment of the waste for a period of 300 to 1000 years after permanent closure. Second, the other engineered barriers must control radionuclide releases after complete containment ends. This issue addresses the ability of the waste package and the other engineered barriers to meet these performance requirements, which are specified in the performance objectives of the NRC regulation 10 CFR 60.113.

Seven information needs have been defined for this issue:

1.9.1 Estimates of, and bounds on, the flow of fluids in the waste-package environment.

1.9.2 Estimates of, and bounds on, the chemical properties of fluids to which waste packages will be exposed.

1.9.3 Estimates of the thermomechanical stressss acting on the waste packages.

1.9.4 Estimates of, and bounds on, the radiation level and its effects on the waste-package environment.

1.9.5 Specifications for, and material properties of, the waste form and estimates of, and bounds on, the rate of radionuclide release from the waste form after the containment barrier is breached.

1.9.6 Material properties relevant to design specifications for the containment barrier and estimates of the rates and mechanisms of containment-barrier degradation in the repository environment.

1.9.7 Design specifications, performance characteristics, and material properties for packing material if packing material is used in the waste package.

The information gathered will lead to (a) an understanding of waste-container degradation; (b) estimates of how long the waste will be contained; (c) an understanding of mechanisms controlling waste-form degradation; and (d) estimates of the rate of radionuclide releases from the waste form after the containment barrier is breached, including the contribution of packing material, if it is used, to the control of radionuclide releases. This information will be combined to provide estimates of, and bounds on, the time at which radionuclide releases will begin (breach of the containment barrier) and of the rates of radionuclide releaees from the waste packages. The results of these calculations will show whether the waste packages will meet the regulatory criteria.

<u>*KEY ISSUE 2*</u>: *Will projected radiological exposures of the general public and releases of radioactive materials to restricted and unrestricted areas during repository operation and closure meet applicable safety requirements set forth in 10 CFR Part 20, 10 CFR Part 60, and 40 CFR Part 191, Subpart A?*

Key issue 2 is derived from the preclosure system guideline for radiological safety (codified as 10 CFR 960.5-1(a)(1)). This guideline requires compliance with the applicable safety requirements of the safety standards proposed by the EPA to be codified as 40 CFR Part 191, Subpart A, and the criteria adopted by the NRC in 10 CFR Part 60 and 10 CFR Part 20. Compliance must be demonstrated by calculating (1) the quantities of radioactive materials that could be released to restricted* and unrestricted areas during repository operation and closure and (2) the resulting radiological exposure, if any, of the general public.

Included in these analyses will be the following elements:

1. The site characteristics that affect the transport of radionuclides (i.e., local weather conditions that affect atmospheric diffusion and transport).

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*"Restricted area" is defined in the guidelines as "any area access to which is controlled by the DOE for purposes of protecting individuals from exposure to radiation and radioactive materials before repository closure, but not including any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area."

2. The engineered repository components whose function is the control of releases of radioactive materials (e.g., the ventilation filters that clean the airborne emissions from the repository)

3. The people who, because of their location, may be affected by radionuclide releases.

4. The present and projected effects of nearby industrial, transportation, or military installations whose presence could adversely affect the safety of the repository (i.e., surface facilities) or its compliance with the radiological standards for unrestricted areas.

Derived from key issue 2 are three issues based on preclosure technical guidelines 960.5-2-1, 960.5-2-3, and 960.5-2-4 and an issue related to the design of the repository.

ISSUE 2.1: During repository operation and closure (1) will the expected average radiation dose to members of the public within any highly populated area be less than a small fraction of the allowable limits and (2) will the expected radiation dose received by any member of the public in an unrestricted area be less than the allowable limits?

The radiation doses referred to in issue 2.1 are the population dose (in man-rem) and the maximum individual dose that would be received by a member of the public from routine repository operations. During repository operation and closure, any releases of radioactive material will most probably be airborne (releases that could reach people through water pathways are very unlikely), and, indeed, there is a potential that very small quantities of radioactive materials may be available for release into the environment. To ensure that such releases are kept well within the limits allowed by regulation, the repository will be equipped with appropriate instrumentation and equipment.

Both of the questions in issue 2.1 will require an affirmative answer if the repository is to receive a license from the NRC. To ensure that the answers are affirmative, another precaution will be taken in addition to engineering measures: a repository will not be sited in a highly populated area.

The information needed to resolve issue 2.1 includes the following:

2.1.1 Estimates of, and bounds on, the population density and distribution in the general region of the site during repository operation and closure.

2.1.2 The basic design and operating parameters for the waste-receiving and waste-handling facilities.

2.1.3 The basic design and operating parameters for the underground waste-handling and waste-emplacement systems and the underground ventilation systems.

2.1.4 The characteristics and amount of any expected routine releases from the surface and underground facilities.

2.1.5 Definition of an emergency preparedness program.

2.1.6 Design-basis accident scenarios and remedial-action plans.

ISSUE 2.2: Will the meteorological conditions prevailing during operation and closure lead to radionuclide releases to an unrestricted area that are greater than those allowed by regulations?

Although a significant airborne release from a repository is highly unlikely (because there are only a few processes by which a significant quantity of radioactive material can be released into the atmosphere, and, furthermore, the design and the operation of the repository will be based on sound principles of radiological protection), knowledge of the atmospheric dispersion potential can be useful in siting surface facilities for maximum safety. Prevailing meteorological conditions determine the probability that airborne emissions from the repository will be effectively dispersed or transported in a particular direction. This direction is compared with the known distribution of population in the area. Also of interest is the potential for extreme-weather phenomena like hurricanes or tornadoes because the repository must be designed to resist phenomena that can occur at the site.

The information needs that have been identified for this issue include the following:

2.2.1 Record of meteorological data collected in the vicinity of the site, such as the prevailing wind direction, wind speeds, precipitation, and the frequency distributions of stability and mixing height.

2.2.2 Estimates of the atmospheric dispersion characteristics prevalent near the repository, including the effects of the terrain.

2.2.3 Identification of locations that are potentially suitable for the siting of surface facilities with respect to atmospheric and meteorological phenomena.

2.2.4 Estimates of, and bounds on, the population density and distribution in the general region of the site during repository operation and closure.

2.2.5 Records of extreme-weather phenomena, such as hurricanes, tornadoes, severe floods, and storms accompanied by lightning and blowing dust and sand.

ISSUE 2.3: Will the present and projected effects from nearby industrial, transportation, and military installations and operations, including atomic energy defense activities, significantly affect repository activities or lead to radionuclide releases to an unrestricted area greater than those allowed by regulations?

Nearby facilities could, in the event of an accident (e.g., an explosion), adversely affect the radiological safety of the repository. Examples include munitions plants, petrochemical plants, or other types of industrial facilities that have the potential for accidents with major consequences. Nearby transportation routes used for the transport of hazardous materials and military or commercial aircraft routes will also need to be examined for their potential impact on safety.

Included in this issue are nearby nuclear facilities. The routine releases from such facilities must be considered in the analysis of repository releases to establish that EPA limits on combined releases are met.

The information needed to address issue 2.3 includes the following:

2.3.1 Identification of nearby industrial, transportation, and military installations and operations (nuclear and nonnuclear).

2.3.2 Impact of operations at nearby installations on the location and design of surface and subsurface facilities.

2.3.3 Estimates of, and bounds on, contributing radionuclide releases from other nuclear installations and operations.

2.3.4 Estimates of, and bounds on, radionuclide releases from the repository.

ISSUE 2.4: Can buildings, underground areas, and waste handling operations be designed, constructed, and operated to accommodate the expected waste characteristics and quantities and to perform the intended operations in a manner that ensures the radiological safety of workers?

The waste characteristics and quantities must be factored into design criteria, selection of building materials, and operations planning. The waste materials are sufficiently hazardous to require considerable care in the development of designs and operational plans.

The following information is needed to address this issue:

2.4.1 Incoming waste characteristics and quantities that the facilities must be designed for.

2.4.2 Handling, packaging, transport, and emplacement operations that must be accomplished.

2.4.3 Technical specifications for facilities and equipment.

2.4.4 Operating procedures.

2.4.5 Structures, systems, and components that are important to safety.

KEY ISSUE 3: Can the repository and its support facilities be sited, constructed, operated, closed, and decommissioned so that the quality of the environment will be protected and waste-transportation operations can be conducted without causing unacceptable risks to public health or safety?

Key issue 3 is derived from preclosure system guideline 960.5-1(a)(2), which is concerned with the environmental, socioeconomic, and transportation-related impacts associated with repository siting, construction, operation, closure, and decommissioning.

ISSUE 3.1: Can a site be located such that the quality of the environment will be protected during repository siting, construction, operation, closure, and decommissioning and can significant adverse environmental impacts in the affected area be mitigated by reasonable measures?

Environmental impacts will be considered throughout all stages of the geologic repository program, and unavoidable adverse impacts will be mitigated to the extent practicable. The affected area can depend on the site and on the impact being considered. For example, the affected area for air quality impacts may differ from that for water quality impacts. As a rule, the affected area will include the repository area and extend outward from the repository area far enough to include impacts perceptibly above background levels. The environmental conditions that will disqualify a site are given in preclosure technical guideline 960.5-2-5, which also identifies a number of potentially adverse and favorable conditions.

To address this issue, it is necessary to establish a data base for existing environmental conditions at the potential site. These data will be used to predict potential impacts; to determine what measures must be taken to prevent, control, and mitigate the impacts; and to ensure compliance with all applicable Federal, State, and local environmental regulations and standards.

The needed baseline data include the following:

3.1.1 Existing air-quality levels and trends.

3.1.2 Existing surface-water and ground-water quantity and quality and trends.

3.1.3 Existing terrestrial and aquatic vegetation and wildlife, including evidence of threatened or endangered species and their critical habitats.

3.1.4 Soil characteristics, such as structure, composition, and erodability.

3.1.5 Existing levels of background radiation.

3.1.6 Land use patterns and trends.

3.1.7 Noise levels.

3.1.8 Locations of State or regional protected-resource areas, such as State parks or wildlife areas.

3.1.9 Locations of significant Native American resources, such as major Indian religious sites, or other sites of unique cultural interest.

3.1.10 Locations of components of the National Park System, National Wildlife Refuge System, National Wild and Scenic Rivers System, National Wildlife Preservation System, and National Forest Land.

3.1.11 Other unique environmental resources, as they become identified.

ISSUE 3.2: Can access routes from existing local highways and railroads to the site be constructed with reasonably available technology, accommodate transportation system components with the performance standards specified in applicable DOT and NRC regulations, and allow transportation operations to be conducted without causing unacceptable risks to public health and safety or unacceptable environmental impacts?

The transportation of waste to a repository site could affect the health and safety of the public, the environment, and the cost of waste disposal. Issue 3.2 does not apply to the movement of waste over the national system of highways and railroads; the regulations of the NRC and the Department of Transportation (10 CFR Part 71 and 49 CFR Parts 171-178) govern those parts of waste transportation. Issue 3.2 is concerned with the factors that are important to siting a repository.

The following information needs have been identified for this issue:

3.2.1 Assessment of whether an existing secondary transportation network can handle the increased traffic load attributable to the repository.

3.2.2 Identification of improvements required in the secondary transportation network and the feasibility, cost, and environmental impacts of the improvements.

3.2.3 Determination of the compatibility of the required transportation network improvements with the local and regional transportation and land-use plans.

3.2.4 Analysis of emergency-response requirements and capabilities.

ISSUE 3.3: Can any significant adverse socioeconomic impacts induced in communities and surrounding regions by repository siting, construction, operation, closure, and decommissioning be offset by reasonable mitigation measures or by compensation?

The socioeconomic impacts of repository siting, construction, operation, closure, and decommissioning will be considered throughout all stages of the geologic repository program. For a candidate site, the impacts will depend on the local socioeconomic conditions and on whether the candidate site is selected for repository construction. The socioeconomic conditions that will disqualify a site are given in preclosure technical guideline 960.5-2-6, which also identifies a number of potentially adverse and favorable conditions.

To address this issue, it is necessary to establish a data base for existing socioeconomic conditions at the potential site. These data will be used to predict potential impacts and to determine what measures must be taken to mitigate these impacts, including compensation as provided for in the Act.

The information needs identified for this issue include the following:

3.3.1 Baseline data on population density and distribution, major industries, employment and the economic base for the affected area, including land-use patterns and trends.

3.3.2 Estimates of local versus migrant work-force numbers for various phases from site characterization through repository operation, consequent demands on local communities for housing, education, utilities, transportation access, and community services, and impacts on lifestyles, government infrastructure, and government expenditures and revenues.

KEY ISSUE 4: Are repository construction, operation, and closure feasible on the basis of reasonably available technology and are the associated costs reasonable?

Key issue 4 is concerned with the feasibility and cost of repository construction, operation, and closure. It is derived directly from the preclosure system guideline codified as 10 CFR 960.5-1(a)(3), which requires the construction, operation, and closure of a repository to be feasible on the basis of "reasonably available technology" and the associated costs to be reasonable in comparison with those of other comparable siting options. Compliance with this guideline must be demonstrated by analyzing the interactions of elements like the following:

1. The site characteristics that would affect the feasibility and cost of construction, operation, and closure (e.g., rock characteristics that affect the need for artificial supports in the underground excavations).

2. The design of the repository (e.g., the required spacing between drifts).

3. The materials and services needed to construct and operate the repository.

4. Applicable Federal, State, and local regulations governing air quality, noise, etc.

5. The safety of repository workers.

As discussed in the paragraphs that follow, seven issues are derived from key issue 4.

ISSUE 4.1: Will the waste package designed for use at a site be cost effective and compatible with the regulatory requirements for safe transportation, handling, emplacement, and retrieval?

The waste package will play an important role in waste handling, emplacement, and, if necessary, retrieval operations, and it will have to meet the performance criteria stipulated in 10 CFR Part 60. Furthermore, because a large number of packages will be required, the cost of each is an important consideration.

This issue will be resolved by technical analysis and testing of waste packages that were designed for the site and built according to design specifications. The results of the analysis and testing will be used to determine whether the packages, as designed and fabricated, are compatible with regulatory requirements. The cost effectiveness of waste packages will be determined by an economic analysis of alternative waste-package designs as part of the repository system.

The following information will be needed:

4.1.1 Summary of all regulatory requirements affecting a waste package up to repository closure.

4.1.2 Designs and specifications developed to meet the dual goals of complying with regulatory requirements and being cost effective.

4.1.3 Designs and specifications of repository equipment that will handle the waste packages.

4.1.4 Cost estimates for the waste package and related repository systems.

ISSUE 4.2: Will the surface characteristics and conditions at the site allow the construction, operation, and closure of a repository to be accomplished with available technology and at reasonable cost?

In sites that are prone to flooding, located in rugged terrain, subject to severe storms, or have other adverse surface features, special measures may be necessary for construction, operation, and closure. The costs could rise to prohibitive levels if a large number of special measures are necessary for these phases.

Four information needs have been identified for this issue:

4.2.1 Topographic characteristics important to the location and design of surface facilities.

4.2.2 Soil properties important to the location of surface facilities and the design of foundations.

4.2.3 Local meteorological conditions important to the location and design of surface facilities.

4.2.4 Surface characteristics, including the failure of dams upstream, that could lead to the flooding of surface or underground facilities.

ISSUE 4.3: Is the repository horizon of sufficient lateral extent, thickness and depth--and are the planned operations of sufficient flexibility to allow a cost-effective repository to be developed?

The initial cost of constructing a repository is very high and must therefore be amortized over a fairly long repository life. The repository horizon must be capable of accommodating a considerable quantity of waste so that the costs per ton of waste are reasonable. Because the host site is unlikely to be a homogeneous block of rock, the ongoing construction of waste disposal areas and the operating plan must be sufficiently flexible to accommodate unexpected geologic and hydrologic conditions. Some of the site-characterization and data-analysis activities must be directed at identifying the range of anomalous conditions that are likely to be encountered. These site-characterization data will be combined with a preliminary underground-design and waste-emplacement plan to assess the disposal-area requirements in relation to the acceptable waste-emplacement area and the expected variability of the rock properties.

The following information is needed to resolve this issue:

4.3.1 The size and configuration of competent host rock.

4.3.2 Characteristics and quantities of waste to be accepted for disposal.

4.3.3 Method of waste emplacement and retrieval.

4.3.4 Mine-development plan and artificial ground-support options to accommodate unexpected ground conditions.

4.3.5 Method for backfilling and sealing drifts, shafts, and boreholes.

ISSUE 4.4: Are the hydrologic conditions at the site compatible with the construction and operation of a cost-effective repository?

In addition to the need for a satisfactory geometric configuration of the disposal horizon, a satisfactory hydrologic setting is necessary. For example, if overlying aquifers were to create major problems in water inflow control or shaft liner construction and maintenance, costs could be increased to unacceptable levels. The resolution of this issue will evolve from an analysis of the following data and design information:

4.4.1 Hydrologic characteristics of units between the repository and the ground surface and between the repository and any underlying aquifer that could result in the upward flow of water into the repository or exploratory shaft.

4.4.2 Preliminary shaft design and repository layout.

4.4.3 Bounds on the effects of hydrologic conditions on the design.

ISSUE 4.5: Are the effects of expected tectonic phenomena, tornadoes, hurricanes, and other natural phenomena and man-induced ground motion compatible with cost-effective repository construction, operation, and closure?

The surface and subsurface facilities must be designed to withstand both the natural and man-induced phenomena expected at the site. This issue will be resolved through an engineering analysis of the following data and information:

4.5.1 Definition of active and inactive tectonic features in the geologic setting.

4.5.2 Historical record of earthquakes within the geologic setting and the correlation of earthquakes with tectonic processes and features.

4.5.3 Record of man-induced ground motion and associated data, if applicable.

4.5.4 Record of the intensity and frequency of tornadoes in the region.

4.5.5 Record of other natural storms, including lightning and blowing dust and sand, and their characteristics.

ISSUE 4.6: Can a repository be designed, constructed, operated, and closed to perform its functions of waste receipt and disposal and protect the health and safety of the workers in a cost-effective manner?

A site that meets all the technical criteria for containment and isolation may not be safe for the repository workers or be cost effective. For example, a site with a highly sorptive but very weak host rock would require costly artificial support and could be hazardous to the miners and waste-handling personnel. To resolve this issue it will be necessary to perform engineering analyses that integrate the functional requirements, the performance criteria, and the constraints on the repository system into a design, an operating plan, a safety analysis, a construction schedule, and a cost estimate. These tasks will require the following information:

4.6.1 Functional requirements, performance criteria, safety criteria, design criteria, and system constraints.

4.6.2 Characteristics of waste forms for use in design and safety analysis.

4.6.3 Resolution of issue 1.3 on whether repository construction might compromise the integrity of the site.

4.6.4 Resolution of issue 1.9 on waste package and engineered barriers.

4.6.5 Resolution of issue 2.1 on radiation exposure of the public.

4.6.6 Resolution of issue 2.3 on effects from offsite installations and operations.

4.6.7 Resolution of issue 2.4 on radiation exposure of workers.

4.6.8 Resolution of issue 4.1 on waste-package costs.

4.6.9 Resolution of issue 4.2 on surface characteristics.

4.6.10 Resolution of issue 4.3 on flexibility of repository horizon.

4.6.11 Resolution of issue 4.4 on hydrology and ease of construction.

4.6.12 Resolution of issue 4.5 on tectonics and ease of construction.

ISSUE 4.7: Can the repository be closed in a cost-effective manner?

Assuming that all other aspects of the repository are acceptable, it must be possible to close the underground disposal area in a cost-effective manner. This closure will require the installation of permanent seals in shafts and boreholes. The information needed to resolve this issue includes the following:

4.7.1 Characteristics of the environment in which plugs and seals are to be placed, such as stratigraphy and geohydrology, load conditions (temperature and pressure), rock properties, borehole and shaft characteristics, and the geochemical environment.

4.7.2 Character and extent of damage caused by the excavation of access shafts and underground workings.

4.7.3 Performance characteristics of sealing materials, including their long-term stability.

4.7.4 Emplacement techniques and operational procedures for acceptable materials and seal geometries.

4.7.5 Repository-design information important to the design and analysis of the sealing system.

4.7.6 Detailed closure requirements and implementation plans.

Chapter 2

PLANS FOR OBTAINING THE INFORMATION NEEDED TO SITE, CONSTRUCT, AND OPERATE A REPOSITORY

An identification of any information described in paragraph (1) that is not available because of any unresolved scientific, engineering, or technical questions, or undemonstrated engineering or systems integration, a schedule including specific major milestones for the research, development, and technology demonstration program required under this Act and any additional activities to be undertaken to provide such information, a schedule for the activities necessary to achieve important programmatic milestones, and an estimate of the costs required to carry out such research, development, and demonstration programs

--Nuclear Waste Policy Act, Section 301(a)(2)

2.1 INTRODUCTION

The first clause of Section 301(a)(2) of the Act requires the DOE to identify the unresolved issues. This task was essentially accomplished by the issues hierarchy used to respond to Section 301(a)(1). That is, all of the issues identified in Chapter 1* remain unresolved to some degree at this stage of repository site investigations and repository development. As mentioned in Chapter 1, however, the DOE expects that some of these issues will be relatively easy to resolve because the methods used to obtain the information and to interpret the information are well established.

Other issues will require information obtainable only from large-scale, long-term testing in an exploratory-shaft facility or from extensive analysis, interpretation, or extrapolation of laboratory or field results. Examples of the difficult technical questions associated with these issues are the modeling of fracture and unsaturated flow; the determination of ground-water-travel times; the demonstration of waste-package performance; assessments of radionuclide sorption, solubility, and speciation; and the analysis of the response of the host rock to the presence of heat-producing waste.

It will become apparent from this chapter that much of the planned work centers on resolving these more-difficult technical issues. Generally, the resolution of these issues requires site-specific information.

The hierarchy of issues and information needs in Chapter 1 provided a logical and convenient way to organize a response to Section 301(a)(1) of the Act. The discussion of plans for resolving the outstanding issues or

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*Unless otherwise indicated, all chapter and section numbers cited here pertain to Part II of Volume I.

obtaining the missing information--the main topic of this chapter--could be structured in exactly the same manner. However, to help the reader relate these plans to the DOE's schedules and budgets, a different method of presentation was selected. The presentation follows the work-breakdown structure of the repository program, concentrating on five major technical tasks: site investigations, exploratory shafts, repository, waste package, and systems (Sections 2.2 through 2.6). Other tasks (regulatory and institutional activities, land acquisition, test facilities, program management, and financial assistance) are treated in less detail (see Section 2.7) because they are not directly aimed at the resolution of outstanding scientific or engineering issues.

The information needs given in Chapter 1 can be related to the tasks listed above. For example, most of the activities done and costed under the "site investigations" task address the issues and information needs associated with key issue 1, which deals with the long-term performance of the repository. Similarly, most of the activities carried out and costed under the "repository" task address the issues and information needs for key issue 4, related to repository design and costs. To enable the interested reader to associate the issues and information needs of Chapter 1 with the plans discussed in this chapter, an index in Section 2.10 shows where each of the more than 140 information needs given in Chapter 1 fits into the work-breakdown structure.

Included in the discussion of each technical task is a logic diagram that shows the relative schedule for activities needed to meet important programmatic milestones. An integrated logic diagram for all tasks is presented in Figure 2-1. Estimated costs (see Section 2.9) are given for each of the tasks in the work-breakdown structure.

Most of the plans presented here pertain to the first repository. The program for the second repository is less advanced and is still concerned with broader site-screening issues. It is nevertheless summarized in Section 2.8.

The discussion of technical tasks for the first repository is predicated on the assumption that a site in each of the three potential host rocks (basalt, salt, and tuff) will be selected for characterization. As explained in Chapter 3 of Part I, however, the selection of sites for characterization is yet to occur (it is scheduled for January 1986), and the plans reported in Sections 2.2 through 2.6 should not be construed as indicating that any final site-recommendation decisions have been made.

2.2 SITE INVESTIGATIONS

For purposes of scheduling and funding, site investigations can be divided into the following major subtasks that represent elements of the work-breakdown structure:

1. Geologic studies include work in the fields of stratigraphy, structural geology, seismology, tectonics, geophysics, paleoclimatology, geomorphology, and resource evaluation. They will be used to evaluate the existing condition of the rock mass, the effects of excava-

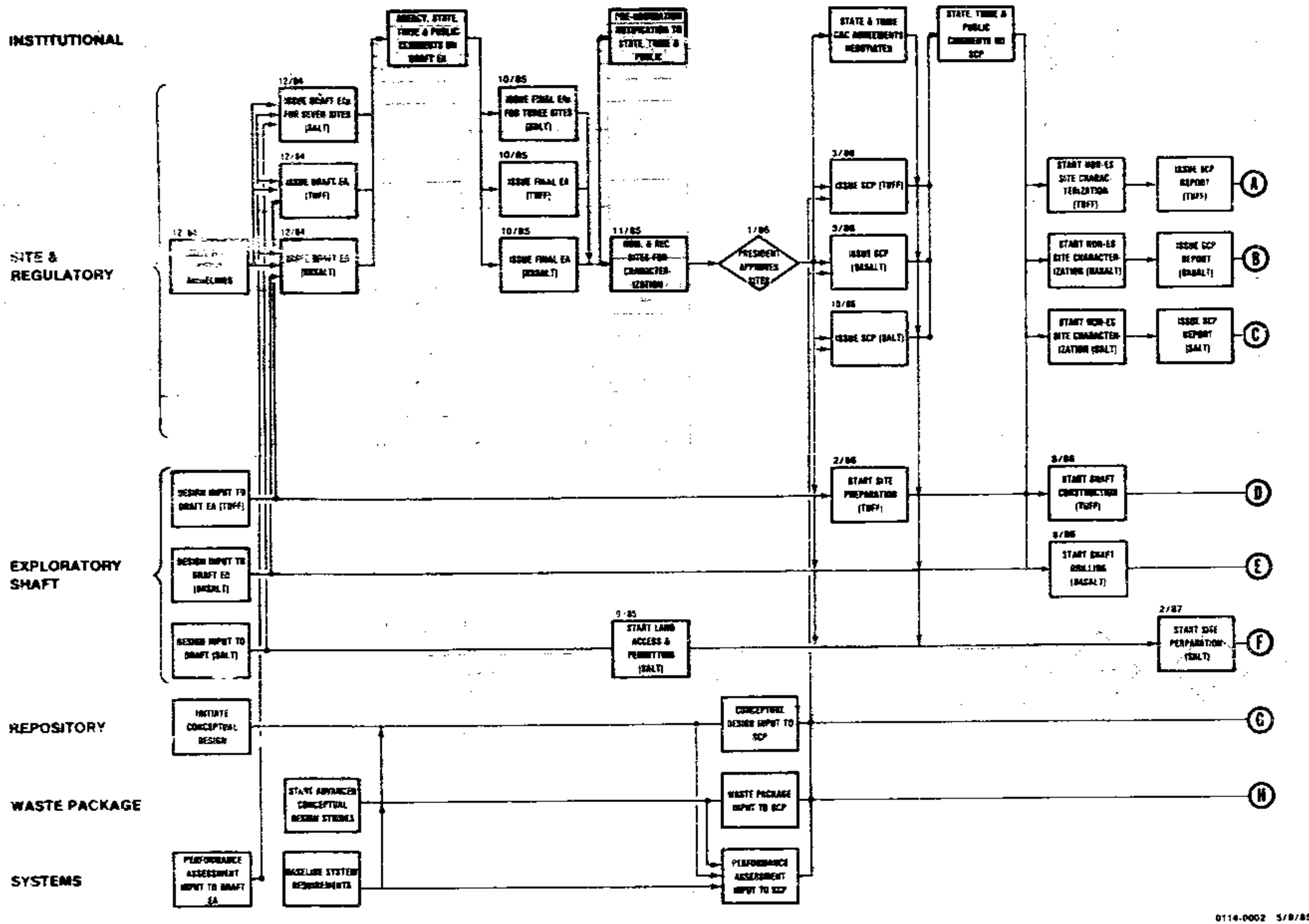

Figure 2-1. Integrated logic diagram for the first repository.

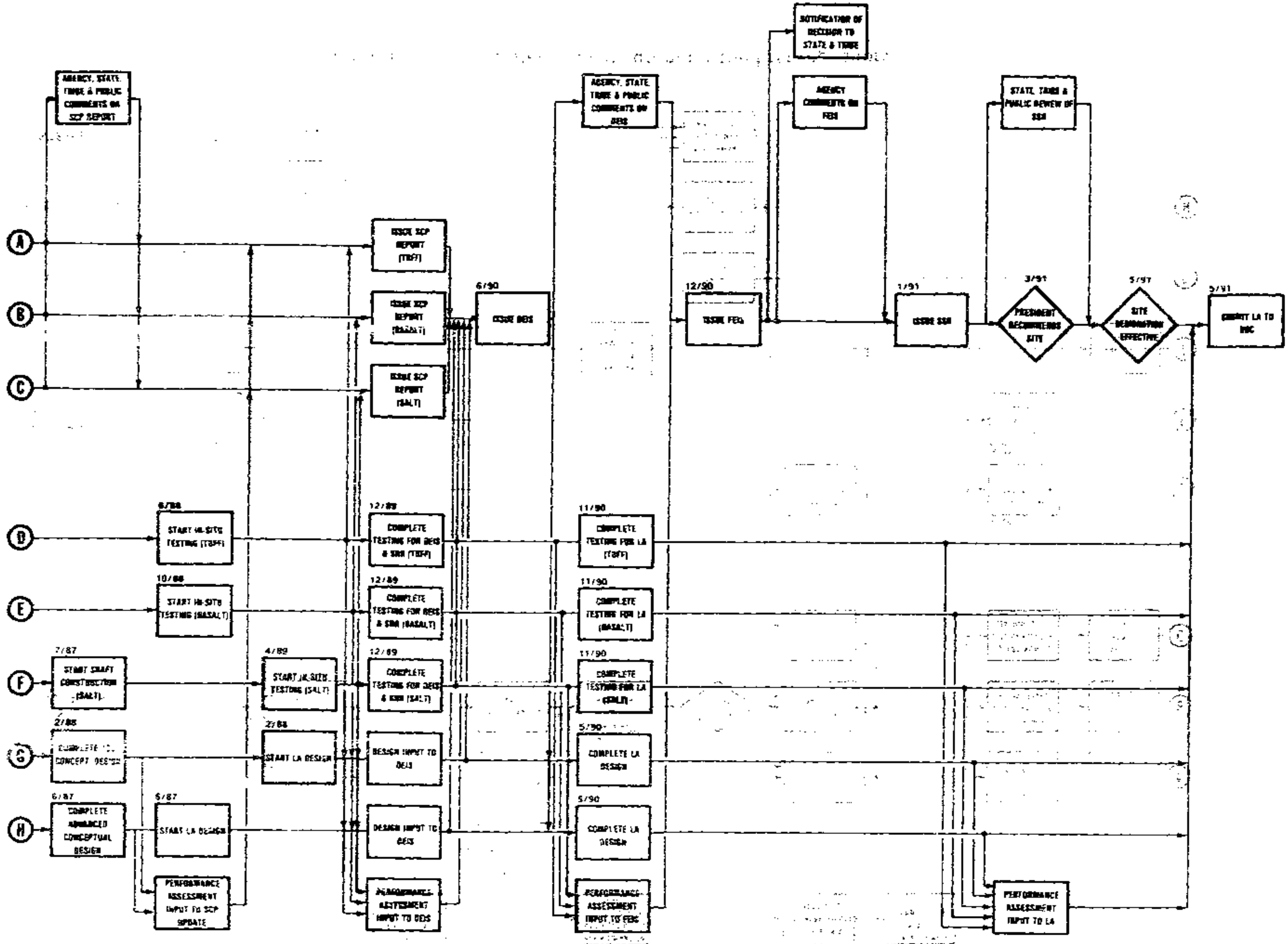

Figure 2-1. Integrated logic diagram for the first repository (continued).

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tion and waste emplacement, and the expected performance of the natural barriers after repository closure. Both local geology and the regional geologic context will be considered. With reference to Chapter 1, these studies address issues 1.3, 1.6, 1.7, 1.8, 4.3, and 4.5.

2. Drilling studies include drilling, coring, and logging and many of the various tests conducted in boreholes. They are the principal mechanisms by which data will be obtained to address the issues identified in the other subtasks described in this section. As a support activity, drilling is used to provide information relevant the other subtasks. Consequently, drilling activities are discussed in conjunction with those subtasks and are not addressed separately here.

3. Geochemical studies evaluate the chemical aspects of both the host rock and surrounding strata and the fluids within them. These studies are directed toward assessing the effect of the in-situ environment on the waste package, the ability of the host rock to contain the radionuclides, and the ability of the surrounding units to retard radionuclides by chemical interactions. With reference to Chapter 1, these studies address issues 1.1, 1.2, 1.6, and 1.9.

4. Hydrologic studies consist of activities such as pumping tests in boreholes, ground-water dating, ground-water sampling, well logging, tracer tests, the development of conceptual and numerical models of the hydrologic-flow system, surface-water monitoring, and calculations of flood potential. With reference to Chapter 1, these studies address issues 1.1, 2.2, and 4.4.

5. Environmental studies include studies of weather conditions and air quality, plant and animal communities and habitats, agricultural resources, cultural and archaeological resources, noise, and background radiation. With reference to Chapter 1, these studies address issues 2.3 and 3.1.

6. Socioeconomic studies include studies of demographic characteristics, labor-force characteristics, housing, community services, and land use. As mentioned in Chapter 1, the topic of socioeconomics is not strictly relevant to Section 301(a)(1) of the Act and hence is not addressed here; however, socioeconomic issues and potential impacts are discussed in Chapters 3 and 11.

7. Site-performance assessment evaluates the capability of the natural systems to isolate the waste. It is accomplished by identifying potential pathways and calculating radionuclide migration away from the repository. The site-performance assessment helps to identify the key data needs in site characterization and to assign priorities to these needs. With reference to Chapter 1, these studies address issues 1.1, 1.2, 1.3, 1.7, and 2.1.

The logic diagram for site investigations is presented in Figure 2-2.

The plans for geologic and hydrologic studies at the salt sites are based on the assumption that only one of the three sites recommended for detailed characterization will be a site in salt. Hence, in the discussions that

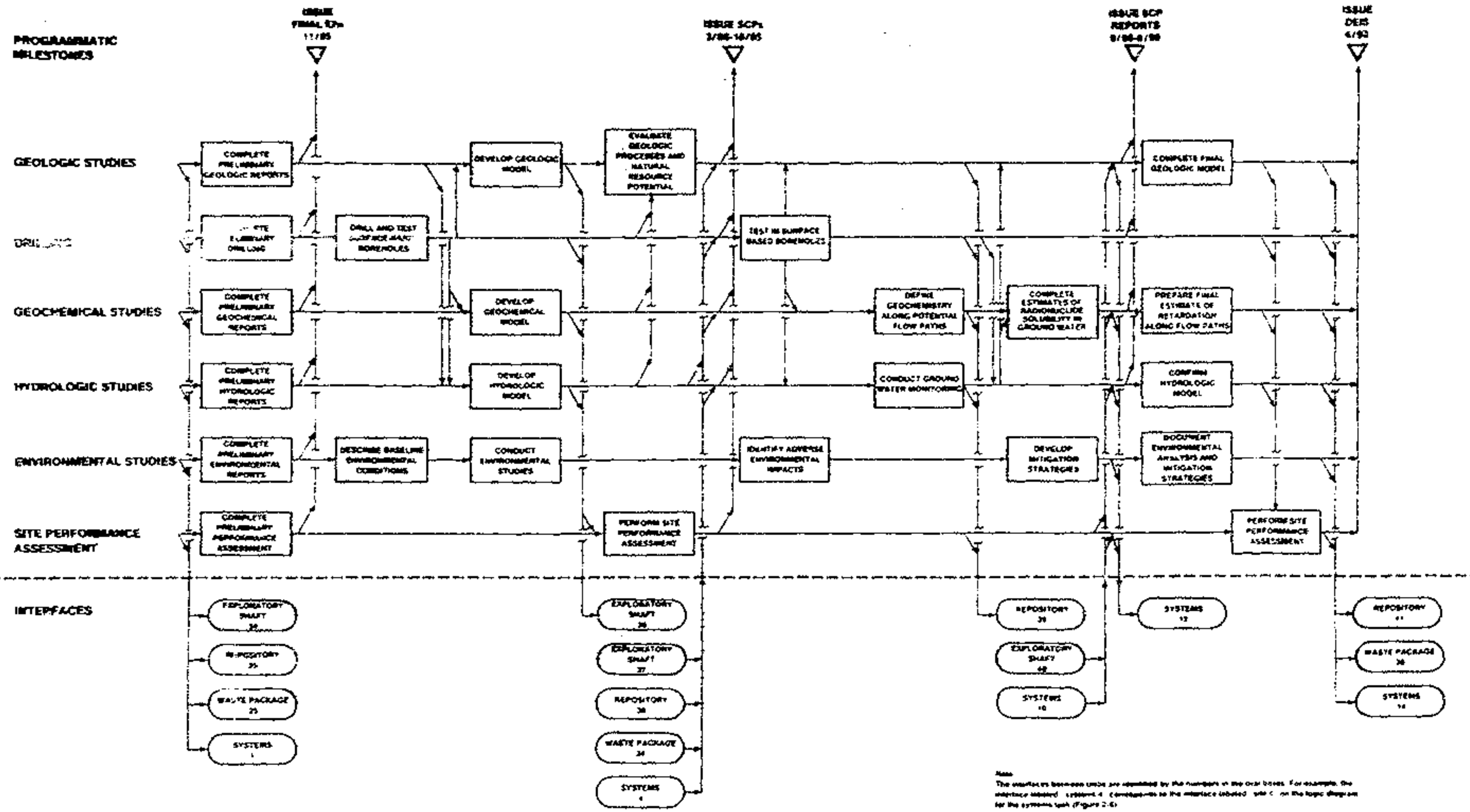

Figure 2-2. Logic diagram for site investigations.

follow, terms like "the selected salt site" mean the salt site that is selected for site characterization from the seven potentially acceptable salt sites. (Brief descriptions of the nine sites identified as potentially acceptable for the first repository are given in Chapter 2.)

2.2.1 GEOLOGIC STUDIES

Basalt

Tectonic studies in basalt will concentrate on the development of conceptual models ("model" in this context means a description rather than a numerical computer code) to explain and predict future changes in the hydrologic system and to bound the expected vibratory ground motion. Surveys will be conducted to ascertain whether and where uplift and subsidence are occurring and to evaluate estimates of strain. In-situ compressional stress relationships will also be evaluated. Shallow trenches will be dug in the vicinity of geologic structures, and geodetic surveys will be performed. In addition, both regional and detailed seismic monitoring from the surface will be conducted. Small earthquakes in the vicinity of the site will be monitored by instruments located at the ground surface, in boreholes drilled into the top of the basalt, and in at least one borehole that will extend approximately to the proposed depth of the repository.

The final plan for tectonic studies is scheduled for completion by September 1986, with a discussion of tectonic models to be included in the site characterization plan (FY86). A revised interpretation of the tectonic setting is scheduled for completion by mid-FY89.

Preliminary assessments of the potential for erosion at the Hanford Site suggest that during the Quaternary Period synclinal areas appear to have been sites of subsidence and deposition rather than erosion. Since the potential for exposing the repository seems to be quite small, no further analyses are planned.

Climatic trends or cycles of the recent geologic past can be used as the basis for predicting future changes in climate. For the basalt site, data about the climate of the Quaternary Period are being collected from such sources as plant-pollen analyses, the record of plant and animal fossils, geologic data, and data from tree-ring analyses. Geologic data include the marginal positions of glacial ice, the duration and frequency of glaciation during the Quaternary Period, the nature and frequency of catastrophic flooding, and the effects of glaciation and catastrophic floods on drainage and ground-water recharge or discharge.

Conceptual and numerical models of climatic change may be developed as appropriate to assess the potential for changes in precipitation and temperature, the potential for glacial erosion in the vicinity of the site, glacially induced changes in ground-water flow, and the potential, frequency, duration, and volume of catastrophic floods in the Pasco Basin. This work is expected to be completed in FY88.

An evaluation of natural resources in the basalt and overlying younger sediments indicates little potential for economic development. However, the effects of ground-water withdrawal will be evaluated in case ground water is withdrawn from these horizons in the future as existing water supplies diminish or become inadequate. In addition, the possibility of hydrocarbon extraction from rocks beneath the basalts and the effects of such extraction will be evaluated. These studies are expected to be completed in FY88. An evaluation of the potential for resources undiscovered at present will also be made.

Salt

The salt sites identified as potentially acceptable for the first repository are located within three distinct geohydrologic settings; the Richton, the Cypress Creek, and the Vacherie Domes are in the Gulf Interior Salt Basin; the Davis Canyon and the Lavender Canyon sites are in the Paradox Basin; and the Deaf Smith County and the Swisher County sites are in the Palo Duro Basin. While certain geologic studies planned for site characterization are designed to address issues peculiar to a specific hydrogeologic setting, many investigations will be carried out regardless of the setting of the salt site(s) selected for detailed characterization. In this discussion of geologic studies, planned characterization activities common to all salt sites are addressed first, followed by a discussion of setting-specific planned activities.

Studies at the salt sites will include continued monitoring of microseismic activity with the seismographic networks operating in the site region. When a salt site has been selected for characterization, monitoring networks at the sites not selected may be discontinued, and the selected site's network will be augmented. A three-dimensional seismic survey is planned for the vicinity of the selected site to gather as much detailed information on structural conditions as possible.

If a site in the Paradox Basin is selected for characterization, trenching will be performed at Shay Graben in an effort to determine when the latest movement of the faults occurred. Other studies in the Paradox Basin will address the clustering of seismicity along the Colorado River, induced seismicity, the influence of observed faults, and dissolution features such as Lockhart Basin and the Needles Fault Zone.

If the selected site is in the Gulf Interior Salt Basin, studies are planned to reanalyze published first-order geodetic survey results that appear to indicate ongoing uplift in Mississippi and subsidence in Louisiana. Overdome and near-dome faults will also be investigated for their ages and offsets and as indicators of dome stability. Faults to the north of the site area will require investigation for the time of the most recent movement.

The selection of a site in the Palo Duro Basin will require an investigation in the site vicinity to locate and determine the amount, time, and distance to the site of any fault offsets. Faults and structures along the basin-bounding uplifts must also be characterized for a detailed tectonic evaluation.

Two engineering design boreholes (EDBs), one for each exploratory shaft, will be drilled, cored, geophysically logged, and tested at the selected salt site. These boreholes will provide not only design information for the exploratory shafts but also additional stratigraphic information. They will be drilled to depths greater than the proposed repository horizon to provide needed design and characterization information.

At least three stratigraphic boreholes will be drilled, cored, geophysically logged, and tested at the selected site. These holes will be located so as not to jeopardize the short- and long-term isolation characteristics of the repository, while circumscribing the site and providing maximum site-specific information about the character of the host rock and the surrounding rock units. These boreholes will also be drilled to depths greater than the proposed repository horizon.

If the selected site is in the Gulf Interior Salt Basin, several dome-flank stratigraphic boreholes will be drilled, cored, geophysically logged, and tested to determine the stratigraphic and geologic characteristics of the formations adjacent to the salt stock. They will be drilled to depths greater than 3000 feet.

Detailed topographic mapping and geologic mapping will be performed on, and in the vicinity, of the selected salt site.

Estimates of the rate and depth of erosion have been made for each of the salt sites. Age dating of near-surface deposits and measurements of Quaternary entrenchment into these deposits will provide the basis for estimating the rate and the depth of erosion under probable future climatic conditions.

Preliminary studies of the Quaternary climate in the vicinity of each of the salt sites are being completed. These studies will be carried out in more detail for the selected salt site to predict future climatic conditions with greater accuracy. The effects to be investigated include the potential for increased pluvial conditions and impacts on erosion and the ground-water regime. Should a site in the Gulf Interior Salt Basin be selected, the potential impact of sea-level fluctuations due to the global melting or buildup of glaciers will be assessed.

The dissolution potential for salt remains to be investigated through drilling. Questions concerning the dome salt-caprock interface and dissolution will be addressed as part of the investigation. For the bedded salt of the Palo Duro Basin, drilling will be carried out in an attempt to answer questions about the possibility of vertical leakage across the evaporite section and the basin-wide conditions of underpressure in the lower units. Data from site-specific wells will be required. In the Paradox Basin, areas of salt dissolution, perhaps several miles in extent, exist north and west of the potential sites. The character of this dissolution will be investigated by drilling and geochemical analyses if one of these sites is recommended for characterization. This work is expected to be completed by FY89.

Preliminary results for the salt domes suggest that the potential for the presence of natural resources is small. However, a definitive evaluation and a comparison with similar domes in the region need to be performed.

In the Palo Duro Basin, a site-specific search for abandoned and unrecorded wells will be conducted. A basin-wide and county-specific evaluation of the hydrocarbon potential is under way.

For the Paradox Basin, mineral-resource development at the Davis and the Lavender Canyon sites appears to be unlikely. Potash deposits of potential economic value are present in the area, but they probably do not extend to either of the two sites. Uranium deposits are known in this area, although they occur elsewhere in greater quantities than in the Paradox Basin. A small amount of petroleum exploration has taken place in the area.

Evaluations of the mineral-resource potential of the salt site that is characterized are expected to be completed in FY86. These evaluations will include estimates and assessments of the potential for undiscovered resources at the site.

Tuff

The tuff site lies in a region of complex tectonic and geologic structure with numerous faults. Many of these faults are considered to be active; others could show activity in the future. Several faults within 8 to 30 miles of the site are known to be seismically active. Patterns of present seismicity have been fairly well defined by an earthquake-monitoring network. Some concentrations of epicenters coincide with known faults, while others do not.

Some data on the in-situ state of stress in tuff at the site have been obtained, but they are too limited to be considered representative of the area at this time. Stress measurements are planned in at least five additional boreholes, and the significance of the data will be evaluated in the context of laboratory measurements of strength. These measurements and others related to present-day stress, such as vertical and lateral surface strain and earthquake activity, will continue throughout site characterization.

Other studies will define the probability and consequences of volcanic activity and the seismic effects of weapons testing at the Nevada Test Site. Both surface and subsurface monitoring equipment will be used in these investigations. These studies are planned for FY85 and FY86.

Beginning in FY85 and continuing through site characterization, a regional map of tectonic features will be developed and the site's tectonic history, uplift rates, and erosion rates will be studied. The seismic network mentioned above will remain operational over this period but will be reduced in size. A final seismic-hazard analysis will be performed to support the preliminary design of repository surface facilities. Tectonic hazards will be analyzed by integrating data collected and synthesized from geophysical, geologic, stress-field, and seismic studies.

The rate and depth of erosion in the vicinity of the tuff site will be determined by a combination of surficial mapping, stratigraphic studies, absolute-age determinations, and measurements of Quaternary entrenchment. The information will be synthesized to produce a semiquantitative and qualitative predictive model of erosion for the site vicinity. This model will be documented in a report during site characterization.

Additional work is planned to predict future climatic and fluvial conditions that might accelerate erosion or raise the current level of the water table. This work will most likely include (1) the evaluation of fossil packrat middens in the candidate area to identify the plant communities that existed during the Quaternary Period; (2) geomorphic studies of sedimentary environments and erosional and depositional processes; (3) studies of soils at the site and in its vicinity to determine the times, depths, and conditions of soil accumulation; (4) coring of lake beds in southern Nevada, accompanied by fossil, plant-pollen, and isotopic studies of the core, to correlate Quaternary climatic cycles of the region with those established on continental and world-wide scales; and (5) studies of debris deposits in channels to determine the magnitude and ages of extreme flood events. A report on the climates of the past and the climatic conditions expected in the future will be completed in FY86.

A resource-potential survey of the region surrounding the tuff site identified no energy, metal, or nonmetal resources unique to the site vicinity or critical to foreseeable national needs. The resources identified within the site vicinity are of lower value than deposits in surrounding regions. Some water resources are present; however, the depths to ground water, topographic conditions, soil unsuitability, and land-use restrictions at and near the tuff site presently limit the availability and attractiveness of this ground-water resource. The potential effects of future ground-water development will be evaluated and documented in FY87. An evaluation of the potential for undiscovered resources will also be made.

2.2.2 GEOCHEMICAL STUDIES

Basalt

Geochemical studies on basalt began in FY76. The results of these studies are being used to determine the effects of water chemistry, radionuclide solubility, sorption, speciation, and other radionuclide-retardation properties along the potential flow paths between the repository and the accessible environment. Work is being done in mineralogy and petrology, ground-water chemistry, sorption and precipitation, solubility and speciation, hydrothermal chemistry, transport processes, and natural-isotope chemistry.

Since FY83, geochemical studies in basalt have been emphasizing the experimental definition of the sorption of key radionuclides on flow-top materials and on fracture-fill materials. This work, based on previous work with crushed basalt, will continue through FY85. Geochemical and mineralogical analyses of materials along potential flow paths to the accessible environment were started in FY84 and will be continued through FY87. These studies are expected to provide statistically valid data on the sorption properties of key radionuclides and will be used in performance-assessment models. Measurements of sorption isotherms and coefficients in ground waters representative of the site vicinity will continue, as required to resolve Issues 1.2 and 1.3.

The measurement of steady-state solution concentrations (to bound solubilities) of actinides started in FY83. This work will continue until sufficient data are obtained to satisfy NRC requirements for licensing.

Hydrochemical data are used to augment hydrologic testing, and a reevaluation of the hydrochemical data base is being completed. Alternative methods for drilling and sampling test boreholes to avoid contamination of the samples by drilling fluids have been developed. Extensive hydrochemical sampling has been made a part of the ground-water monitoring and testing program and will continue until FY86. Data on ground-water composition, including isotopic characteristics, will be used in geochemical models to support a conceptual model of hydrologic flow.

Salt

The discussion that follows applies to both bedded and dome salt.

Geochemical studies on salt began in FY72. The results of these studies are being used to determine the environment of the waste package inside a repository, the performance of the waste package, and the possible migration of radionuclides in far-field aquifers. Work is under way to quantify the waste-package corrosion that will result from interactions between the waste package, with its attendant heat and radiation, and the host salt, with its associated brines. Measurements of the solubility of key radionuclides in near-field brines were started in FY84. The behavior of radionuclides in the nearest far-field aquifers is also being evaluated.

Geochemical work is proceeding in five areas, briefly discussed below:

1. Laboratory testing to determine interactions between waste-package components and the natural salt and brines of the salt sites.

2. The geochemical development of modeling codes and the data bases needed to use the codes.

3. The characterization of the rocks, ground waters, and geochemical processes at the salt sites.

4. Laboratory and field testing of the seal materials to be used during repository closure.

5. Field tests and modeling of brine migration.

The interactions being investigated in laboratory tests include (1) radiation and thermal effects on the brines, with various waste-package components and host salt present in the tests and (2) the type of corrosion (e.g., uniform, pitting) experienced by waste-package components in the above tests. Included in this work is the elucidation of mechanisms controlling the degradation of the waste package and release of radionuclides as well as the construction of mathematical models that describe these mechanisms.

The development of modeling codes extends to the formal verification of these codes and the validation of their suitability. These codes cover the corrosion and degradation of waste-package components and include calculations of radionuclide speciation and solubility, as well as modeling of the reaction paths leading to final solubility limits.

The measurements of actinide solubilities in sodium chloride brines started in FY84. This work will be expanded to cover more complex, high-magnesium brines and include all key radionuclides contributing to calculated radionuclide releases. It will continue until sufficient data are obtained to demonstrate safety and to satisfy NRC requirements for licensing.

The geochemical characterization of the host salt consists primarily of determining the mineralogic composition of the host salt and the amounts and chemical composition of the brine present in the salt as fluid inclusions. The origin of brines in the host salt is also being investigated. Intergranular brines and brines that could result from the thermal decomposition of hydrous minerals are also being investigated.

The search for materials suitable for constructing the borehole, shaft, and tunnel seals to be emplaced at repository closure has been under way since FY80.

Brine migration is the tendency of brine to migrate toward sources of heat, such as waste packages emplaced in salt. The investigations are directed at determining the composition, the maximum realistic amounts, and the rate of brine transport to waste packages by brine migration. These investigations have been under way for several years and will continue until NRC requirements for licensing are satisfied.

Tuff

Geochemical studies on tuff began in FY77. The results of these studies are being used to determine the effects of water chemistry, radionuclide solubility and speciation, and the retardation characteristics of potential ground-water-flow paths between the repository and the accessible environment on the transport of radionuclides. Work is being done in the following general areas: mineralogy and petrology, ground-water chemistry, sorption and precipitation, solubility and speciation, hydrothermal geochemistry, dynamic transport processes, natural-isotope chemistry, and sensitivity analyses for radionuclide retardation. This work will continue through FY89. A statistical evaluation of the host-rock variability was started in the second half of FY84 and will continue through site characterization. In addition, flow and transport experiments in unsaturated columns have begun.

Solubility measurements on actinides started in FY84. This work will continue until sufficient data are obtained to satisfy NRC requirements for licensing.

Sorption-isotherm experiments and sorption measurements on thermally altered tuff will begin in FY85. In addition, work to model the chemical composition of Yucca Mountain ground water as a function of location and depth along possible transport pathways will continue through site characterization.

The data obtained from these studies will be used to model the transport of radionuclides from the proposed repository at Yucca Mountain to the accessible environment. In addition, sensitivity analyses of chemical and physical retardation properties along potential flow paths to the accessible environment will be conducted as the mineralogic and petrologic variability along those flow paths is better defined.

2.2.3 HYDROLOGIC STUDIES

Basalt

Reconnaissance hydrologic studies for the basalt site have been conducted mainly in the Cold Creek syncline and adjoining areas. The information obtained from these studies has identified basalt intervals of high to low hydraulic conductivity, preliminary areal and stratigraphic hydraulic-head distributions, water-chemistry trends, and the local hydrologic influence of geologic structures. However, the existing data base is too undeveloped to conclusively support a single quantified conceptual model or a very narrow range of such models; thus, several hypotheses have been developed. Numerical simulations of ground-water-travel time and radionuclide-transport calculations will require an intense research effort over the next 4 to 5 years. In addition to the tests to be performed in the exploratory-shaft program (see Section 2.3), this research effort will include (1) large-scale multiwell pump tests, (2) the installation of additional piezometers, (3) hydrologic analyses of critical structural and stratigraphic discontinuities, and (4) hydrochemical modeling. Portions of these activities were begun in early FY84, with all planned for completion in FY90. Concurrent with these studies is an ongoing regional modeling program initiated in FY83 and continuing into FY88. Through interagency agreements, a modeling effort was initiated to establish existing regional hydrologic conditions for the Pasco Basin and to estimate historical hydrologic conditions. As part of this effort, a regional groundwater monitoring program has been established for measuring time-dependent hydraulic heads and collecting ground-water samples. This and supplementary information will assist in setting boundary conditions for numerical modeling.

The geohydrologic and hydrochemical data obtained from the tests noted above will be integrated with a description of the geologic setting to develop conceptual models of ground-water movement from the repository to the accessible environment. Existing conceptual models have major uncertainties associated with the areal and stratigraphic distributions of physical properties and hydraulic heads, the influence of structural and stratigraphic discontinuities, ground-water-discharge areas, and hydrochemical conditions. The studies planned for the basalt site should provide the data needed to resolve the questions critical to assessing the reliability of basalt for waste isolation. The conceptual flow model is planned for completion by 1989.

Most existing measurements of hydraulic conductivity and storativity have been made in small-scale tests in single boreholes, but the large-scale (areal) representativeness of these data has been questioned. In addition, only one small-scale test of vertical hydraulic conductivity across a flow interior and two tracer tests in flow tops have been completed. This leaves unquantified the average vertical hydraulic conductivity of the preferred candidate horizon or overlying basalt flow interiors as well as the representative effective porosities and dispersivities critical in calculating groundwater travel times and radionuclide transport. To address these concerns, hydrologic tests in boreholes and the exploratory shafts are planned. Included in the borehole plans are methods for large- and small-scale pumping and injection tests as well as tests with conservative and non-conservative tracers. These borehole studies are mainly designed for measuring flow-top and interbed properties through hydraulic head monitoring in rock zones within, above, and below the stressed interval and may allow large-scale evaluations of vertical hydraulic conductivity. The tests are scheduled to begin in FY85 and end in FY88-39. The exploratory-shaft program will complement the data collected in boreholes through hydrologic measurements within the interior of a basalt flow. It will include room-scale and cross-hole tests conducted underground to measure the hydraulic-conductivity tensor, to measure the effective porosity across fracture sets, and to directly observe and measure water inflow into a large underground opening.

Data on hydraulic heads have been collected with established piezometers and on a progressive "drill-and-test" basis. They appear to suggest that areal and deep vertical head gradients are low. Ground water appears to move southeast from the basalt site. However, to resolve questions resulting from data paucity, the uncertainty associated with hydraulic-head data collected from boreholes, and the difficulty of defining head gradients in a low-gradient field, a ground-water-monitoring program is being conducted. The plan for this program will be described in detail in the site-characterization plan. The installation of three major nested piezometer stations in wells within and adjacent to the basalt site was completed in February 1984. At each station, nine individual stratigraphic intervals are being monitored simultaneously. A hydraulic-head baseline is expected to be established in 1985 before large-scale pumping tests and the sinking of the exploratory shafts begin.

Analyses of ground-water samples collected from springs and boreholes (ranging from shallow to deep) have identified areal and stratigraphic hydrochemical characteristics and changes. Questions remain on the origin of more-mineralized ground waters originating within or near the repository site, gases, specific dissolved chemical species and the in-situ oxidation-reduction potential, the age of the low-carbon ground waters, and the phenomena of radionuclide transport beyond the engineered repository. The plan for hydrochemical studies is scheduled for completion in FY85. This plan will detail the hydrochemistry program from FY85 through the completion of site characterization. Included in the plan is the collection of data needed to hydrochemically characterize the basalt/ground-water environment and to quantify the transport characteristics (e.g., sorption, precipitation, filtration, complexation, and colloid formation) of key radionuclides.

Available data suggest that models for porous media and equivalent porous media are suitable for modeling large-scale ground-water movement and solute transport in basalt. In the future, fracture-flow models may be necessary for modeling discrete geologic discontinuities. Site-characterization data collected from surface boreholes and the exploratory-shaft tests noted above will form the data base needed to address issues pertinent to flow and transport in a saturated and fractured basalt.

Salt

The geohydrologic information gathered to date has been used to provide a preliminary evaluation of the hydrostratigraphy, potentiometric surfaces, hydrologic parameters, geochemistry, and recharge-discharge areas on a regional scale within the salt basins. Regional conceptual models for the sites are discussed in Section 5.3.2.

The data base for the Palo Duro Basin includes stratigraphic and hydrologic information from 14 DOE wells, numerous oil and gas wells, and private and municipal water wells. Consequently, the regional hydrostratigraphic units and potentiometric surfaces within the Palo Duro Basin are well defined. Furthermore, permeability values for the major units have been determined from aquifer tests performed in the DOE wells and from reanalyzed oil-field data. Geochemical data for water samples from the DOE wells have also been analyzed.

The regional and site-specific hydrostratigraphy at the salt-dome sites in Mississippi and Louisiana has been defined with data from approximately 150 DOE wells and from oil and gas wells. In addition, the potentiometric surface of the fresh-water Miocene aquifer has been defined with water-level information from DOE and municipal wells. The potentiometric information for deeper saline aquifers is less reliable.

Information for defining the regional geohydrology near the Davis and the Lavender Canyons in the Paradox Basin includes data from three DOE wells and numerous oil and gas wells. The hydrostratigraphy of the region has been tentatively defined. Potentiometric surfaces, hydraulic parameters, and recharge-discharge areas have been evaluated from available data, but more information is necessary to adequately define the regional system. This information will be acquired during site characterization if one of the Paradox Basin sites is selected for characterization.

After the site to be characterized is chosen, a series of nests of test wells in the upper and lower aquifers will be installed to evaluate the hydraulic parameters necessary to define the geohydrology near that site. Plans for the geochemical sampling and monitoring of surface water will be included in the site-characterization plan. The geochemical sampling will be used to determine water chemistry, characterize the deep brine aquifers, determine the age of the brine, and predict radionuclide behavior in the deep aquifer in the vicinity of the selected salt site.

<u>Tuff</u>

The tuff site is unique in that the proposed repository would be sited in the unsaturated zone. The components of the hydrologic system that must be characterized include the hydrologic environment of the waste package and the repository system, the vertical flow path through the vertical zone from the repository down to the water table, and lateral flow in the saturated zone to the accessible environment.

A series of shallow boreholes will be monitored by neutron-logging techniques over several years to relate the intensity of precipitation to the recharge of ground water. Deeper boreholes will be used to monitor moisture content, permeability, and potential for moisture movement in rock pores and fractures, as well as to determine changes over time. Both vertical and lateral gas-pressure transmission tests will be conducted to define fracture permeability and interconnectivity. The studies will include the tuffs above, at, and beneath the repository horizon. The results of these studies will be used to complete a preliminary model of flow in the unsaturated zone. The final model will be developed when the detailed tests in the exploratory shafts have been completed.

Preliminary data on the configuration of the water table beneath the tuff site are available from drill holes, but additional drilling and precision surveys are needed to refine the data and to establish flow paths to the accessible environment. Tracer tests will be conducted at two or more locations along the flow paths to determine fracture permeability, effective porosity, and ground-water-flow velocity in the tuffs beneath the water table. Piezometers are already in place in five holes to define the potentials for vertical flow, and high-precision temperature surveys will be continued throughout site characterization to help define vertical movement in both the unsaturated and the saturated zones. A regional flow model has been developed; a more detailed model of flow in the saturated zone will be developed for the vicinity of the site to support estimates of flow time and transport from the repository to the accessible environment.

Chemical analyses and age dating of water samples will continue during site-characterization drilling and during the sinking of the exploratory shafts if water is encountered. The data will provide independent evidence of ground-water flow paths and velocities.

2.2.4 ENVIRONMENTAL STUDIES

Basalt

Environmental studies at the basalt site can draw on the large quantities of information collected in earlier studies of the Hanford Site (e.g., an environmental impact statement prepared in 1975). In FY85, an environmental monitoring program will be initiated. A detailed study of the ecological and radiological effects that may result from the construction of a repository will start in FY86 and should be completed in FY88. An evaluation of alternative mitigation measures for unacceptable adverse effects, if required, followed by the selection of possible mitigation measures, will be completed in FY88. A detailed implementation plan for these measures will be completed in FY89.

Salt

Existing environmental data for the potentially acceptable salt sites are presented in the Draft environmental assessments (EAs) for the Lavender Canyon, Davis Canyon, Cypress Creek Dome, Richton Dome, Deaf Smith County, Swisher County, and Vacherie Dome sites (DOE/RW-0009, 0010, 0011, 0013, 0014, 0015, and 0016, respectively, December 1984) and the supporting topical reports cited in the EAs. The environmental field studies to be conducted in conjunction with site characterization at the selected salt site will include air quality, meteorology, noise, soils, land use, population density and distribution, background radiation, ecosystems and threatened and endangered species, transportation, visual (aesthetic) resources, cultural and historical resources, and natural resources. The results of such studies will be incorporated into the environmental impact statement and other subsequent program documents.

Tuff

Environmental characterization activities were initiated at the tuff site in 1980. Using previous studies of the region as a baseline (e.g., an environmental impact statement prepared in 1977 for the Nevada Test Site), additional environmental data needs were identified, and limited field-survey and monitoring plans that focused on the ecological and archaeological resources of the area were developed and implemented in 1981. During 1982 and 1983, field studies were continued in an effort to characterize both the natural environment and the socioeconomic conditions in the Yucca Mountain area.

During FY84, a detailed evaluation of the historical environmental data base was initiated. Plans for field surveys and monitoring will be prepared for implementation in FY86 and FY87. The resulting data base is intended to provide a suitable environmental baseline for the assessment of potential impacts of repository development and the evaluation of mitigation strategies.

2.2.5 SITE-PERFORMANCE ASSESSMENT

The assessment of site performance involves the simulation of the transport of radionuclides throughout the natural barrier system of the site. The EAs contain preliminary results obtained with some performance-assessment computer codes developed for estimating the ability of the sites to isolate the wastes. However, the codes used for the preliminary analyses reported in the EAs are not necessarily appropriate for more-detailed analyses.

The site characterization plans (SCPs) will provide details of the conceptual models, numerical models, and codes to be used for the detailed performance assessments needed to support the license application to the NRC. They will also define the data needed to use these codes. The SCPs will be accompanied by site-specific performance-assessment plans that will give overviews of the performance-assessment codes; describe plans to verify, validate, and benchmark these codes; describe plans for uncertainty and sensitivity analyses using these codes; and outline quality-assurance plans. Site-specific engineering and design requirements documents that set targets for subsystem and component performance will also be prepared in order to focus data-acquisition and design activities.

Subsystem-modeling efforts will be integrated to assess the overall system. This integration will be completed in time to support the license application. The assessment of site performance for the environmental impact statement (EIS) and the preliminary safety analysis report will be based on computer codes that have been verified, benchmarked, and validated to the extent practicable. Confirmation testing before and during the construction of the repository will allow the reevaluation of some of the codes before any waste is actually received. The testing and reevaluation of models and results will continue up to the time of permanent repository closure, as mandated by regulation.

2.3 EXPLORATORY SHAFTS

Much of the information needed to resolve the issues discussed in Chapter 1 can be acquired by surface-based investigations, examples being weather conditions, climatic changes, and surface characteristics. Other data (e.g., some of the geohydrologic parameters) can be obtained from a systematic series of deep and shallow boreholes and by laboratory testing of mechanical and thermal properties. However, as mentioned in Chapter 1, some of the information needed can be obtained only by gaining access to rock at points along the length of exploratory shafts constructed to the depth of the target horizon and by performing tests in an exploratory-shaft facility (ESF).

The ESF at each candidate site will consist of two exploratory shafts and associated surface and underground facilities and workings. Two shafts will be sunk to provide adequate safety for operating personnel by offering a secondary means of egress from the underground stations and by providing adequate ventilation. The current sizes of the shafts are based on the DOE policy of compliance with Sections 113(a) and 113(c)(1) of the Act, providing an adequate margin for compliance with all safety criteria, increased flexibility with respect to the in-situ test programs, institutional acceptability, cost effectiveness with emphasis on near-term expenditures, and the requirements of the site-characterization schedule.

The ESF shafts will be sunk either in parallel or in series, depending on the candidate site. Underground ESF development will start as soon as the first shaft is sunk to full depth and is sufficiently equipped. This initial development work will provide a ventilation loop, improve safety egress capability, and provide safety-related information at the repository horizon. The first phase of in-situ testing will begin shortly after shaft construction for conventionally sunk shafts. The longer-term in-situ testing program conducted in the underground tunnels will commence after the second shaft is sunk, equipped, and connected to the first shaft. The DOE intends to use the exploratory shafts, as required, to ensure that the construction of the repository can be completed in time to meet the January 1998 date mandated by the Act and will continue to evaluate the most cost-effective use of the exploratory shafts in the operating repository. The current technical plans for these shafts are described in this section; the rationale for two shafts is discussed in more detail in Chapter 7, which also covers other general aspects of site characterization.

The activities to be performed in the exploratory-shaft task include the design and construction of access roads, auxiliary surface structures, and impoundments; the design and construction of the shafts and liners; the design and construction of test rooms and tunnels; and the planning and execution of the in-situ test program. Of these many activities, plans for design, construction, and testing are described below for each of the potential host rocks for the first repository. These activities are also shown in the logic diagram for the exploratory shafts (Figure 2-3).

With reference to Chapter 1, the information obtained from the construction of, and testing in, the exploratory shafts addresses issues 1.1, 1.2, 1.3, 1.9, 4.3, 4.4, and 4.7.

The schedules presented in the next five sections (2.3.1 to 2.3.5) are shown for each host rock in Figure 2-4.

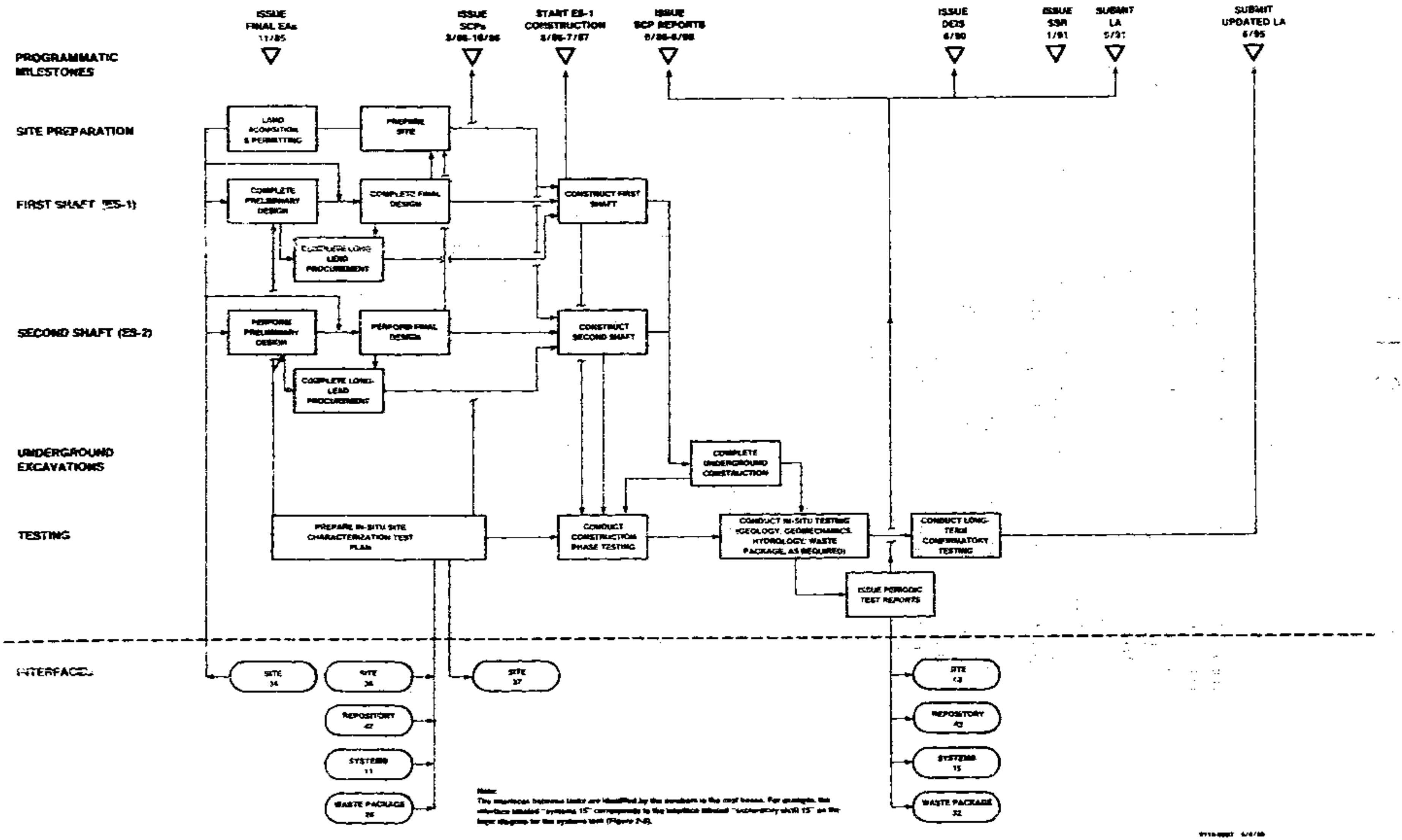

Figure 2-3. Logic diagram for the exploratory-shaft task.

8 0 0 0 8 2 1 4 0

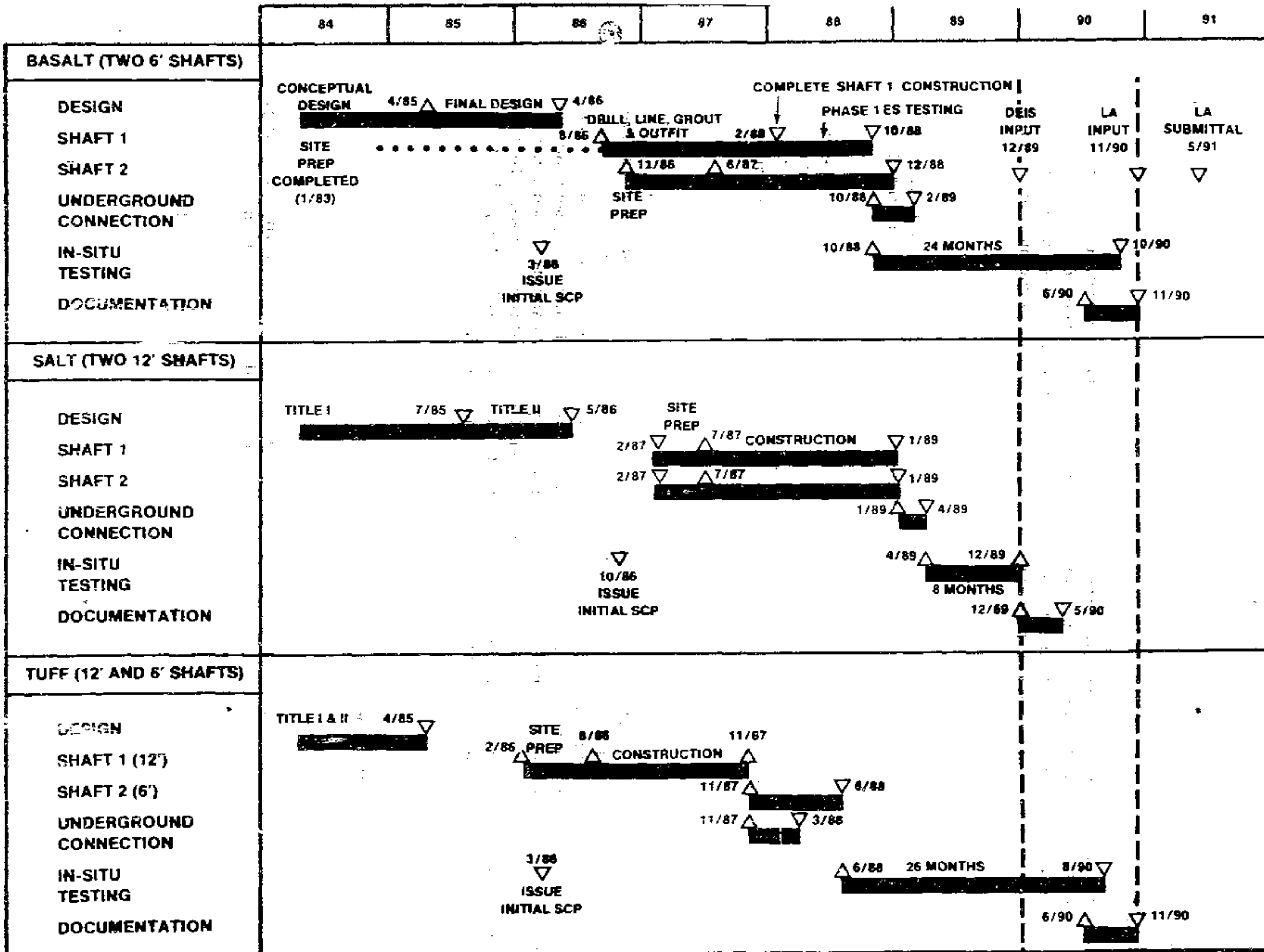

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Figure 2-4. Exploratory-shaft and testing schedule.

2.3.1 GENERAL

Basalt

The exploratory-shaft facility will consist of two shafts, each with a finished (inside) diameter of 6 feet; approximately 1500 feet of subsurface excavations; and various support facilities. The underground excavations will be developed through the first shaft. Primary access for personnel and equipment will also be provided by the first shaft.

Salt

The exploratory-shaft facility will include two shafts with a finished diameter of 12 feet. Surface and underground facilities will be provided as necessary to support ESF activities.

Three preliminary designs, one for each geohydrologic basin, will be completed in July 1985. One final design will be prepared after the candidate salt site is selected. Site-specific geologic and hydrologic data from the engineered design borehole (EDBH) are needed to complete the final design. Drilling for this borehole is scheduled to start in January 1986.

Tuff

The exploratory-shaft facility at the tuff site will consist of two shafts, surface facilities, one main underground testing area, and two smaller underground testing areas. The first exploratory shaft will have a finished diameter of 12 feet; the second shaft will have a finished diameter of 6 feet. The larger first shaft will be used for routine personnel and equipment access and egress. The second shaft will serve primarily as a means for emergency egress, in addition to supporting the underground ventilation system. Testing activities will begin with the construction of the first exploratory shaft with such activities as shaft-wall mapping and photography and large-block sampling and analysis.

2.3.2 SITE PREPARATION

Basalt

Site preparation for the first shaft includes clearing, grading, fencing, and the installation of utilities for the drilling pad and starter hole. These activities were completed in January 1983.

The plan for preparing the site for the second shaft is scheduled for completion in April 1986.

Salt

Site preparation will include the construction of an access road, the installation of utilities, clearing and grading, and the preparation of the salt-storage area and impoundments. Design activities for site preparation are shown on the logic diagram as part of shaft design. Site preparation will require about 6 months starting in February 1987.

Tuff

Site preparation will consist of constructing access roads, electric power lines and a substation, a water-supply line, and a 5 -acre pad for surface structures (shops, a warehouse, office buildings, change rooms, etc.). The design of site preparation will be completed by April 1985. The preparation of the site and the construction of surface facilities will require about 5 months starting in February 1986.

2.3.3 FIRST EXPLORATORY SHAFT

Basalt

The final design for the first exploratory shaft was completed in September 1983.

The first exploratory shaft will be blindbored and lined to a finished inside diameter of 6 feet. A steel liner capable of withstanding the hydrostatic head to the total depth will be used. The liner will be equipped with portholes to allow testing in selected horizons before and after breakout.

The present plan is based on drilling the shafts to a depth of approximately 3400 feet, with a shaft station in the Cohassett flow at approximately 3160 feet.

The construction schedule for the first shaft is as follows:

Site preparation	Completed
Shaft drilling	9 months
Shaft lining and grouting	3 months
Shaft outfitting	6 months
Porthole testing	4 months

The construction of the first exploratory shaft in basalt is scheduled to start in August 1986 if the site is selected for characterization.

Salt

The shaft will be sunk by conventional methods (drilling and blasting) and is scheduled to be fully operational before the start of in-situ testing. Site-specific conditions may or may not require ground freezing before sinking. The shaft will be lined with concrete or a combination of concrete and steel, depending on site-specific conditions, either to full depth or to the bottom of the lowest major aquifer. Adequate seals behind the liner will be provided to protect the water quality of the aquifers and to inhibit the migration of water to the test horizon.

An economic evaluation of the shaft-construction method for the shaft depths and size under consideration (12-foot inside diameter) showed that the conventional shaft-sinking method is significantly less expensive than the previously planned drilled method. In addition to cost savings, the conventional method provides better opportunity and control for characterizing, the walls of the shaft, ability to construct seals manually at any required horizon to prevent the contamination of aquifers and water inflow, and valuable experience for sinking the larger shafts that will be required for a repository.

A sequential construction schedule is as follows:

EDBH drilling and initial report	4 months
Confirmation of design assumptions with EDBH data	2 months
Completion of ESF permitting concurrent with procurement activities	5 months
Site preparation	5 months
Shaft construction	18 months
Shaft connections	3 months
Drift mining	5 months

Tuff

The final design for the first exploratory shaft in tuff is being updated to incorporate some changes necessitated by the addition of the second shaft. The first shaft will be excavated by conventional mining methods and lined with concrete. The shaft will be constructed to a total depth of about 1480 feet, with breakouts at the 520-, 1200-, and 1480-foot levels. The shaft will be outfitted with two hoisting compartments and a manway; it will house underground utility and service lines. Activities associated with construction-phase testing will proceed in parallel with the sinking operations.

The construction schedule for the first exploratory shaft in tuff is as follows:

Site preparation	6 months
Shaft construction	15 months
Breakout, drift mining, and equipment installation	7 months

If the tuff site is selected for characterization, site preparation will start in February 1986, with the construction of the first shaft beginning in August 1986.

2.3.4 SECOND EXPLORATORY SHAFT

Basalt

The final design for the second exploratory shaft in basalt is scheduled for completion in April 1986.

The second shaft will be finished to an inside diameter of 6 feet. Its design and construction will be similar to those of the first exploratory shaft.

8 0 0 0 9 2 1 4 4

The construction schedule for the second shaft is as follows:

Site preparation	2 months
Shaft drilling	[illegible] months
Shaft lining and grouting	[illegible] months
Shaft outfitting	3 months
Porthole testing	1 month

The construction of the second exploratory shaft is scheduled to start in June 1987, after the completion of site preparation.

Salt

The second exploratory shaft in salt will be of the same size and basic design as the first shaft and will be constructed simultaneously with the first shaft. For details see Section 2.3.3.

Tuff

The second exploratory shaft in tuff will be constructed by upreaming from the 1200-foot level to the surface. It will have a finished diameter of 6 feet. The final design of this shaft was completed in April 1985. This shaft will be located about 280 feet from the 12-foot-diameter shaft, and the two shafts will be connected by underground excavations at the 1200-foot level. The shaft will be integrated into the overall ESF ventilation system and equipped with hoisting equipment to provide a means for emergency egress. The construction of the second shaft, including the drilling of the initial pilot hole, will require about 7 months.

2.3.5 UNDERGROUND EXCAVATIONS

Basalt

The final design for the underground excavations is scheduled for completion in April 1986. The underground drift will be constructed from the first shaft station. The conceptual arrangement provides a drift for hydrologic tests, a drift for geomechanics tests with a parallel mine-by drift, an area for heater tests, and adequate space for drilling exploratory boreholes. Approximately 1500 linear feet will be excavated.

The schedule for the underground excavations is as follows:

First-shaft breakout and initial overcore tests	4 months
Connection to second shaft and underground facility	4 months

The breakout from the first shaft is scheduled to start in October 1988.

Salt

From one of the shafts, a drift will be excavated to connect with the other shaft. This connection will provide the ventilation and egress necessary to begin continuous mining for the underground test facilities. From the other shaft, a small station will be excavated by drilling and blasting to provide space for the breakthrough from the first shaft. After the shaft connection is completed, a continuous-mining machine will be used to excavate the drifts, crosscuts, and test rooms needed for the in situ test program, which will start after the connecting drift is completed. The total footage of drifts to be excavated may be on the order of 5000 linear feet. The shaft stations and work areas will be outfitted to the degree necessary to support continuous-mining operations and the in-situ testing program.

Tuff

In order to adequately evaluate the potential location for a repository at Yucca Mountain, three underground testing areas will be constructed: two small testing areas, one at the 520-foot level and the other at the bottom of the 12-foot-diameter shaft, and the main testing area, which will be at the 1200-foot level. The main testing area, consisting of about 1250 linear feet of a 15- by 15-foot drift, will be constructed in the Topopah Spring unit. In addition to providing rooms for various tests, the excavation at the 1200-foot level will connect the two shafts and provide room for drilling up to eight lateral core holes 500 to 2000 feet long. The upper shaft breakout (520-foot level of the larger shaft) will also be in the Topopah Spring unit, while the breakout at the bottom of the shaft will be in the Calico Hills unit. The design of the underground excavations is scheduled for completion by June 1985. If the tuff site is selected for characterization, the construction of the underground excavations at the 520-foot level and the bottom of the shaft will be done in conjunction with the shaft construction, while the construction of the main testing area will begin in September 1987 and require about 4 months to complete. An additional 6 months will be required to drill the 500-to 2000-foot-long core holes at the 1200-foot level.

2.3.6 TESTING

The requirements for in-situ testing stem from the DOE's siting guidelines (10 CFR Part 960) and the NRC's regulations (10 CFR Part 60). The siting guidelines specify that, in order to proceed with repository site-selection, the DOE must have evidence to support a finding that the site meets all the qualifying conditions of the guidelines. The NRC's criteria in 10 CFR Part 60 require that, unless otherwise determined, site characterization will include exploration and testing at depths at which wastes are to be placed and states that results from site characterization will be an important part of the license application.

Testing, to be conducted in two phases, will commence with the start of shaft construction and end only after reasonable assurance has been obtained that the data adequately represent the site. The first phase, construction testing, is defined as the tests and investigations starting with shaft construction and continuing until the two shafts are connected underground. In-situ testing at depth will start at the completion of construction testing and continue until sufficient data have been collected.

Two major reports will be produced during the in-situ testing program. The first will address the site-suitability requirements of the siting guidelines and will be used for the preparation of the draft environmental impact statement (DEIS); the second will address the license application requirements of the NRC. In large part, these reports will be based on results from the same tests with different data-cutoff dates.

Basalt

The detailed test plan for the in-situ testing program has been prepared; an internal review of the plan is proceeding. The first phase of the test program will include the monitoring of construction activities and limited in-situ testing.

Construction-phase testing will include the following:

- Drill-rig performance.
- Grout-seal integrity.
- Blasting performance.
- Air quality.
- Ground-water inflow.
- Initial geologic mapping.
- Performance of excavation and supports.

The in-situ testing phase will begin at the completion of construction, except for the mine-by drift. The current program for in-situ testing includes the following:

- Geologic characterization tests.
- Small-scale geomechanical tests.
- Hydrology chamber test.
- Hydrology cluster test.
- Heater test.
- Plate-bearing test.
- Mine-by test.
- Overcoring test.
- Shaft hydrology tests.
- Geophysical tests.
- Geochemical sampling.

The in-situ test program is scheduled to start in October 1988 and continue for approximately 24 months.

Data for the DEIS are required by December 1989. The basalt in-situ testing program will provide constructibility and early preclosure data at that time. The additional test data required for the license application will be available in November 1990.

Salt

Current plans call for a construction-phase testing program of 21 months. The program will include such activities as--

- Initial monitoring of shaft behavior.
- Initial monitoring of aquifer-seal performance.

- Horizon selection and verification.
- Geologic mapping of shafts.
- Geologic mapping of initial underground openings.
- Blasting performance.
- Initial air-quality measurements.
- General assessments of underground stability.
- Documenting any evidence of ground-water inflow or seeps.
- Initial ground-closure observations.

In-situ testing will begin in April 1989 and continue for 8 months. This testing will support the DEIS and the license application and will include such activities as--

- Continued monitoring of the tests started during the construction phase.

- Geologic mapping of underground openings.

- Evaluation of excavation supports.

- Laboratory-sample characterization.

- In-situ measurement of the state of stress, thermal properties, and permeability.

- Analysis of interbeds (if any).

- Analysis of underground gases (if any).

- Analysis of interim results from long-term testing for thermomechanical response and brine migration, room-closure (salt-creep) measurements, and waste-package tests with electrical heaters.

Tuff

The testing program in tuff will begin shortly after shaft construction begins. Some in-situ tests can begin when the underground openings are completed. However, until the construction of the second shaft is completed, this testing will be on a limited basis because of the high level of construction activities underground.

The tests conducted during construction will include--

- Shaft- and drift-wall mapping and photography.
- Large-block sampling for age dating and pore-water analysis.
- Ground-water sampling.
- Shaft-convergence measurements.
- Vertical and lateral-core drilling.
- Test of breakout-room deformation.

The tests conducted after construction will include--

- Measurement of drift and pillar deformation.
- Overcore test.

- Sampling of intact fractures.
- Bulk-permeability test
- Infiltration test.
- Waste-package tests with electrical heaters.
- Heated-block tests.

The test plan for tuff is scheduled to be completed by September 1985. The test program will begin shortly after the start of shaft construction in June 1986 and continue for 26 months after construction, ending by August 1990.

2.4 REPOSITORY

Work under the repository task is directed at developing site-specific designs for repositories that meet regulatory performance requirements, are efficient, and are cost effective. The task is related to issues 1.3, 2.1, 2.3, 2.5, and 4.2 through 4.7 in Chapter 1. To resolve these issues, it is necessary to (1) establish the properties of the host rock and to develop constitutive models; (2) develop and demonstrate site-specific equipment for packaging and handling the waste and to perform specific mining and drilling tasks; (3) identify site-specific seal requirements and develop site-specific materials, designs, and emplacement techniques for the seals; and (4) integrate the results of tasks 1, 2, and 3 into an overall design that will meet the functional requirements and performance criteria established for the repository. The design task is an evolutionary and iterative process that includes the formulation, testing, and refinement of concepts; the combination of concepts into the design; analyses of the design for technical validity; and comparisons of the design with criteria and requirements. This sequence is repeated and refined until the design meets the requirements established for performance, efficiency, and cost effectiveness.

The plans described in the sections that follow are limited to the preconstruction phase of repository development. The actual construction, operation, closure, and decommissioning of a repository are not included in the DOE's current work-task structure. Detailed plans for these activities are being developed, and general descriptions of the construction and operation of a repository are available elsewhere.* The annual costs of construction and operation are reported in Chapter 10.

Two of the sections that follow, "Rock Mechanics" and "Seal Design," are divided into separate discussions for basalt, salt, and tuff. The remaining sections were not structured by host rock to avoid unnecessary repetition.

The logic diagram for the repository task is shown in Figure 2-5.

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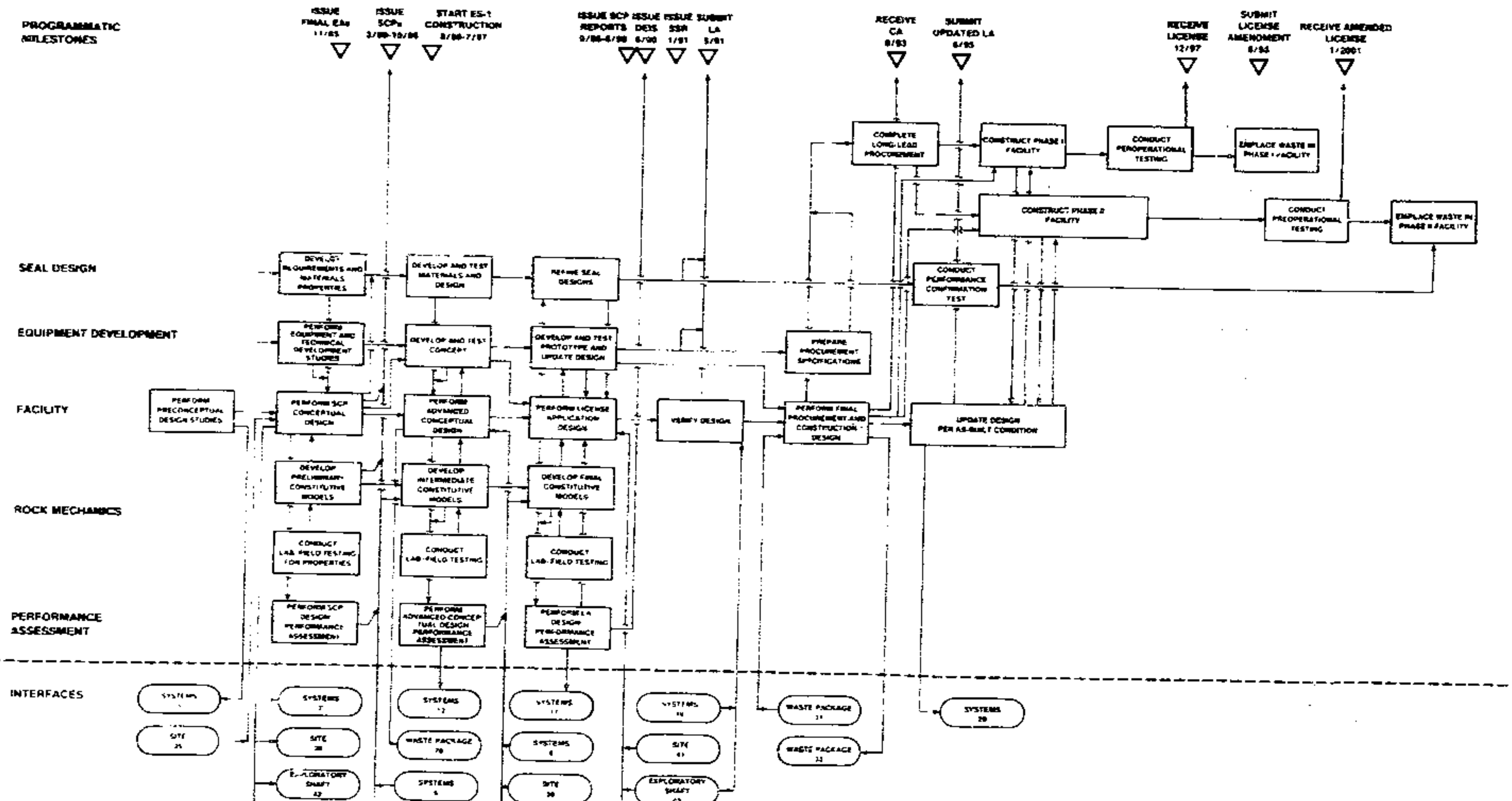
*See, for example, the Final Environmental Impact Statement--Management of Commercially Generated Radioactive Waste, DOE/EIS-0046, U.S. Department of Energy, Washington, D.C., 1980.



Note

The interfaces between tasks are identified by the numbers in the oval boxes. For example, the interface labeled "system 8" corresponds to the interface labeled "repository 8" on the logic diagram for the systems task (Figure 2-6).

Figure 2-5. Logic diagram for the repository task.

2.4.1 ROCK MECHANICS

The rock-mechanics task is concerned with obtaining field and laboratory data on the thermal and mechanical properties of the host rock (see issue 1.3 in Chapter 1 of Part II) and developing mathematical models for predicting the response of the host rock to the construction of shafts, the excavation of the repository, and the emplacement of heat-generating radioactive waste.

Basalt

In basalt, a heated-block test has been conducted. The results will be used to analyze the modes in which underground openings can fail. In parallel with a continuing laboratory testing program, hydrofracture field tests on candidate basalt flows are being conducted to measure in-situ stress. In addition, tests of thermal expansion and rock-mass strength are being conducted to amplify the geotechnical data base.

Before starting the exploratory-shaft program (see Section 2.3), sensitivity studies of stress and displacement around underground openings will be conducted to select geotechnical design parameters. The results of these studies will be used in defining laboratory and field test programs for the exploratory shafts.

Salt

The material properties of salt are being obtained from testing rock cores in the laboratory and from field tests. Studies of ongoing deformation processes have been undertaken and are in progress. Diapiric evolution of salt domes has been studied by both physical and numerical modeling techniques. In addition, the instability due to more dense liquid overlying a less dense liquid in a gravity field is being studied. This instability is an analog of a more dense rock overlying a salt bed. A study of this type, known as a Rayleigh-Taylor instability study, is being conducted. In addition to these modeling efforts, field data have also been used. Thermomechanical testing has determined the strength and deformational characteristics of salt from proposed repository horizons and of various rock units above and below the horizons. Constitutive models that treat the thermomechanical response of materials under expected repository conditions have been formulated. Specifically, the parameters for salt creep, the compressive and tensile strengths of salt, and the elastic properties of salt have been determined.

At present, the salt studies are developing an adequate data base of physical properties to compare the seven salt sites from a geoengineering perspective. The rates of room closure, the quantities of brine transported to the waste packages, rock stresses acting on the package, and similar quantities are being estimated by means of predictive models that use physical properties determined in the laboratory and in the field.

Data on rock-mass properties will be investigated in FY85 and future years. The impact of bedding planes, interbeds, inclusions, jointing, faults, and folds on the response of the rock mass can control the design of the underground facilities. The results of field tests (e.g., heated-core jack tests in a salt dome) will be available in FY85. Analyzed brine-migration data obtained from experiments in the Asse mine in the Federal Republic of Germany will also be available in FY85.

Future testing in FY86 and beyond will concentrate on additional room-scale in-situ experiments to validate the predictive codes used for the preliminary design and licensing activities. As data become available, they will be incorporated into the numerical computer codes to evaluate underground repository designs, predict rock-mass responses, and analyze in-situ test results.

Tuff

Data on core samples of welded tuff are being used to establish the material properties of welded tuff. Testing on the effects of sample size and openings in the rocks (i.e., lithophysae) will be completed in FY85. Additional confirmatory laboratory tests will be performed with samples obtained in the exploratory-shaft program. In FY84 and FY85 emphasis has shifted to larger scale and more complex field experiments. Preliminary data on the properties of the rock mass were obtained in FY84. Data from experiments with heated blocks and electrical heaters will be available in FY85. Additional large-scale in-situ experiments may be conducted in FY85 and continued in the exploratory-shaft program.

As rock-mass data become available, they will be factored into the constitutive models. Preliminary models that account for fractures in the rock will be used for the conceptual design of the repository. The more-complex models incorporating the results of the large-scale field data will be available in FY87 for use in the license-application design.

2.4.2 REPOSITORY DESIGN

The DOE has decided that the design of the systems, components, excavations, structures, and barriers necessary to establish and demonstrate compliance with the performance objectives of the NRC's 10 CFR Part 60 should be substantially completed at the time the license application (LA) is submitted to the NRC. To accomplish this, the DOE has divided the design of the repository as follows:

1. Conceptual design phase

    a. Conceptual design for the site-characterization plans
    b. Advanced conceptual design

2. Title I and II design

    a. License-application design
    b. Final procurement and construction design

2.4.2.1 Design Phases

2.4.2.1.1 Conceptual Design Phase

Conceptual Design for the Site-Characterization Plans

The SCP conceptual design phase will result in a design report for each of the three sites approved for site characterization. The design reports will be summarized and referenced in the reports. This design phase will concentrate on the surface and underground system, structure, emplacement, and component designs which require site characterization data and will provide the information to ensure that data-gathering plans relative to design will be adequately included in the SCPs. Known site-specific data will be incorporated to assist in the identification of additional data needs, and sufficient design detail will be developed to ensure that all site data needs are identified. In addition, data-accuracy requirements will be established, and site-specific licensing issues related to site characterization will be identified. This design will be referenced in Chapter 6 of the SCP, which satisfies the requirements of Section 113(b)(1)(c) of the Act and provides a conceptual repository design that takes into account likely site-specific requirements, and 10 CFR 60.11(a)(b)ii. This design phase will end with the submittal of the SCPs. The site-characterization process, however, may lead to design changes during later design phases.

Advanced Conceptual Design

The advanced conceptual design (ACD) phase will start after the completion of the SCP conceptual design reports for the candidate sites being characterized. The advanced conceptual design phase will be used to explore design alternatives and will firmly fix and refine the design criteria and concepts to be made final in later design efforts. The project feasibility will be demonstrated, the life-cycle cost estimated, preliminary drawings prepared, and a construction schedule developed as required in DOE Order 6410.1. The design will be developed with project and configuration control as required in the DOE procedures for major system acquisitions and will comply with the configuration control program requirements of Appendix B, 10 CFR Part 50, as implemented by the NRC Review Plan: Quality Assurance Programs For Site Characterization of High-Level Nuclear Waste Repositories, June 1984. This design will also identify any remaining design-related licensing issues not defined in the SCP conceptual design.

During the advanced conceptual design phase, the DOE's objective is to develop appropriate solutions to all identified design-related licensing issues through consultation with the NRC as established by the DOE-NRC procedural agreement. Site-characterization data and their impact on the design process will be reported in semiannual reports, as required by the Act.

2.4.2.1.2 Title I and II Design Phases

License-Application Design

The license-application (LA) portion of the Title I and Title II design phases will start after the completion of the ACD reports for the candidate sites being characterized; it will conclude with the development of three LA design reports. The LA design phase will complete the resolution of design and licensing issues identified and assessed in earlier design phases and will develop the design of the items necessary to demonstrate compliance with the design requirements and performance objectives of 10 CFR Part 60. Therefore, sufficient design information will be developed during the LA design phase to meet the requirements of 10 CFR 60.31 for the license application. Design requirements resulting from detailed safety and reliability analyses will be fully integrated into the LA design and will form the basis for information required in the safety analysis report. Site-characterization data and their impact on the design process will continue to be reported during this design effort in semiannual SCP reports, as required by the Act. To minimize the cost of this design phase, the design of non-licensing-related ancillary systems will be developed only to the extent necessary to ensure their proper function and adequate cost and schedule planning.

Final Procurement and Construction Design

This portion of the Title I and II phases will start for the one site selected from the three characterized candidate sites. It will develop the final (working) drawings and specifications for procurement and construction. The completion of this design phase will match the completion of the Title II design effort for the entire repository. 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. Minimal disruption in the NRC review process will be experienced during this design phase since the level of design detail on safety-related systems and components will have been adequately covered in the LA design.

2.4.2.2 Status and Approach

The conceptual designs for repositories in basalt, salt, and tuff are at different stages of development. For salt, several generic designs are available for use. However, since specific sites have not been selected, site-specific conceptual designs will not commence until FY86. For basalt, the description of the site-specific conceptual system design has been published and a conceptual design for the SCP will be completed in FY86. Preliminary repository concepts have been developed for tuff, with a conceptual design to be described in the SCP.

During the advanced conceptual design, the designs and specifications developed will be reviewed to ensure that regulatory requirements are met. Additional design reviews will confirm that appropriate codes and standards are followed and that the specified procedures and methods are acceptable; these reviews will check for accuracy, consistency, and completeness. The results of these reviews will be documented and incorporated into the design reports.

As a part of the planned engineering tradeoff studies, alternative designs for elements of the repository system may be proposed to cover a range of possible concepts. These design elements will be combined into alternative systems, if appropriate, and analyzed with respect to the reference concepts. The results of these studies will be used in the design efforts.

2.4.2.3 General Concerns

Discussed below are some general design-related concerns that the DOE recognizes in meeting the 1998 waste-acceptance schedule.

First, the ESF test program will not occur early enough to provide full verification of the data and assumptions used to initiate the LA design. The construction-phase testing will have been completed, but the major portion of the long-term ESF in-situ testing program will not have been started at the start of the LA design. A key design assumption is that at the start of the LA design the DOE will have sufficient data on the basic rock characteristics that will be used for design, licensing, and performance assessment to proceed with the LA design. The objective of the ESF in-situ testing is to confirm the ranges of values assumed in the design phases and in the performance assessment. The DOE recognizes the schedule and cost risk involved in making the above assumption and expects that the data from in-situ testing will resolve this issue before the submittal of the license application.

To expedite the design process and meet the project schedule, very limited time has been allowed for formal design reviews. To provide the necessary NRC review and concurrence with the design, an ongoing iterative review process will be employed. As the designs of major systems, components, and structures mature to the point where concurrence with the approach can be achieved, a review and partial-design acceptance will be made. With care and a more complete level of planning at the start, an acceptable design can be developed and approved earlier than would be the case if the entire design is completed before review and approval.

The revised design approach, which includes a license-application design and a final procurement and construction design (instead of the traditional Title I and Title II designs), is expected to increase the level of effort required to produce acceptable designs to support the LA at all three sites. At the same time, the DOE believes that this approach fully satisfies the NRC's license application requirements and thereby assists in meeting the 1998 schedule requirements.

2.4.3 EQUIPMENT AND TECHNOLOGY DEVELOPMENT

Work in equipment and technology development currently is divided into (1) mining and drilling; (2) waste handling and encapsulation; (3) waste transport, emplacement, and retrieval; and (4) instrumentation. Additional development work may be identified later. Each of the host rocks has specific needs for equipment and technology development. Common elements will be coordinated across the program by sharing costs and results.

Mining in hard rock has typically used drilling and blasting, with some tunnel boring. Soft rock like salt has been mined by either drilling and blasting or continuous mechanical mining. Recent developments in mechanical mining equipment build confidence that mechanical mining can be used in rocks of intermediate hardness, such as welded tuff. The development and demonstration of such capability are planned for FY87.

The technology for drilling shallow vertical holes and short horizontal boreholes for waste emplacement in the repository is available. Current equipment specifications and procedures for procurement and acceptance testing should be adequate. The design for a horizontal drill will be accomplished during FY85, with fabrication and testing during FY86.

Waste-handling and waste-encapsulation hardware will be specific to the host rock. Considerable testing of designs and hardware has been accomplished by private firms (with some Federal funding) in the disassembly of spent fuel. The results of these activities will be incorporated into the design of high-production systems for the repository. All package-development activities for three rock types will receive added emphasis in the near future with the identification of package fabrication requirements, prototype fabrication, and testing. Development, demonstration, and testing of major safety-related equipment will be performed to support the license application.

Waste transport, vertical emplacement, and retrieval have been demonstrated for salt, but additional development is required to accommodate the required waste-acceptance rate. The conceptual design of transport and emplacement equipment, as well as development and prototype testing, will be completed during FY90. For basalt, the preparation of test plans to demonstrate waste emplacement and retrieval will begin in FY86. For tuff, proof-of-concept hardware for horizontal emplacement and retrieval will be tested in FY86 and FY87. Demonstration, advanced testing and design refinement, and a final prototype demonstration will occur in FY88.

Instrumentation development centers around expected field problems (e.g., stress and deformation in salt, difficulty in pore-pressure measurements in tuff, etc.). Other objectives are improvements in the measurements or improvements in the longevity and reliability of instruments. Efforts in FY84 and FY85 are directed at the instrumentation needed for the exploratory shaft experiments. The FY86 and FY87 effort will be directed at the resolution of problems discovered by the field measurements.

2.4.4 DESIGN OF SHAFT AND BOREHOLE SEALS

The design of seals for any host rock involves: (1) the identification of seal requirements, (2) the selection and development of materials, (3) field testing and analysis, and (4) design for the repository.

Basalt

During the first quarter of FY85, a preliminary assessment of seal-performance requirements was completed. This assessment is based on an allocation of total-system performance among the three repository subsystems: the site, the waste package, and the repository. The assessment indicates that the parameter of principal interest in seal design is the ratio of effective hydraulic conductivity to effective porosity in the zone around a repository shaft. This zone includes the engineered material constituting the shaft plug, the interface between this plug and the host rock and that portion of the host rock (the "disturbed rock zone") affected by repository construction and/or thermal loading by emplaced waste.

The seal-performance requirements will be used during FY85 to develop a seal system preconceptual design to support the preparation of the site-characterization plan. Seal-conceptual-design work will be completed during FY86. Seal preliminary design is currently scheduled to be completed during FY89 and will be based on laboratory and bench-scale development work completed in FY86-87.

Laboratory testing to date has been directed toward screening candidate seal materials to identify those that have the required engineering properties and are thermodynamically stable under the expected conditions. A preliminary assessment suggests that a mixture of 75 percent crushed basalt and 25 percent sodium bentonite clay might possess the required material characteristics. The work in seal preconceptual design will focus on this material as a principal component of the seal system. Laboratory testing during the FY86-89 period will continue to examine the chemical and physical properties of candidate seal materials in support of the seal design effort.

Laboratory testing will be complemented by bench-scale development work directed toward the development of techniques for emplacing seal materials and identifying any problems in scaling up from the use of laboratory data in seal design. Bench-scale development work will be completed, according to the current program schedule, during FY88-89 and will constitute a principal input to the preliminary seal design to be completed during FY89.

Field testing will be conducted during late FY89 and during FY90 to provide full-scale confirmation of seal-emplacement techniques. The field tests are currently perceived as a full-scale extension of the preceding bench-scale development tests.

The design of in-situ tests for repository seals will start during FY90; it will be based on the repository-seal preliminary design and the results of field testing. The objective of the seal in-situ tests, which would be conducted in the exploratory-shaft facilities, will be verification that the seal design meets seal-performance requirements under in-situ conditions representative of those expected in a repository following permanent closure.

Salt

The selection and the development of seal materials have been in progress for more than 8 years. The initial selection of cement-based grouts and concretes, crushed salt, clays, bitumens, and polymers from among the considered alternatives was made for the following reasons:

- Well-established borehole-sealing technology and construction practice not requiring substantial development.

- Extensive data base.
- Opportunity to evaluate existing long-lived structures.
- Widely available, low-cost raw materials.

These materials are being considered for borehole plugs, embedding grouts for the shaft liners, shaft and tunnel bulkheads, and a high-density, low-permeability backfill.

The results of field testing will be used to validate the existing analytical models. The planning for field testing is complete. Two general types of activities are being scheduled: field testing to support design and testing of sealing materials.

Schematic designs for three salt sites have been prepared. Site-specific conceptual designs will be started after November 1985.

The development of seal-performance requirements for a salt repository is also under way. Until site-specific performance modeling reaches a more advanced stage of development, interim semiquantitative design requirements are being set as program objectives.

Tuff

For the tuff project, sealing concepts and requirements were developed in FY84, and a draft repository-sealing plan was prepared in FY84. Preliminary materials development and testing and planning for field tests were done in FY84. In FY85 the resolution of sealing issues and an updated repository-sealing plan will be finished. The design of seals for the conceptual design will also be completed. In FY86 and FY87, efforts will concentrate on field testing and advanced materials development if required and the design of seals for the license-application design of the repository.

2.4.5 REPOSITORY-PERFORMANCE ASSESSMENT

The assessment of repository performance is divided into two phases: preclosure and postclosure.

The assessment of repository preclosure performance will be directed at determining that the repository will not adversely affect the health and safety of the public and the operators and that the security of repository operations can be maintained. The range of expected and unexpected events and conditions to be considered and the failure modes that could give rise to those conditions will be identified by means of logical-choice methods. These methods will require quality control, small-group review, documentation, and peer review.

In particular, for accident scenarios that require the modeling and calculation of specific disruptive conditions (e.g., postulated radionuclide releases, ground-water infiltration combustible-gas explosions, and stored-energy releases) a variety of special purpose codes will be employed. These codes will be developed, verified, validated, and benchmarked for the application in which they are to be used. They will also undergo peer review.

The first safety analyses will be conducted to suppo: preliminary-design activities. The analyses will be a continuing activity as the design proceeds, becoming more specific as more detail becomes available. The items important to public safety and radionuclide isolation will be identified and be subjected to particular scrutiny in support of the license application design. The entire work will be documented in the license application. Subsequent work will be largely confirmatory and will contribute to the final procurement and construction design.

The assessment of repository postclosure performance is an integral part of the performance assessment for the mined geologic disposal system. These system-performance assessments will be done with the assistance of site and waste-package specialists and repository designers. The repository designers, in particular, will provide the details of repository- and shaft-closure methods and verification testing results, seal designs, and repository configuration. This information is to be an integral part of the data base for the systems postclosure-performance analyses. Computer codes will be developed, verified, benchmarked, and validated. Preliminary codes have been developed and were used to support the draft environmental assessments. Postclosure system performance evaluation will be a continuing activity leading to documentation in the license application. A system performance assessment, based on confirmatory test results at the time of the final procurement and construction design, will support the license application update. Final system-performance assessments, incorporating experience from testing during the construction phase, will be conducted in support of the license amendment to receive waste.

2.5 WASTE PACKAGE

The waste package is defined as the waste form and any containers, shielding, packing, and other absorbent materials immediately surrounding an individual waste canister. The waste form will be spent fuel or high-level waste, which will be solidified into glass. Spent fuel in the form of intact fuel rods with metal cladding is considered to be an acceptable waste form for the repository and will be the principal waste form accepted at the repository (see also Chapter 8 in Part II).

Work under the waste-package task is directed toward the development of site-specific waste packages that can meet the performance requirements of the NRC criteria and are cost effective. Work in this task addresses issues 1.3, 1.9, 2.4, 3.2, 4.1, 4.3, and 4.6 in Chapter 1 of Part II. The waste-package design must be site specific because the geochemical conditions at each of the potential repository sites are different. Because of these differences and because of the sensitivity of materials to environmental conditions, it is necessary first to establish the range of physical and chemical conditions expected at each potential repository site; the plans for these investigations are discussed in Section 2.5.1. This range of conditions is then used to guide the selection of waste-package materials for the site. As briefly described in Section 2.5.2, reference and alternative materials will be selected and tested for their behavior under the range of expected repository conditions.

Reference and alternative waste-package conceptual designs will then be developed for each site (see Section 2.5.3); the designs will be based on the candidate materials identified during testing. These designs will be analyzed and refined into the license-application design and the final procurement and construction designs. As part of the design activities, prototype waste packages will be fabricated and tested for performance characteristics (see Sections 2.5.4 and 2.5.5).

During the design process, the performance of the waste package will be assessed as discussed in Section 2.5.6. The results of these assessments will be fed back into the design process along with the results of the materials tests. These results and the results of economic analyses of alternative designs will be used to optimize the design in terms of both performance and cost effectiveness. After the completion of the design, prototype waste packages will be tested during repository-performance confirmation. The fabrication of packages for emplacement in the repository will start on a schedule consistent with repository operation.

A simplified logic diagram illustrating these various activities is shown in Figure 2-6.

2.5.1 WASTE-PACKAGE ENVIRONMENT

Ground-water samples have been obtained from drill holes and wells at the basalt site and the tuff site. Samples of brine and of fresh ground water have been obtained from several of the salt sites. The chemical properties of these waters and brines have been evaluated to assess their potential for corroding metals and dissolving waste forms. Water samples from the unsaturated horizon in tuff will be obtained during the exploratory shaft program.

Preliminary results have been published from hydrothermal tests of basalt with synthetic ground water and of tuff with ground-water samples obtained from a well that penetrates the host rock to below the water table. The objective of these tests is to establish the effects of the heat emitted by the waste on the chemical composition of the water and the mineral composition of the host rock. These experiments will be completed in FY88 for basalt and FY85 for tuff. Some of the hydrothermal tests for tuff will be repeated by FY88 if the samples of unsaturated-zone water differ significantly in composition from the saturated-zone ground water used in the previous tests.

Two natural analogs of the waste-package environment are being investigated for basalt. One of them involves the Icelandic basalt geothermal systems. The results of this study, which is scheduled for completion in FY85, will be used to evaluate the long-term stability of the alteration phases formed during hydrothermal interactions between basalt and ground water. The other study involves the Columbia Plateau basalt system, which is being studied to evaluate the long-term stability of the basalt and the alter-

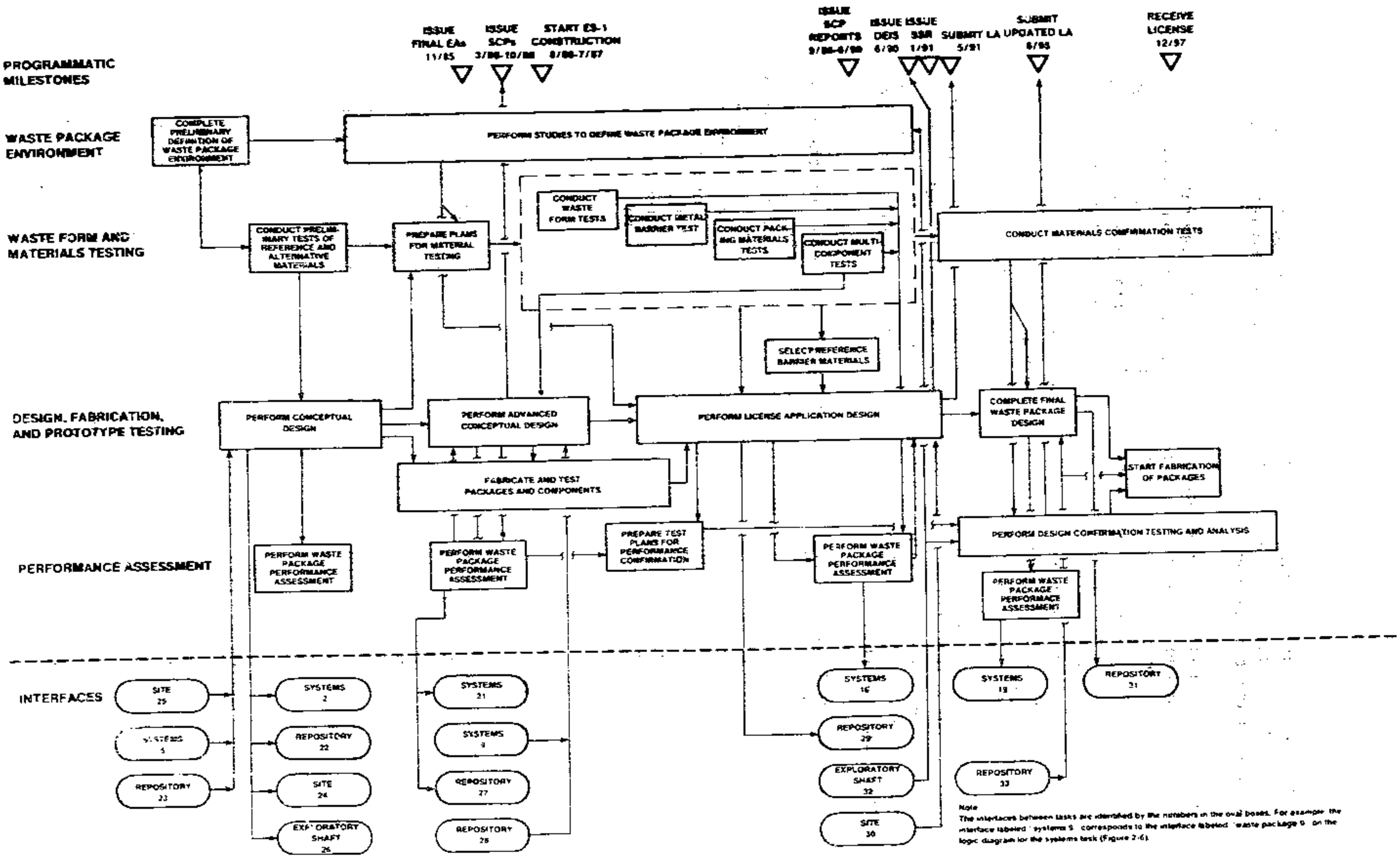


Figure 2-6. Logic diagram for the waste-package task.

ation products formed during hydrothermal reactions. The Columbia Plateau study is part of the ongoing research effort and will be completed concurrently with site characterization.

An experimental program is examining the effects of temperature and ionizing radiation on the composition of brines in contact with rock salt and the effects of radiation on rock salt. This work is scheduled for completion in FY86. A geochemical study at the Salton Sea Geothermal Field is evaluating a natural analog of the waste-package environment. The objective is to examine the effects of heated brines on the corrosion of metals and the mobility of the radionuclides in the natural setting. This study will be completed in FY86. The effects of ionizing radiation on the rock-water systems will be investigated during FY84-90 for basalt and FY85-86 for tuff.

Also scheduled for completion in FY86 is a study of the stability of borehole openings in welded tuff. The results will be used to determine whether it will be necessary to line the boreholes for safe emplacement and retrieval and the conditions of stress to which the waste packages will be subjected after emplacement.

Another study for tuff involves investigating the response of the water contained in unsaturated tuff to the heat emitted by the waste. The objective is to determine the rates and mechanisms for the dehydration of unsaturated tuff, with and without fractures. The rates and mechanisms of resaturation after the peak in the thermal pulse are also being studied to determine the time at which water (in the liquid phase) can first come into contact with the waste packages. The results of these studies will define the fluid phase available for corroding the waste container and the flow mechanisms by which liquid water will come into contact with the waste packages. This work will be completed by FY86.

2.5.2 WASTE-FORM TESTING

Tests with spent fuel and borosilicate glass have been started under site-specific conditions for basalt, salt, and tuff. Preliminary waste-acceptance documents have been developed for tuff, basalt, and salt for borosilicate glass from the Defense Waste Processing Facility (DWPF) and from the West Valley Demonstration Project. These documents identify the specifications and requirements that must be met by the producer of the glassified waste for acceptance at the repository.

<u>Basalt</u>

The waste-form testing program for basalt is directed at predicting long-term rates of radionuclide releases from the waste package. Hydrothermal tests with simulated spent fuel, borosilicate glass, and synthetic ground water were started in FY83. These tests were expanded in FY84 to include borosilicate glass doped with tracers and glass fully loaded with radioactive waste. Preliminary results of experiments with simulated and tracer-doped waste forms have been published; preliminary results for fully radioactive waste forms will be available by September 1985. Static and flow-through hydrothermal tests of tracer and fully radioactive borosilicate glass and spent fuel will continue through FY90, with experiments increasing in complexity from simple systems consisting of the waste form and water to testing of full assemblages (waste form, container, packing, basalt, and water).

Testing with single and simple multiple waste-package components will be completed by FY87 to provide input for formulating the requirements for the preliminary waste-package design. Flow-through tests designed to simulate actual waste-package configurations (laboratory scale) will be started in FY85. Full-assemblage static-interaction tests and flow-through tests of the waste-package configuration, with sufficient replicate testing for reliability analyses, will be completed by FY89 to provide data for the license application and the development of final design requirements for the waste package. This testing program includes both long- and short-term tests.

All testing is conducted over the range of conditions expected for a repository in basalt. Waste forms other than borosilicate glass or spent fuel will be added to the test program as they are identified. A small number of long-term laboratory tests may continue beyond FY89 to enhance the confidence in the predictions of long-term performance. Summaries of test results to date will be provided in the initial site-characterization plan (SCP) and in the SCP reports. Detailed documentation of test results will be provided in periodic topical reports.

Salt

Tests with unirradiated fuel pellets (i.e., uranium dioxide), oxidized fuel cladding (Zircaloy), and ductile iron in site-specific brines were started in FY84; testing with clad spent fuel will be conducted in FY85. Tests of the interactions between spent fuel and other package components will begin in FY85. Performance testing of simulated-waste borosilicate glasses in site-specific brines began in FY83. Studies are emphasizing actinide leaching and the potential for colloid formation. Preliminary results will be available in FY85, and final data will be published in FY86.

Tuff

Test methods are being developed to allow waste-form testing under conditions that simulate those of the unsaturated zone. A laboratory-verified test method will be available by FY85. Both simulated and actinide-doped borosilicate glasses are being tested to obtain information on the sensitivity of radionuclide-release rates to the waste-package environment in a repository. Tests with reaction vessels fabricated from tuff are also in progress. These tests are being conducted under conditions of full saturation (waste form immersed in water) and as such are not representative of the conditions expected at the repository; however, their results will provide an upper bound on radionuclide release rates under conditions expected at the repository and will address the potential case of temporary saturation. A summary of all test results will be provided in late FY85. Long-term testing of glass waste forms under both saturated and unsaturated conditions will begin in FY86. The results will be documented in FY88 and used as input to the final design of the waste package and its performance analyses. Long-term confirmation tests of radionuclide release rates will begin in FY88 and will continue until sufficient data have been obtained to substantiate the predictions of long-term performance.

Spent fuel testing began in FY83 and continued through FY84 with site-specific ground water. Later tests will use both site-specific ground water and tuff. A summary of results will be provided in FY85. Corrosion testing of irradiated cladding (Zircaloy) was started in FY84 to aid in determining the service lifetime of intact cladding as a containment barrier for spent fuel. Long-term testing of spent fuel will begin in FY8, and will follow a schedule parallel to that given for tests with the gla s waste form.

2.5.3 TESTING OF CONTAINERS

As explained in Chapter 8 of Part II, it is currently assumed for repository planning purposes that spent fuel and other high-level wastes will be encapsulated for disposal at the repository. The waste received at the repository (spent-fuel assemblies, commercial high-level waste, and defense high-level waste) will be encapsulated in a metal container to provide the containment performance required by the NRC regulations.

The testing of candidate materials for containers will concentrate on corrosion rates. Corrosion testing has been initiated for all rock types with site-specific waters. These test results have been evaluated to allow the list of candidate materials to be shortened to a reference material and several alternative materials for each site.

<u>Basalt</u>

The current reference container material for basalt is carbon steel. Alternative materials are an iron-chromium-molybdenum alloy, copper, and a copper-nickel alloy. Testing centers around two major areas: mechanical properties and corrosion. Data from the corrosion tests will be used to develop waste package design requirements and performance models, to provide the data base for design analyses, and to verify the selection of the reference material for the container. Testing in FY85 includes a continuation of short-term corrosion tests, testing to evaluate the kinetics of pitting, the initiation of long-term static and dynamic interaction tests with container and packing materials, the continuation of tests related to crack growth, slow-strain-rate tests of materials and weldments, and an evaluation of the effect of radiation on corrosion.

A status report will be issued at the end of FY85 on the progress of the evaluation of copper (and selected alloys) as a container material. The evaluation is currently planned to be completed by the end of FY86. Slow-strain-rate tests with and without irradiation will be completed in FY86; static and cyclic crack-growth tests with and without irradiation will be completed in FY88. The data from these tests will be used to develop license-application designs for the waste package and to verify the selection of the reference or alternative materials for the container.

Short-term corrosion tests of container materials, including static and flow-through saturated-system tests with and without irradiation, air and steam corrosion tests with and without irradiation, and studies of pitting kinetics will continue through FY90. Long-term laboratory corrosion tests similar in scope to the short-term tests will also continue through FY90.

Long-term engineering-scale containment-materials testing in the presence of packing material will start in FY87 and end in FY94. Long-term tests will allow an assessment of the effects of sequential changes in the environment with time on container corrosion.

Salt

On the basis of preliminary corrosion-test results, carbon steel has been selected as the reference container material for salt. A container constructed of a thin layer of a titanium alloy, Ticode-12, over carbon steel has been designated as an alternative design. Corrosion testing during FY85 will develop the data base necessary to verify the selection of the reference or the alternative material. Long-term corrosion testing will begin in FY85 and will be based on site-specific brine by FY86. Product specifications for the container will be issued in FY87.

Tuff

Survey corrosion testing for tuff has identified type 304L stainless steel as the reference container material and other austenitic stainless steels (such as type 316) and Inconel as alternatives. Copper and selected copper alloys will also be evaluated as alternatives. Survey testing of the reference and alternative materials will continue in FY85 under repository-relevant conditions, with and without irradiation, and under stressed conditions to determine the service-limiting conditions. Corrosion work in FY85 will include failure-mode analyses, studies of stress-assisted corrosion mechanisms, and tests of weldments. At the end of FY85, the DOE will issue a status report on the progress of the evaluation of copper (and selected alloys) as an overpack material. The evaluation is currently planned to be completed by the end of FY86. Long-term corrosion testing with the reference and alternative materials will begin in FY86. The container material will be selected in FY87, and long-term corrosion testing will continue with that material in order to add confidence to the long-term-performance predictions based on the results of earlier tests.

2.5.4 PACKING-MATERIAL TESTING

Basalt

Packing material is included in the reference waste package for basalt. The reference packing material is a mixture of crushed basalt and sodium-bentonite clay. The functions of packing materials are described in Chapter 8 of Part II. Studies are under way to determine the long-term stability of the packing material in the repository environment, its oxygen buffering capacity, permeability, hydraulic conductivity, swelling pressure, thermal conductivity, and resaturation rate. Other tests will determine the nature of diffusion-limited water flow around waste packages, radionuclide solubility and sorption characteristics, and diffusion coefficients in the presence of altered and unaltered packing material. The effects of the packing material on the waste form and on the container materials are also being investigated.

All experiments will be conducted with unaltered and hydrothermally altered packing material and under the range of conditions expected for a repository in basalt. Ongoing physical-property testing of reference packing material, including resaturation rates and hydraulic conductivities, will be completed in FY87 to provide input to the development of preliminary requirements for the waste-package design and to the modeling of waste-package performance. Ongoing radionuclide sorption, solubility, and diffusion testing in the presence of packing material will be completed during FY90 to provide input to the final procurement and construction design waste package and the license application. The data also will be used in analyses of waste-package performance to evaluate radionuclide releases. A summary of all test results to date will be provided in the site-characterization plan and in the subsequent SCP reports. Detailed documentation of test results will be completed in FY85, FY87, and FY89 to support the site-characterization plan, the advanced conceptual design, the license application design, and the license application, respectively.

Salt

The present waste-package design for salt uses crushed salt as a packing material. Alternatives include tailoring the crushed-salt packing with additives to control brine composition in order to reduce container corrosion.

Tuff

Packing material is included in the alternative waste-package design for spent fuel in a tuff repository. The packing consists of either crushed and recompressed tuff or of crushed tuff mixed with clay and then recompressed. A decision on whether to continue consideration of this alternative design will be made in late FY85. If it is decided to include packing material in the preliminary design for spent-fuel packages, work will start to develop the capability to fabricate large samples of the packing material. A program of materials testing will also be started to determine the effectiveness of the packing material in controlling the rate of radionuclide releases from spent fuel. The stability of the packing material under repository-relevant conditions will also be investigated.

2.5.5 DESIGN, FABRICATION, AND PROTOTYPE TESTING

Waste-package conceptual designs have been developed for basalt, salt, and tuff.

In-situ testing of simulated waste packages may be performed during the exploratory shaft test program at each of the sites recommended for characterization. Any such testing will be confirmatory state-of-the-art testing to verify the results of laboratory, engineering, and field tests conducted before and during site characterization. Test descriptions will be developed as part of the exploratory-shaft test plan and will give the objectives and schedules for the in-situ testing. Present schedules call for in-situ test procedures to be completed in FY87 and testing to start in FY88. These schedules depend on the schedules for the exploratory shaft. A limited amount of preliminary data may be available to support the license-application design of the waste package, and the license application. Most of the data from in-situ testing will be obtained over a longer period of time and will provide data for the validation of postclosure performance-assessment analyses for the license application update. The nature, scope, and schedule for in-situ testing will depend on assessments by each site of its specific requirements.

Basalt

Three design phases remain for the waste packages to be used in basalt: advanced conceptual, license application, and final procurement and construction. The advanced conceptual design, scheduled for completion in FY86, will provide a reference design and one or more alternative designs to accommodate alternative waste emplacement configurations. The requirements for the license-application design will be developed in FY87, and the license-application design will be completed in early FY91.

Engineering development testing of the waste package is being conducted in parallel with the design effort. Tests of packing-material emplacement started in FY83 and will be completed in FY87 for the preliminary design. Current testing is focused on evaluating the feasibility of fabricating precompressed annular rings for emplacing the packing material in boreholes. Container fabrication, closure welding by remote control, and inspection-process development will be initiated in FY85 and completed in FY89 to provide the data necessary for the license-application design.

Salt

Design efforts for the waste packages to be used in salt concentrated on the refinement of existing conceptual designs during FY84. Requirements for an advanced conceptual design will be developed, along with requirements for development testing. A program of package-fabrication technology began in FY85. The advanced conceptual design will begin after the recommendation of sites for detailed characterization. The license-application design to be started in FY87, will provide input to the license-application design of the repository. This design process will emphasize package fabrication and assembly, along with cost analysis and issues related to emplacement and retrieval.

Tuff

A conceptual design report for a waste package for the unsaturated zone was produced in FY84; it will be followed by the development and analysis of advanced conceptual (prototype) designs during FY85 and FY86. The resulting design report will be issued in FY86. After a design review, prototype waste packages will be fabricated from these designs. The prototype packages will be tested in FY87. During FY87, requirements for the license-application design will be developed.

2.5.6 ASSESSMENT OF WASTE-PACKAGE PERFORMANCE

The assessment of waste-package performance requires the development of theoretical and empirical models to describe the corrosion of metal barriers and the dissolution of waste forms. Geochemical models of solutions containing elements that can be leached from the waste and the interaction of these solutions with other components of the waste package must also be developed. In addition, it is necessary to calculate and model the thermal and mechanical conditions expected after waste emplacement, the fluid-flow conditions, and radionuclide transport from the waste package. The code-development effort at each repository project will be described in the performance-assessment plans (see Section 2.6.2).

2.6 SYSTEMS

The systems task consists of two major activities: systems engineering and performance assessment. Systems engineering is an orderly process of defining the nature, relationship, and interfaces within and between the mined geologic disposal system, its major subsystems (i.e., the natural system at the site, the waste package, and repository), and the rest of the nuclear fuel cycle. It develops the framework for a systematic and orderly control of repository development activities.

Performance assessments analyze the combined effects of the many phenomena that might affect the mined geologic disposal system. Preclosure performance assessments will address the safety aspects of the operating repository. Postclosure performance assessments will use mathematical models to predict the degree of containment and isolation provided by the system and to determine compliance with applicable performance standards, objectives, and requirements. Emphasis on the very long term (postclosure) distinguishes the performance assessment of the repository system from those of more commonly analyzed systems, such as nuclear power plants.

Figure 2-7 presents a logic diagram for systems engineering and performance assessment. Sections 2.6.1 and 2.6.2 describe some of the more-important activities in systems engineering and performance assessment, respectively.

2.6.1 SYSTEMS ENGINEERING

A document describing generic requirements for a mined geologic disposal system has been developed by the Office of Civilian Radioactive Waste Management. This document provides an integrated and uniform set of top-level requirements for that system, its subsystems, and major components (see DOE/NE/44301-1, "Generic Requirements for a Mined Geologic Disposal System," U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington, D.C., September 1984). These requirements reflect and interpret applicable regulatory performance objectives, standards, and criteria on a generic basis. This document has been accepted by both headquarters and the repository projects as the official basis for system descriptions and design activities. To this generic document the projects will add site-specific objectives, standards, and criteria to define project-specific requirements, which will be the basis for site-specific design criteria and performance specifications for subsystems and components. The site-specific requirements will be published as separate documents.

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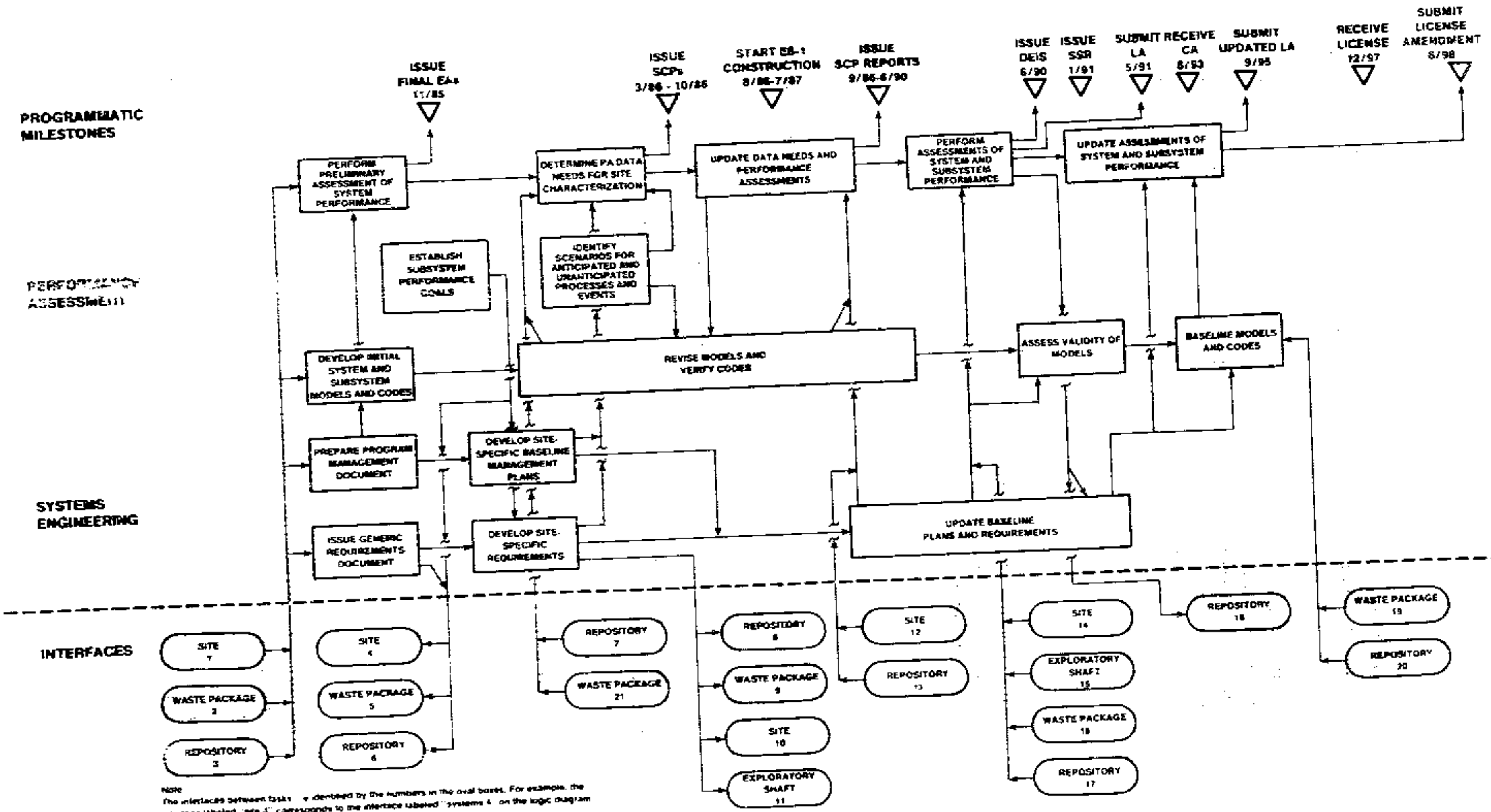

Note
The interfaces between tasks are identified by the numbers in the oval boxes. For example, the interface labeled "site 4" corresponds to the interface labeled "systems 4" on the logic diagram for the site-investigations task (Figure 2-2).

Figure 2-7. Logic diagram for the systems task.

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Each project is also developing a site-specific systems engineering management plan. This document will govern the scope of the technical work at the project.

Baselined management plans and technical-requirements documents must be reviewed and updated as a part of an ongoing iterative activity that maintains the "correctness" of the key elements that control project activities. This mandatory review of baseline documents and requirements will be able to accommodate changes in regulatory objectives and standards, management strategies, technical plans, data needs, or other elements that may affect the conduct of data acquisition and interpretation. The objective is to maintain effective control of, and efficiency in, site-characterization, design, and performance-confirmation activities.

The site-characterization plans will more fully describe the status of these site-specific requirements documents and the plans for their completion. Site-specific technical plans and requirements will be reported in the SCP reports that will be issued twice a year.

2.6.2 SYSTEM PERFORMANCE ASSESSMENT

Performance assessment is a set of activities that will allow the DOE to predict the abilities of the repository system, its subsystems, and its components to meet the requirements set through the systems-engineering process. It is an iterative process of comparing the site-specific performance goals of repository systems, subsystems, and components with calculated performance predictions, using increasingly more detailed site-specific data and design information. Generic system and subsystem performance goals, as given in the Generic Requirements for a Mined Geologic Disposal System, include the regulatory standards and objectives of 40 CFR Part 191, 10 CFR Part 60, and 10 CFR Part 960.

The site-characterization plans will describe how site-specific performance goals for the various components of the repository system will be identified and controlled. The site-specific performance goals for the repository system fall into two major categories: goals for the engineered-barrier system and goals for the natural-barrier system. The goals for the engineered-barrier system can be achieved through a variety of designs, while the goals for the natural-barrier system must be achieved through the characteristics of the selected site.

Determining whether the performance goals for the engineered-barrier system will be met is a process of iteration between design and performance assessment. The process involves setting tentative design goals and then collecting data, developing models, identifying failure scenarios, and assessing whether the preliminary design will achieve the specified performance goals. This iterative process will ultimately result in the final allocations of performance to the individual components of the engineered-barrier system.

The process of determining site suitability requires that extensive site-characterization investigations be conducted to ascertain that the individual siting criteria in the DOE siting guidelines (10 CFR Part 960) and in the NRC technical criteria (10 CFR 60) will be met. The determination of the contributions of individual characteristics of the natural barrier system to overall repository performance also involves iteration between performance-assessment and site-characterization activities. The process involves a determination of baseline conditions and conditions since the Quaternary Period, the development of scenarios, the development of conceptual and numerical models, sensitivity analyses, assessment of results through expert judgment, and, if justified, a finding of site suitability.

As site-specific requirements are developed and performance goals for the system, subsystems, and components are established, the data requirements for site characterization will be further refined. The performance goals and data needs will be identified in terms of the anticipated and unanticipated processes defined in 10 CFR Part 60 and event scenarios that address potential licensing issues in the site-characterization plans. This entire iterative process will be updated continuously, with formal compilations and presentations of results at key program milestones, such as selected SCP reports, the site recommendation report, the draft environmental impact statement, and the license-application.

In order to provide assurance of compliance with regulatory objectives and numerical criteria through performance assessment, specific conceptual models and numerical codes are being developed to assess the performance of the repository system, its subsystems, and, in some instances, key components determined to be important to safety or waste isolation. In addition, exercising these codes in uncertainty and sensitivity analyses will serve to define uncertainties and result in further guidance for data acquisition, the refinement of performance goals, design changes, and testing.

Preliminary models and codes have been developed, and preliminary performance assessments have been reported in the draft environmental assessments for each of the potentially acceptable sites for the first repository.

The initial models and codes are being adapted, as needed, to allow uncertainty and sensitivity analyses to be performed. The results of these analyses are now beginning to be used to help establish and refine data needs and priorities for site characterization. As more site and design information becomes available during site characterization, the models of system and subsystem behavior will be modified to reflect the most current understandings of conditions and processes.

The use of modeling results to refine data needs and priorities, and the use of new data to refine models represents the iterative linkages that exist at the interfaces between the performance assessment, waste package, site, and repository tasks. The conceptual models needed of each of these systems, subsystems, and key components is the working interface between these various tasks and the performance-assessment task.

Sensitivity and uncertainty analyses will be performed periodically with the revised codes to reassess data needs and priorities in light of the evolving data base provided by site characterization and by the design activities. System, subsystem, or special purpose codes will be used, as appropriate, to guide decisions on the types of tests that will best provide the data needed to reduce uncertainty in the assessments of compliance with performance goals for the system, subsystems, and components.

In addition, the ongoing process of code documentation and verification, including benchmarking, will be a major activity during site characterization to ensure that the mathematics and the programming of computer codes are correct. Simultaneously, outputs from models and codes will be compared with measured physical conditions. These conditions may include test results from the sites or reasonably well-known natural analogs of site conditions or barrier components. These comparisons will begin the process of building confidence in the ability of the models to reflect the physical behavior of real systems.

Peer review will also be used to provide an overview by the technical community. Such expert reviews will help build confidence that the models and the codes are as reliable as is reasonably achievable.

As the time of the license application approaches, the process of verification will be completed. Comparisons of code predictions against test results and natural-analog behavior will have established the degree of validity of the codes by the time of the license-application update.

Models and codes will be baselined in a document that supports the level of confidence of the predictive results shown in the license application. This level of confidence will be established by the results of testing, augmented by consensus among technical experts. The reason for baselining this document is to ensure complete control over any changes in models and codes that may be made before a license-application update or a license amendment is prepared.

A performance-assessment plan will be prepared for each of the three sites selected for site characterization. These plans will describe detailed performance-assessment plans and activities. They will be updated to support the site-characterization plans and the SCP reports.

2.7 OTHER TASKS

2.7.1 REGULATORY AND INSTITUTIONAL ACTIVITIES

The regulatory and institutional task monitors the development of regulations that affect the licensing of a geologic repository; coordinates the preparation of statutory and licensing documentation; and interfaces with regulatory agencies, States, affected Indian tribes, the public, and other program participants.

Two major documents required by the Act of 1982 are to be prepared in FY85-87: the environmental assessments (EAs) that are to accompany the nomination and recommendation of sites for characterization and the site-characterization plans (SCPs). The draft EAs were released for public comment in December 1984; final versions are to be available in November 1985. The SCPs will be issued between March 1986 and October 1986. Semiannual SCP reports will provide the results of site-characterization studies, identify the decision points that are reached, and indicate modifications to schedules.

The institutional and regulatory task will also provide input needed for the environmental impact statement that will be prepared to accompany the recommendation of one site for development as a repository.

Among the principal licensing documents will be the preliminary safety analysis report, which will include the results of the performance assessment for the total repository system. This document will conform with the requirements of the Act.

2.7.2 LAND ACQUISITION

The DOE plans to purchase or lease most of the land needed for site characterization. Land acquisition or access procedures will only occur at those sites that are recommended for characterization or selected for repository development. No land will be acquired or leased at sites nominated, but not recommended, for characterization.

Land at sites that are characterized, but not selected for a repository, will be returned to its original use as soon as the site is no longer under consideration for the first or the second repository.

Basalt

For the basalt site, no action on the land-acquisition task is needed because the title to all land needed for the exploratory shafts and the repository is held by the U.S. Government.

Salt

If a salt site is on private land, access for the exploratory shafts will be achieved either through long-term leases or fee-simple purchase. For a repository, the land for construction and operations will be purchased. Additional land to protect the site will be purchased or leased.

If a salt site is on public land (e.g., in Utah), land access for site characterization will be obtained through a cooperative agreement with the appropriate agency (in Utah, the Bureau of Land Management). If a repository is to be built on public land, the land required for construction and operation will be obtained through permanent land withdrawal.

Tuff

The tuff site is located in an area where lands under the jurisdiction and control of three Federal agencies adjoin. The eastern portion of the site is on the southwestern reaches of the Nevada Test Site (NTS), on land that has been withdrawn from the public domain for nuclear testing and related research by the DOE. The northwestern portion of the site is on an extreme corner of the Nellis Bombing Range, on land that has been withdrawn as an aerial bombing and gunnery range for the Air Force. All preexisting rights on the DOE and Air Force lands have been extinguished. The remaining southwestern portion is on land in the public domain under the jurisdiction and control of the Bureau of Land Management; this land is currently free and clear of encumbrances of record.

Ultimately, the portions of the envisioned site not on the NTS must be withdrawn and reserved for use by the DOE. It is currently intended not to seek withdrawal until such time as the tuff site is recommended by the President for a repository and that recommendation is supported by Congress. In the meantime, the DOE has secured permits and agreements with the Air Force and Bureau of Land Management to allow access, exploration, and investigation.

2.7.3 PROGRAM-MANAGEMENT TASK

The program management task is concerned with all of the tasks discussed in the preceding sections. Its objective is to provide the necessary project management, project control, quality assurance, and data management.

2.7.4 TEST FACILITIES

The DOE operates facilities for the purpose of conducting tests to better understand the behavior of materials, waste, and rock when exposed to potential or actual repository conditions and to develop equipment and instrumentation for the repository.

1. Near-Surface Test Facility. Located on the Hanford Site, this facility was constructed in basalt to conduct electrical heater tests, jointed block tests, and other experiments in order to gain a better understanding of the thermomechanical properties of basalt. Other tests are now being conducted or are planned to support the exploratory-shaft test program.

2. G-Tunnel Facility. Located on the Nevada Test Site, this test facility in tuff provides for tests to determine the thermomechanical behavior of tuff.

3. Climax Spent Fuel Test Facility. Located on the Nevada Test Site, this facility was constructed in granite to demonstrate the receipt, handling, emplacement, and retrieval of spent fuel; to determine the effects on granite from spent fuel; and to evaluate differences between the thermomechanical effects produced by radioactivity decay heat and electric heaters.

4. Colorado School of Mines Facility. Located near Idaho Springs, Colorado, this facility was constructed in an existing granite gneiss experimental mine to assess the effects of blasting on the rock mass, to evaluate the heated flat-jack test as a thermomechanical test method, and to determine functional relationships for crystalline rock-masses.

5. Avery Island Facility. Located near New Iberia, Louisiana, this test facility is located in a salt dome. Tests were conducted to examine the thermomechanical response of, and brine migration in, dome salt, to evaluate experimental equipment and instrumentation, to determine permeability of heated and unheated salt, etc.

In addition to these test facilities, a field test known as Project Salt Vault was conducted in bedded salt in the 1960s near Lyons, Kansas to demonstrate waste-handling techniques, to determine gross effects of radiation, and observe salt-creep behavior. Technical information from the Waste Isolation Pilot Plant (WIPP) Project, an R&D facility located in bedded salt outside Carlsbad, New Mexico to demonstrate safe disposal of defense-generated radioactive wastes, will be used in the program. Test facilities outside the United States, including the Asse facility (salt) in the Federal Republic of Germany, the Stripa facility (granite) in Sweden, and the Underground Research Laboratory (granite) to be constructed in Canada, will provide additional information on potential repository behavior.

2.7.5 FINANCIAL ASSISTANCE

The DOE will make financial assistance available to the affected States and Indian tribes as required by the Act. These funds will ensure that the States, affected Indian tribes, and others can fully and meaningfully participate in the plans and activities of the geologic repository program. The funds would be used by the States and affected Indian tribes to allow them to study, determine, comment on, and make recommendations on the possible health, safety, environmental, social, and economic impacts of a repository.

2.8 SECOND REPOSITORY

The DOE is actively pursuing the siting and development of the second repository. The primary focus of planning for the second repository discussed herein will be related to siting. Detailed planning to ensure collection of the information necessary to address the issues identified in Chapter 1 will occur during the development of the area-characterization plan and the subsequent site-characterization plans. Preliminary plans for research and technology development will also be discussed below. The plans described below have been specifically developed for the second repository. As discussed in Part I, potentially acceptable sites identified but not nominated for characterization for the first repository and sites characterized, but not selected, for the first repository can also be considered for the second repository.

2.8.1 SITE INVESTIGATIONS

The national survey identified nearly 250 crystalline rock bodies within the northcentral, northeastern, and southeastern regions of the United States for further investigation to evaluate their suitability for repository development. The investigations are currently in the regional site-screening phase. The regional phase involves the evaluation of crystalline rock formations with respect to the siting guidelines, using open-literature information on the geologic and environmental characteristics of the region.

Draft regional geologic- and environmental-characterization reports have been published to document the information the DOE intends to use in evaluating the crystalline rock bodies identified for further investigation. To assist in the evaluation, State participation in the development of a region-to-area screening methodology has been sought. The region-to-area screening methodology will be used to evaluate the more than 200 crystalline-rock bodies previously identified. After this evaluation, the DOE will prepare the draft area recommendation report, which will identify areas within the 17 States currently under study where the DOE plans to conduct more detailed studies, including field investigations. The field investigation that the DOE will undertake during the area characterization to evaluate site suitability will be described in an area-characterization plan. Both the draft area-recommendation report and area-characterization plan will be issued for State review and comment.

Activities to be conducted during the area phase include geologic, hydrologic, engineering, environmental, and socioeconomic studies. Preliminary performance assessments will be used to evaluate areas under consideration and to identify key site performance parameters for investigation during the area phase. Geologic studies to be undertaken may include resistivity, shallow seismic, aeromagnetic, and gravity surveys as well as the mapping of rock bodies, outcrops, overburden, fracture density, and faults. Data will be collected on the in-situ state of stress and the geochemistry of ground water. Other studies to be undertaken may include aquatic/terrestrial ecology (including threatened and endangered species), water rights, terrain characteristics, offsite hazards, meteorology and climatology, and socioeconomic impacts.

After the completion of the area phase, the DOE will proceed with the nomination and recommendation process for site characterization. The activities to be conducted during site characterization will address the issues identified in Chapter 1 and will be described in the site-characterization Plan for each site recommended. It is expected that many of the site-characterization activities conducted for the second repository will be similar to those discussed here for the sites being considered for the first repository.

2.8.2 SUPPORTING RESEARCH AND DEVELOPMENT

Potential supporting research- and development-activities may be subdivided into five distinct categories, each of which may provide information covering a broad spectrum of concerns.

2.8.2.1 Information from First-Repository Studies

Although the host rocks for the first repository are different from the crystalline-rock bodies being investigated for the second repository, it is expected that data on the following elements from the first-repository studies may provide a substantial base for guiding the design or test efforts in crystalline rock:

- Waste-package-design concepts.
- Materials testing for thermomechanical responses.
- Design of surface and subsurface facilities.

It is not possible at present to confidently predict the precise extent to which first repository data can be applied to technical issues in crystalline rock, though the applicability of the theoretical models, at least, is expected to be considerable.

2.8.2.2 International Cooperation and Data Exchange

In addition to benefiting from the research and development activities conducted for the first repository, the second-repository program will also be able to draw on information from the geologic, hydrologic, and engineering investigations that are being conducted in the crystalline rocks of Canada, Sweden, France, and Switzerland. The exchange of data and possibly of staff should result in the acquisition of information on the following:

- Methodologies in field geologic, hydrologic, and geophysical testing and characterization, and field data from these technologies.
- Methodologies for, and data from, laboratory hydrologic testing.
- Field and laboratory engineering testing, including thermomechanical and rock-mechanics testing of rock, thermomechanical responses of materials, and hydrochemistry.
- Field and laboratory studies of fracture flow, including modeling.
- Analog studies to investigate potential geochemical effects on rock, materials, and radionuclide migration.
- Radionuclide migration testing in the field and in the laboratory.
- Computer-model code development, verification, and validation.

2.8.2.3 Geologic and Hydrologic Field and Laboratory Investigations

Programmatic research and development activities for characterizing crystalline rocks may include the following elements:

- Methodologies for field and laboratory testing for hydrologic characterization and fracture-flow analyses.
- Model studies for fracture flow.
- Analysis of geophysical investigative methods.
- Analysis of surface-to-subsurface extrapolation for geologic, hydrologic, and geophysical characteristics.

- Analog studies in fossil and active geothermal systems for analyzing potential geochemical effects on rock materials and radionuclide migration.

- Field and laboratory tests on radionuclide migration.

2.8.2.4 Engineering-Related Field and Laboratory Investigations

Programmatic research and development activities for analyzing engineering related elements will include the following:

- Analyses of the mechanical and thermomechanical responses of rock and materials.

- Waste-package-materials testing and design studies.

- Design studies for surface facilities.

- Design studies for subsurface facilities, including shafts, and waste emplacement configurations.

- Sealing.

- Design and construction of and in-situ testing in exploratory shafts.

2.8.2.5 Model-Code Development, Verification, and Validation

Programmatic research in performance-assessment code development and modeling will include analyses to support the following:

- Fracture-flow models.

- Total-system models that address geologic, hydrologic, environmental, and regulatory factors.

- Licensing.

2.9 ESTIMATED TOTAL COSTS

The estimated annual costs of research and development activities for the entire waste-management program are given in Chapter 10. These costs are consistent with the program strategy underlying the January 1985 budget submission. Work is under way to develop costs based on the reference repository schedule shown in Part I.

The cumulative costs (undiscounted) associated with siting, designing, and licensing the first and second repositories are summarized in Table 2-1. These cost estimates are based on financial data developed as part of the

Office of Civilian Radioactive Waste Management Fund budgetary process for the period 1983 through 1990, plus projected spending levels for the activities scheduled to take place beyond 1990, as discussed in preceding sections of this chapter. The costs are detailed by work-breakdown-structure category and are estimated separately for the first and the second repository.

For the first repository, costs for site investigations, the systems task, regulatory and institutional activities, test facilities, and project management are assumed to occur from 1983 through 1998, the year in which repository operations are expected to begin. Waste-package design will continue through 1995, while the license application repository design will be completed in 1990. In-situ testing will continue through 1994.

Table 2-1. Summary of the Total Costs of Repository Research and Development (Millions of 1984 dollars)

Category in the work-breakdown structure	First repository (1983-1998)	Second repository (1983-2005)
Site investigations	767	653
Exploratory shafts	676	441
Repository	535	175
Waste package	266	103
Systems	190	125
Regulatory and institutional	396	289
Land acquisition	28	118
Program management	275	194
Test facilities	46	42
Total	3179	2138

For the second repository, costs for site investigations, the systems task, regulatory and institutional activities, test facilities, and project management are assumed to continue through the year 2006, or up to the start of operations.

2.10 INDEX OF INFORMATION NEEDS AND PLANS

Table 2-2 is an index of the information needs identified in Chapter 1 and the plans described in this chapter for acquiring that information.

Table 2-2. Cross Reference of Information Needs and Plans

Issue and information need*	Pertinent section of Chapter 2
Issue 1.1: Geohydrology	
1.1.1	2.2.2, 2.2.3
1.1.2	2.2.2, 2.2.3, 2.3.6
1.1.3	2.2.2, 2.3.6
1.1.4	2.2.1, 2.2.3
1.1.5	2.2.1, 2.2.3, 2.2.5
1.1.6	2.2.1, 2.2.3, 2.2.5
1.1.7	2.2.1
Issue 1.2: Geochemistry	
1.2.1	2.2.1.2, 2.2.2, 2.3.3
1.2.2	2.2.1.2, 2.6.1
1.2.3	2.2.1.2, 2.2.2, 2.6.2
Issue 1.3: Rock characteristics	
1.3.1	2.2.1, 2.3.6
1.3.2	2.2.1, 2.3.6
1.3.3	2.5.2, 2.5.6
1.3.4	2.3.6, 2.6.2
1.3.5	2.5.2, 2.5.5, 2.5.6
1.3.6	2.4.2, 2.5.5
1.3.7	2.3.6, 2.4.1, 2.4.2 2.4.5
1.3.8	2.3.6, 2.4.2
1.3.9	2.4.4
1.3.10	2.4.2, 2.4.3, 2.4.4
Issue 1.4: Erosion	
1.4.1	2.2.1
1.4.2	2.2.1
1.4.3	2.2.1
1.4.4	2.2.1, 2.2.5
1.4.5	2.2.1, 2.2.5
1.4.6	2.2.1

Table 2-2. Cross Reference of Information Needs and Plans (continued)

Issue and information need[a]	Pertinent section of Chapter 2
Issue 1.5: Paleoclimatology	
1.5.1	2.2.1
1.5.2	2.2.1
1.5.3	2.2.1
1.5.4	2.2.1
1.5.5	2.2.1
1.5.6	2.2.1
1.5.7	2.2.1
1.5.8	2.2.1
Issue 1.6: Rock dissolution	
1.6.1	2.2.1, 2.2.3
1.6.2	2.2.1, 2.2.3
1.6.3	2.2.1, 2.2.2
1.6.4	2.2.1
1.6.5	2.2.1, 2.2.5
1.6.6	2.2.1
Issue 1.7: Tectonics	
1.7.1	2.2.1, 2.2.3
1.7.2	2.2.1
1.7.3	Available[b]
1.7.4	2.2.1
1.7.5	2.2.1
1.7.6	2.2.1
1.7.7	2.2.1, 2.2.3, 2.2.5
Issue 1.8: Human interference	
1.8.1	Available[b]
1.8.2	2.2.1
1.8.3	2.2.1
1.8.4	Available[b]
1.8.5	2.2.1, 2.2.3, 2.2.4
Issue 1.9: Waste package and other engineered barriers	
1.9.1	2.2.3, 2.3.6 2.5.1
1.9.2	2.2.2, 2.3.6
1.9.3	2.5.2, 2.5.6
1.9.4	2.5.1, 2.5.6
1.9.5	2.5.3, 2.5.6
1.9.6	2.2.2, 2.5.4
1.9.7	2.5.4

Table 2-2. Cross Reference of Information Needs and Plans (continued)

Issue and information need[a]	Pertinent section of Chapter 2
Issue 2.1: Preclosure radiological protection of the public	
2.1.1	Available[b]
2.1.2	2.4.2, 2.4.3
2.1.3	2.4.2, 2.4.3
2.1.4	2.4.5
2.1.5	2.7.1
2.1.6	2.7.1
Issue 2.2: Meteorology	
2.2.1	Available[b]
2.2.2	2.2.4
2.2.3	2.4.2
2.2.4	Available[b]
2.2.5	Available[b]
Issue 2.3: Offsite installations and operations	
2.3.1	2.2.4
2.3.2	2.4.2
2.3.3	Available[b]
2.3.4	2.6.2, 2.4.2
Issue 2.4: Preclosure radiological safety of workers	
2.4.1	2.4.2, 2.5.3, 2.5.5
2.4.2	2.4.2, 2.4.3
2.4.3	2.4.2, 2.4.3
2.4.4	2.4.2, 2.4.3
2.4.5	2.4.2
Issue 3.1: Environmental impacts	
3.1.1	2.2.4
3.1.2	Available[b]
3.1.3	2.2.4
3.1.4	2.2.4
3.1.5	2.2.4
3.1.6	2.2.4
3.1.7	2.2.4
3.1.8	Available[b]
3.1.9	Available[b]
3.1.10	Available[b]
3.1.11	2.2.4

Table 2-2. Cross Reference of Information Needs and Plans (continued)

Issue and information need[a]	Pertinent section of Chapter 2
Issue 3.2: Local transportation	
3.2.1	2.4.2
3.2.2	2.4.2
3.2.3	2.2.4
3.2.4	2.4.2, 2.7.1
Issue 3.3: Socioeconomic impacts	
3.3.1	Available[b]
3.3.2	2.4.2
Issue 4.1: Waste package and costs	
4.1.1	2.7.1
4.1.2	2.5.4, 2.5.5
4.1.3	2.4.2, 2.4.3, 2.5.5
4.1.4	2.4.2, 2.4.3, 2.5.5
Issue 4.2: Surface characteristics	
4.2.1	2.2.1, 2.4.2
4.2.2	2.4.1, 2.4.2, 2.2.1
4.2.3	2.2.4, 2.4.2
4.2.4	2.2.3, 2.4.2
Issue 4.3: Flexibility of repository horizon	
4.3.1	2.2.1, 2.3.6
4.3.2	2.4.2
4.3.3	2.4.2, 2.5.3
4.3.4	2.2.1, 2.2.3, 2.4.1, 2.4.2
4.3.5	2.3.6, 2.4.2, 2.4.4
Issue 4.4: Hydrology and ease of construction	
4.4.1	2.2.3, 2.3.6
4.4.2	2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.4.2
4.4.3	2.2.3, 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.4.2

Table 2-2. Cross Reference of Information Needs and Plans (continued)

Issue and information need[a]	Pertinent section of Chapter 2
Issue 4.5: Tectonics and construction	
4.5.1	2.2.1
4.5.2	2.2.1
4.5.3	Available[b]
4.5.4	Available[b]
4.5.5	Available[b]
Issue 4.6: Cost effectiveness, safety, and repository construction	
4.6.1	2.4.2, 2.6.1, 2.7.1
4.6.2	2.5.2
4.6.3	See issue 1.9
4.6.4	See issue 1.3
4.6.5	See issue 2.1
4.6.6	See issue 2.3
4.6.7	See issue 2.4
4.6.8	See issue 4.1
4.6.9	See issue 4.2
4.6.10	See issue 4.3
4.6.11	See issue 4.4
4.6.12	See issue 4.5
Issue 4.7: Permanent sealing and cost	
4.7.1	2.2.1, 2.2.2, 2.2.3, 2.3.6, 2.4.1, 2.4.2, 2.4.4
4.7.2	2.3.3, 2.3.4, 2.3.5, 2.4.1, 2.4.2
4.7.3	2.4.4, 2.4.5
4.7.4	2.3.3, 2.3.4, 2.3.5, 2.4.3, 2.4.4
4.7.5	2.4.2
4.7.6	2.4.2, 2.4.4, 2.7.1

[a]See Chapter 1 of Part II for definitions of the issues and information needs.

[b]In this context, "available" means from readily available sources of geologic and related data useful in the siting, design, and construction of engineering projects. Examples of these data sources would be libraries; local, State, and regional agencies; the U.S. Geological Survey; and State Geological Surveys. (See Bulletin of the Association of Engineering Geologists, Vol. XX, No. 4, 1983, pp. 439-454.)

Chapter 3

POTENTIAL FINANCIAL, POLITICAL, LEGAL, AND INSTITUTIONAL PROBLEMS

An evaluation of financial, political, legal, or institutional problems that may impede the implementation of this Act, the plans of the Secretary to resolve such problems, and recommendations for any necessary legislation to resolve such problems

--Nuclear Waste Policy Act, Section 301(a)(3)

This chapter discusses the financial, political, legal, and institutional problems the DOE has identified as having the potential to impede the implementation of the Act. These problems include the following:

1. Failure to reach or implement a consultation-and-cooperation agreement.

2. Time needed for Federal agencies, States, or affected Indian tribes to develop full participation capabilities.

3. Difficulty in acquiring access to, or control of, land.

4. Difficulty in obtaining State and local permits.

5. State or local laws that are in conflict with Federal laws or otherwise incompatible with the DOE's responsibilities.

6. Litigation by States, affected Indian tribes, or other parties.

7. Conflict over State representation of local interests.

8. Conflict between the executive and the legislative branches of the State governments.

9. State or tribal notice of disapproval of a site selected for a repository.

10. Timing of grants for the mitigation of repository impacts.

11. Impediments to the transportation of waste.

12. Financial uncertainty and inadequacy of funds.

As the DOE addresses these problems and formulates plans for their resolution, it will continue to do all that is required to meet its primary responsibility for the safe and timely isolation of radioactive waste. The sections that follow discuss each of these potential problems and review the DOE's plans for resolving them. The DOE does not recommend legislative changes at this time.

3.1 FAILURE TO REACH OR IMPLEMENT CONSULTATION-AND-COOPERATION AGREEMENTS

3.1.1 POTENTIAL ISSUES AND PROBLEMS

Written consultation-and-cooperation agreements form one foundation for the DOE's interactions with States and affected Indian tribes on the waste-management program. The DOE believes that failure to achieve a strong agreement would limit the effectiveness of these interactions even though, in the absence of a formal agreement, the DOE will provide information on program activities, financial assistance to support the participation of States and affected Indian tribes in program activities, and opportunities for frequent informal interaction. An agreement might not be reached for any of the several reasons discussed below.

- A State or an affected Indian tribe may not consider negotiating a written agreement with the DOE to be in its interest. Accordingly, a State or an affected Indian tribe may decline at the outset to negotiate an agreement.

- The DOE and the State or tribal representatives may negotiate in good faith, but may reach an impasse on one or more issues. If the impasse cannot be resolved, negotiations may terminate without reaching final agreement.

- The agreements reached by the negotiators could be rejected in subsequent legislative or executive review.

Even if a formal agreement is signed by a State or an affected Indian tribe and the DOE, a number of problems could occur in the implementation of the agreement. The potential causes of such problems may include the following:

- Once the written agreement is in place, one of the parties could fail to fulfill its obligations. A failure to comply with the terms of the agreement could be either intentional or unintentional.

- The DOE, the State or affected Indian tribe, or a third party may seek to have the validity of one or more provisions of the agreement tested in court. This could result in the modification of provisions or voiding of the agreement.

3.1.2 PLANS FOR RESOLUTION

The DOE has begun consultation-and-cooperation negotiations with the State of Washington and with the Yakima Indian Nation, as provided for under Section 117(c) of the Act. In addition, preliminary discussions of consultation-and-cooperation procedures are under way with several States in which site screening is being conducted for the second repository.

The DOE will make every effort to ensure the successful negotiation and implementation of consultation-and-cooperation agreements, and will take actions that should reduce the chances of failure. For example, the DOE will express its continued willingness to negotiate a formal agreement, consistent with the provisions of Section 117(c), at any time a State or affected Indian tribe determines that it is advantageous to have one.

To minimize barriers to negotiations, the DOE will work with States and affected Indian tribes to identify mutually acceptable negotiating procedures. The DOE will encourage States and affected Indian tribes to adopt specific review and ratification procedures early in the negotiation process.

To minimize implementation problems once agreements are negotiated, the DOE will seek to establish agreements with specific procedures and clear guidelines, including conflict-resolution provisions that avoid confusion or ambiguity. Such specific procedures and guidelines should prevent one party from unintentionally violating the agreement as perceived by the other party. The DOE will attempt to work with States and affected Indian tribes to resolve problems in implementing the agreements.

If an agreement is modified or voided as a result of judicial review, the DOE will consider appealing or renegotiating the agreement to satisfy the conditions set by the court.

If the DOE and a State or affected Indian tribe cannot negotiate or implement a written agreement in spite of its best efforts, the DOE will continue to fulfill its responsibilities, as specified in the Act, to develop a repository on schedule, and to encourage an effective program of consultation and cooperation with all affected parties.

3.2 TIME NEEDED FOR STATES OR AFFECTED INDIAN TRIBES TO DEVELOP FULL PARTICIPATION CAPABILITIES

3.2.1 POTENTIAL ISSUES AND PROBLEMS

For States and affected Indian tribes, as well as Federal agencies other than the DOE, to be full participants in developing and implementing the repository program, they must enlist or train the necessary personnel. States, affected Indian tribes, and other Federal agencies are developing the capabilities needed to monitor the waste-management program and to interact with the DOE. New organizations composed of legislative-committee staffs and policy and technical staffs from State agencies will assume significant roles in State programs. Affected Indian tribes will also need to develop policy and technical staffs that can assume a major role in the monitoring of the DOE's waste-management programs and in interactions with the DOE. States, tribes, and Federal agencies will need to review and comment on large quantities of information. New tasks associated with the waste-management program may be added to the responsibilities of staff members whose primary duties and experience lie in other fields. Problems may arise because of the time required to develop this capacity to participate in the program at the level they and the DOE desire. Conflict between these needs and the schedule requirements of the Act may result.

3.2.2 PLANS FOR RESOLUTION

To address the "startup time" problem faced by State agencies and the governments of affected Indian tribes, the DOE will provide as much time as possible within mandated schedules for the review of program documents and will inform States and affected Indian tribes of program plans as early as possible. To ensure smooth transfers of information, the DOE will encourage the creation of State coordinating organizations that interact with the DOE and other agencies involved in the waste-management program. In addition, the DOE is improving its capability to provide technical information. To help States improve the ability of their staffs to participate in the program, the DOE holds periodic meetings with States and affected Indian tribes to explain how the DOE is implementing the Act and to provide a status report on program activities. Furthermore, the DOE has provided funds to national organizations--such as the National Governors' Association, the National Conference of State Legislatures, the Council of Energy Resource Tribes, the Western Interstate Energy Board, and the National Congress of American Indians--to conduct seminars and help provide information to the States and tribes. Plans to strengthen the coordination between the DOE and other Federal agencies are discussed in Chapter 4 of Part I.

3.3 DIFFICULTY IN ACQUIRING ACCESS TO, OR CONTROL OF, LAND

3.3.1 POTENTIAL ISSUES AND PROBLEMS

The DOE is required by NRC regulations (10 CFR Part 60) to obtain ownership, surface and subsurface rights, and control of access to land at the site of the repository. Before site characterization begins, the DOE must acquire land for exploratory shafts at the three sites recommended for characterization and must control additional land in the event the site is selected for a repository. The entire site area may be acquired from public land under the control of Federal agencies, State or tribal land, and/or privately owned land.

Regardless how control of the land is achieved, the DOE intends to allow the existing land uses (e.g., farming) to continue to the maximum extent practicable. Furthermore, the DOE intends to acquire only the property that is essential to the mission.

Several potential problems are associated with the DOE's obtaining the necessary access to, and control of, land. If the needed land is under the jurisdiction of another Federal agency, such as the Bureau of Land Management, that land must be withdrawn from public use, which may require Congressional action. The withdrawal will require the other agency to comply with its own procedural and substantive requirements, which could prolong the transfer of land.

If State land is involved, the DOE must negotiate with the affected State for title to the land and obtain applicable permits for drilling and field testing. If the affected State opposes the DOE's efforts, it may require a period of time to transfer land to the Federal Government.

Private land will be acquired under the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970. If the owners are not willing to sell, the DOE may exercise the power of eminent domain.

3.3.2 PLANS FOR RESOLUTION

To avoid delays that may result from the efforts of other Federal agencies to meet their statutory responsibilities, the DOE will work with those agencies to expedite the issuance of required authorizations, as provided for in Section 120 of the Act. The DOE will seek memoranda of understanding (MOUs) with Federal agencies to clarify their respective roles in obtaining needed permits and authorizations.

The DOE will maintain up-to-date information on State and local land-use regulations and permit requirements. As part of its consultation and cooperation with States and affected Indian tribes, the DOE will seek to establish procedures for obtaining applicable permits required to gain access to land. Until the consultation-and-cooperation agreements are signed, the DOE will work with States and affected Indian tribes to reach agreements on land-use and permit issues (see also Section 3.4). Because of the unique relationship between Indian tribes and the Federal Government, the DOE will work closely with the Department of the Interior on issues concerning reservation lands or lands to which the tribes have possessory or usage rights. In addition, the DOE will be mindful of the American Indian Religious Freedom Act of 1978, the 1975 Indian Self-Determination and Education Assistance Act, the Tribal Government Tax Status Act, and other pertinent mandates.

The DOE will attempt to obviate legal problems with private landowners by starting negotiations to obtain title to land as early as possible and by offering fair market prices for the land in question as required by the Uniform Relocation Assistance and Real Property Policies Act of 1970. The DOE will use its power of eminent domain to acquire needed land only as a last resort. The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 provides the DOE with the ability to make comprehensive payments to private landowners, tenants, and businesses that must be displaced. To facilitate the land-acquisition process, the DOE may work in close cooperation with the U.S. Army Corps of Engineers, which has considerable experience in this area.

3.4 DIFFICULTY IN OBTAINING STATE AND LOCAL PERMITS

3.4.1 POTENTIAL ISSUES AND PROBLEMS

Repository siting and development activities may require the DOE to obtain a variety of permits from States and local governments. Although most or all of these activities will be identical with those carried out at other large-scale projects, public concerns about the repository may cause the permit-issuing authorities to subject the DOE's applications to especially intensive and lengthy reviews. It is also possible that other parties may use permit-issuing procedures as a means of delaying the program.

3.4.2 PLANS FOR RESOLUTION

The DOE will attempt to facilitate the permit process by consulting with States and local authorities as early as possible. Means for resolving disputes over permit requirements with State authorities will be specified in the consultation-and-cooperation agreements, specifically in the sections that discuss the facilitation of the permit process (required by Section 117(c)(9) of the Act) and conflict resolution (required by Section 117(c)(11)). Where such agreements have not been signed, the DOE will work with State or local authorities in an effort to identify and resolve issues informally.

3.5 STATE OR LOCAL LAWS THAT ARE IN CONFLICT WITH FEDERAL LAWS OR OTHERWISE INCOMPATIBLE WITH THE DOE'S RESPONSIBILITIES

3.5.1 POTENTIAL ISSUES AND PROBLEMS

Many State and local governments and Indian tribes have or may enact legislation that affects the repository program. Conflicts may occur if the State imposes extensive substantive or procedural requirements that prevent the DOE from fulfilling its responsibilities under the Act in a timely manner. Several States have enacted legislation that attempts to directly regulate the repository program. In some of these instances, such State and local regulatory controls may be impermissible under the U.S. Constitution.

3.5.2 PLANS FOR RESOLUTION

The DOE intends to comply with all State and local regulations consistent with its responsibilities under the Act.

The DOE will identify State and local laws and regulations that may conflict with the DOE's responsibilities under the Act. In conjunction with this effort, the DOE will attempt to define the issues of concern that prompted the State or the local government to enact the law or regulation in question and will work with the appropriate officials to address these issues in a manner compatible with the Act. In the case of State laws, such steps might be incorporated into the formal consultation-and-cooperation agreements.

3.6 LITIGATION BY STATES, AFFECTED INDIAN TRIBES, OR OTHER PARTIES

3.6.1 POTENTIAL ISSUES AND PROBLEMS

States, affected Indian tribes, local governments, and a variety of other parties may oppose the DOE's activities at any time during the siting process. If they resort to court action, the program may be delayed. Section 119 of the Act allows a party to seek in the U.S. Courts of Appeals judicial review of certain actions taken by the Secretary of Energy in the repository-siting program within 180 days after the action in question. The 180-day period for seeking judicial review is significantly longer than the 60-day period usually allowed for seeking the review of agency actions in a Court of Appeals. This increases the opportunity for States, affected Indian tribes, or other parties to resort to court action. The subsequent litigation could prevent the DOE from meeting the schedule set forth in the Act.

3.6.2 PLANS FOR RESOLUTION

The DOE hopes to minimize the likelihood of litigation by seeking the views of all interested parties and implementing a comprehensive consultation-and-cooperation process with States and affected Indian tribes. To achieve these goals, the DOE will work with States and affected Indian tribes to establish formal and informal procedures for resolving their concerns and objections. The Act specifies that consultation-and-cooperation agreements shall include procedures "for resolving objections of a State and affected Indian tribes at any stage of the planning, siting, development, construction, operation, or closure of such facility within such State through negotiation, arbitration, or other appropriate mechanisms" (Section 117(c)(11)). These formal agreements offer the opportunity to minimize litigation. In addition, the DOE will establish program-wide procedures to ensure that all parties have timely access to information about the program. The DOE will also endeavor to resolve potential conflicts through the use of informal interactions, thus obviating the need to pursue lengthy legal remedies.

The DOE also intends to document key decisions and program actions in such a manner as to to insure that, if challenged, the decisions can be fully explained and justified. This will minimize the possibility that the program could be stopped or delayed for a significant period.

3.7 CONFLICT OVER STATE REPRESENTATION OF LOCAL INTERESTS

3.7.1 POTENTIAL ISSUES AND PROBLEMS

Differences between the interests of local communities and State governments may arise in States affected by repository development. These differences may arise from the historical divergence between urban and rural interests in State government or because the attitudes about a repository may differ between host communities and the State or for many other reasons. These differences could lead to conflicting expectations or demands being placed on the DOE or to delays in program implementation while the State and local governments resolve their disagreements.

Specific issues that may lead to such differences are the degree of State cooperation in siting activities and how grants are allocated. Experience with the intrastate allocation of other Federal grants suggests that conflict may arise between State and local governments over the allocation of grants provided to the States under the Act, especially the grants provided for impact-mitigation assistance under Section 116(c)(2).

3.7.2 PLANS FOR RESOLUTION

The DOE is prepared to work with both State and local governments during the development of a repository. The DOE intends to continue public meetings and outreach programs for local leaders and the general public in the vicinity of potential sites and to keep State officials informed of such activities. Procedures for local-government representation could be included in the consultation-and-cooperation agreement as per Section 117(c)(5) of the Act. The DOE plans to encourage States to involve local representatives in impact-assessment efforts leading to the preparation of State impact reports.

3.8 CONFLICT BETWEEN THE EXECUTIVE AND THE LEGISLATIVE BRANCHES OF STATE GOVERNMENTS

3.8.1 POTENTIAL ISSUES AND PROBLEMS

The Act provides opportunities for the executive and the legislative branches of State governments to participate in the waste-management program. However, the Act does not in every instance codify their respective responsibilities. For example, Section 117 requires the DOE to consult and cooperate with both the Governor and the legislature. Section 115 provides that the selection of a site will become final unless the Governor and the legislature submit a notice of disapproval, but Section 116 provides that the Governor or the legislature may submit a notice of disapproval unless prohibited by State law. The Act makes clear that the DOE must work with both the executive and the legislative branches of State governments, but makes no provision to ensure that conflicts will not arise between these two branches during their interactions with the DOE. Conflicts within State government could create obstacles to implementing the Act. For example, the DOE may have difficulty keeping all concerned parties in the State government informed of programmatic activities if the division of responsibility is unclear.

3.8.2 PLANS FOR RESOLUTION

The DOE will maintain contact with both the executive and the legislative branches of State governments. The DOE recognizes that elections and changing interests of State officials or agencies may change the way in which they interact with the DOE. In order to allow such changes to be accommodated by the consultation-and-cooperation process without disrupting that process, the DOE will encourage States to assign responsibilities to specific agencies or officials. A clear assignment of responsibilities will permit institutional continuity in a changing political climate.

The DOE will encourage each State to establish one focal point, such as a State coordinating council, for all interactions with the DOE in order to minimize the possibility of misunderstandings in the consultation-and-cooperation process. While remaining neutral in intrastate disputes, the DOE will provide information and assistance on request to all parties.

3.9 STATE OR TRIBAL NOTICE OF DISAPPROVAL OF A SITE SELECTED FOR A REPOSITORY

3.9.1 POTENTIAL ISSUES AND PROBLEMS

The Act provides an opportunity for the Governor or the legislature of a State and the governing body of an affected Indian tribe with a proposed site on its reservation to submit to Congress a notice of disapproval if a site is recommended for repository development (Sections 116(b) and 118(a)). Such a notice of disapproval would eliminate that site from further consideration for a repository unless both Houses of Congress override the notice by passing a joint resolution that approves the selection of the site.

Because of the public concern and apprehension about radioactive waste, State and tribal leaders may be under considerable pressure from many groups to issue a notice of disapproval. Members of Congress, in turn, will be sensitive to the prerogatives of States under the Federal system of government and to the concerns of their own constituents. It is possible, therefore, that a site recommended for a repository could be rejected, which would cause considerable program delay and additional cost.

3.9.2 PLANS FOR RESOLUTION

The DOE will make every effort to evaluate and select a site so as to give no valid cause for States or affected Indian tribes to issue a notice of disapproval. Part of this effort is to evaluate sites in a manner that will provide technically sound and defensible reasons for the site-selection decision.

Another part of the effort is to support regular and careful reviews of the DOE's siting activities by giving full attention to the process of interacting with States and affected Indian tribes. This will be accomplished through formal and informal consultation-and-cooperation activities with States and affected Indian tribes, including the sharing of preliminary versions of siting documents and the financing of program reviews by States and affected Indian tribes, as provided for by the Act.

In addition, the DOE will attempt to identify concerns and potential disagreements as early as possible and to resolve such disagreements through informal consultation or through the formal conflict-resolution procedures specified in written consultation-and-cooperation agreements.

3.10 TIMING OF GRANTS FOR THE MITIGATION OF REPOSITORY IMPACTS

3.10.1 POTENTIAL ISSUES AND PROBLEMS

If the repository is sited in a rural area, it may be necessary to improve roads, sewer and water services, utilities, housing and other parts of the local infrastructure before large numbers of construction workers move into the area. However, the DOE's ability to provide impact-mitigation assistance to States or tribes before construction begins may be legally constrained by Sections 116(c)(2)(A) and 118(b)(3)(A) of the Act, which are explicit in providing for mitigation grants "following the initiation of construction activities."

3.10.2 PLANS FOR RESOLUTION

The DOE will work closely with States, affected Indian tribes, and local governments to ensure that impact-mitigation needs are met in a timely fashion. This may be achieved, in part, by creating work groups composed of representatives from the DOE, State, affected Indian tribes, and local governments; these groups would work together to develop impact avoidance and mitigation strategies that would reduce requirements for financing before construction begins.

The DOE may want to establish a task force that would coordinate requests for impact-mitigation assistance from the States and affected Indian tribes. It may be possible to make preconstruction assistance available from other Federal agencies through interagency agreements with the DOE.

The DOE may also provide some types of technical or other assistance directly rather than through grant assistance.

The amount of financial assistance that the DOE will provide for mitigating public health and safety, environmental, and socioeconomic impacts will be negotiated with the States or affected Indian tribes and will be based primarily on the impact-assessment report submitted by the State or the tribe. Provision may be made for adjustments in funding levels as more is learned about the impacts that actually occur.

The DOE is also examining the Act's provisions on grants equal to taxes (GETT). These grants will be provided to the host States, units of local government, and affected Indian tribes; they will be equal to the amount these parties would receive if they were authorized to tax site-characterization and repository-development activities as they would tax other real property and industrial projects. As such, these funds will be provided before the construction of the repository begins and may be used to ease problems related to the timing of impact-mitigation assistance.

3.11 IMPEDIMENTS TO THE TRANSPORTATION OF WASTE

3.11.1 POTENTIAL ISSUES AND PROBLEMS

Regardless of where facilities for the storage or permanent isolation of waste might eventually be sited, spent fuel from reactors will be transported through several States. As a result, the number of States, Indian tribes, and local communities with which the DOE will interact will increase substantially.

The large number of States and Indian tribes that may be affected by transportation activities may create additional financial demands if there are specific transportation-related costs that the DOE must offset. When decisions are made concerning the mode of transportation and specific routes, their financial implications will be considered accordingly. Concerns about transportation may attract the political involvement of elected officials in a large number of States. Among the issues that the DOE expects to arise are routing, travel times, prenotification of States, escorts, emergency-response capability and preparedness, liability, and financial assistance to allow the States to study transportation issues. Legal problems may also arise over continuing efforts by States, Indian tribes, or local units of government to regulate the transportation of radioactive wastes through their jurisdictions. Recent court decisions supporting Federal preemption of certain local restrictions are not likely to discourage efforts to regulate the transportation of waste at the local or State level. Institutional problems may arise from the need to coordinate all of the Federal, State, and local agencies that are concerned with issues related to the transportation of radioactive waste.

3.11.2 PLANS FOR RESOLUTION

The DOE recognizes the need for States and Indian tribes affected by waste transportation to participate in the repository program, and it will provide opportunities for the States to identify issues of concern. Since the Act does not establish specific requirements for interacting with the States affected by the transportation of waste, this process will be less formal than the consultation-and-cooperation process with States that contain potential repository sites. The DOE will work with existing interstate organizations and Federal and State coordinating bodies.

The DOE will continue to hold public information meetings to inform interested parties of the DOE's transportation program and to identify their concerns.

The DOE will coordinate with the Department of Transportation and with other Federal agencies concerned with issues related to radioactive-waste transportation. Such coordination is discussed in greater detail in Chapter 4 of Part I and in the DOE's Project Decision Schedule (DOE/RW-0018, January 1985).

3.12 FINANCIAL UNCERTAINTY AND ADEQUACY OF FUNDS

3.12.1 POTENTIAL ISSUES AND PROBLEMS

The Nuclear Waste Fund established by the Act (Section 302(c)) consists of all revenues collected by the DOE in accordance with the provisions of Section 302(a) of the Act, any appropriations made by Congress for the fund, and unexpended monies available on the date of the Act's enactment for the repository program.

Section 302(a) of the Act specifies that the fee charged by the DOE for the disposal of spent fuel or high-level waste is to be 1 mill per kilowatt-hour (or the equivalent to an average charge of 1 mill per kilowatt-hour for existing spent fuel or high-level waste). The Act also specifies procedures for administering the fund and authorizing expenditures from the fund. In addition to establishing a source of revenue for the program, the Act requires the DOE to make payments to affected States and affected Indian tribes (Sections 116(c), 118(b), 141(f), and 219).

However, there are uncertainties about the potential revenues and the life-cycle costs of the program. The uncertainties related to revenues depend largely on the amount of electricity that will be generated by commercial nuclear power plants. The amount of electricity generated by nuclear power is affected by the state of the economy, the total demand for electricity, the financial condition of electric power companies, relative construction and operating costs for alternative power plants, nuclear-plant capacity factors, and fuel-burnup rates.

Program costs are also uncertain at this time because many program assumptions have not yet been agreed on: the site for the repository has not been selected; the amount of waste to be disposed is uncertain; and there is no firm engineering design for any of the system's components. The costs for siting, designing, and licensing the repository are uncertain because it is unclear how extensive site-characterization activities must be in order to support the selection of a site and also meet the requirements of the NRC and the EPA. Transportation costs are uncertain because transportation-cask designs are being further developed and transportation routes have not been selected. Repository construction and operation costs are uncertain because they are currently based on "preconceptual" designs only and the various cost-related variables for the various host rocks have not been sufficiently analyzed. The construction and operation of a facility for monitored retrievable storage will also affect the cost of the entire system.

The DOE must also provide funds for addressing safety, environmental, and socioeconomic issues; funds for the mitigation of socioeconomic impacts where applicable; and funds for program administration. At this stage of the program, it is difficult for the DOE to estimate how much funding will be needed to ensure the continued full participation of States and affected Indian tribes in the development and implementation of the program. Financial assistance will be essential to provide States and affected Indian tribes with the technical capability needed for participation in the program. Program-administration costs depend largely on the success of the DOE's efforts to resolve the technical and institutional problems of repository siting. Delays will contribute to higher program costs.

3.12.2 PLANS FOR RESOLUTION

To monitor the adequacy of the Nuclear Waste Fund, the DOE is using the best available financial techniques to identify and monitor key variables that will affect revenues and to access revenues against projected program costs. Costs are discussed in Chapter 10 of Part II.

Several options to remedy inadequacies are available if needed: the DOE may issue obligations to the Treasury under Section 302(e)(5) of the Act or adjust the fee of 1 mill per kilowatt-hour in accordance with Section 302(a)(4). The DOE's revenue projections will be regularly and routinely disseminated to Congress, States and affected Indian tribes, and the public.

While committed to meeting program goals and addressing the concerns of States, affected Indian tribes, and the public, the DOE intends to control program costs. The DOE will work with States and affected Indian tribes to identify appropriate funding levels for each program phase with adequate lead time, possibly in parallel with the triennial budget cycle of the Nuclear Waste Fund.

Chapter 4

THE TEST AND EVALUATION FACILITY

Any comments of the Secretary with respect to the purpose and program of the test and evaluation facility

—Nuclear Waste Policy Act, Section 301(a)(4)

Before the passage of the Act, the DOE's strategy for repository development included the construction of an underground test facility to demonstrate the technology needed for routine repository operations. This facility, called a "test and evaluation facility (TEF)," was to be constructed at one of the three candidate sites for the first repository. It was to be used for experiments designed to confirm the performance of waste-handling systems, the control of radiological exposure, the performance of repository ventilation and instrumentation systems, and similar issues. Since the passage of the Act, however, the term "test and evaluation facility" has taken on a broader meaning. The Act expanded the term to mean a facility in which all types of research and development, including at-depth testing, can be conducted. The DOE is authorized to construct such a facility, but the construction is not mandatory. The Act gives the DOE the option of constructing the TEF either at a repository site (colocate) or at some other site.

After the passage of the Act, the DOE evaluated the purpose and the location of the TEF in terms of Congressional intent (Section 217(a) of the Act) as well as in relation to engineering development and licensing requirements for the repository. This evaluation led to the conclusion that many of the TEF objectives stated in Section 217(a) can be satisfied with non-site-specific data acquired in existing facilities or in planned test programs. These generic data can be used to resolve many of the design, engineering, and operational issues associated with successful repository development. Other objectives in Section 217(a) can be addressed most efficiently by a TEF colocated with the repository. The activities at such a facility would be directed at verifying the final design of the repository, confirming the expected performance of the site, and developing and demonstrating technology for repository operations. If necessary, a colocated TEF would also provide a means for resolving site-specific repository licensing issues. Accordingly, in March 1984 the DOE notified Congress that the TEF will be colocated with the repository if the need for such a facility is established.

The need for a colocated TEF will depend on the data needs of the repository program after site characterization and on the projected ability of the TEF to provide the needed data on time and cost effectively. At this time, the role that these data will play in the program and the degree of their importance are uncertain. To a large extent, this uncertainty will diminish as the site-characterization plans for the three candidate repository sites are issued and as they mature through interactions with the NRC. The DOE plans to decide on the need for a colocated TEF in late 1987.

Section 21[illegible](f) of the Act requires that the DOE and the NRC reach a written understanding on the TEF. Because of the current uncertainty regarding the need for the TEF, the DOE has decided not to complete the written understanding with the NRC. The written understanding will be completed when and if the DOE decides to proceed with a colocated TEF.

Chapter 5

SIGNIFICANT RESULTS AND IMPLICATIONS OF RESEARCH AND DEVELOPMENT PROGRAMS

A discussion of the significant results of research and development programs conducted and the implications for each of the different geologic media under consideration for the siting of repositories, and, on the basis of such information, a comparison of the advantages and disadvantages associated with the use of such media for repository sites.

--Nuclear Waste Policy Act, Section 301(a)(5)

5.1 INTRODUCTION

This chapter discusses the significant results of research and development in four disciplines: geology, hydrology, geochemistry, and geomechanics. These results are significant because they contribute heavily to the resolution of key issues 1 and 4 (see Chapter 1 in Part II) which pertain to long-term waste isolation and the constructibility of the repository. They are presented for each of the host rocks that are being considered for the first repository: basalt lavas, rock salt (bedded and dome varieties), and volcanic tuff.* Nine potentially acceptable sites underlain by these rocks have been identified: a basalt site in the Pasco Basin of Washington, three salt domes in the Gulf Interior region, two bedded-salt sites in the Paradox Basin of Utah, two bedded-salt sites in the Palo Duro Basin of Texas, and a site in tuff in the southern Great Basin in southern Nevada. General descriptions of these sites and maps are given in Chapter 7 of Part II.

It is not always possible to translate certain results by themselves into specific implications for repository siting, because the performance of the repository will depend on many factors acting in concert as a system. However, the implications of the collective results are given where possible, and a summary of the advantages and disadvantages of the host rocks is presented in the last section of this chapter. A brief summary of tests conducted in various underground facilities is also given (see Section 5.6).

To aid the reader in understanding the technical discussions that follow, Appendix C has been prepared. It describes the origin and nature of the potential host rocks, which in turn have influenced the direction of the DOE's research and development programs (e.g., the hydraulic properties of fractures in basalt and tuff must be investigated). As noted in Chapter 2 of Part II, the discussion of results for the three potential host rocks should not be construed as indicating that any site-recommendation decisions have been made.

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*The program for the second repository is less advanced, and "significant" results, generally obtainable only through extensive field studies, are not yet available.

5.2 SIGNIFICANT RESULTS OF GEOLOGIC RESEARCH

The principal focus of research and development in geology has been to understand the spatial distribution of the host rocks and surrounding units, the tectonic setting, and the structural history. This information is needed to assess the probable future stability of the site and region.

In each site region, research has been conducted to--

1. Provide the regional and local geologic framework.

2. Define three-dimensional geometry, properties, and behavior of the host rock and the surrounding units.

3. Characterize the geologic history, particularly during the last 2 million years (the Quaternary Period), and assess the future stability of the site and the region.

4. Identify processes and conditions that could affect the expected performance of the repository (e.g., earthquakes, faulting, volcanism, landslides, and the occurrence and likely development of natural resources).

The results of these studies are used to evaluate the potential of the natural setting at a site for waste isolation and to provide engineering design parameters for surface and underground facilities, stationary equipment, and access routes.

5.2.1 BASALT

The host rocks at the site in basalt are the lavas of the vast Columbia Plateau, which occupies parts of Washington, Idaho, and Oregon. The site, or reference repository location, is in the central Pasco Basin, at the DOE's Hanford Site (see Figure 7-2). The origin of the basalt is described in Appendix C.

The geologic literature of the Columbia Plateau dates back to the early 1900s, and detailed investigations commensurate with nuclear facility licensing date back to 1970. As a result, the stratigraphy and structure within the setting, down to the depth of the candidate horizon, have been defined in a preliminary fashion.

Volcanic activity between 17 and 6 million years ago resulted in the deposition of a 2-mile thick sequence of basalt flows beneath the Hanford Site. The sequence consists of more than 50 basalt flows that are interbedded with fluvial sediments in the upper part of the sequence. Individual flows consist of a dense flow interior capped by a flow top. The flow top is a vesicular or brecciated crust that grades into the dense flow interior. The dense interior is subdivided into a central entablature, which is comprised of irregularly or regularly jointed rock with relatively small columns, and a basal colonnade, which consists of relatively well-formed columns typically with fewer primary fractures than in the entablature. These primary internal features may vary in thickness, be absent from any given flow, or occur repeatedly within a single flow. Primary fractures and other fractures ubiquitous to basalt flows are largely filled with secondary minerals of high sorption capacity.

Deformation of the basalt flows has resulted in a series of folded asymmetrical ridges, called anticlines, separated by broad troughs, called synclines. Although exposure is limited, borehole and other data suggest that strata in the Cold Creek and other synclines dip very gently. In a study of structures on eastern Umtanum Ridge, Price (1981) determined that strain was directly correlated with dip of the layers (i.e., the most steeply dipping layers exhibited the most strain while gently dipping layers exhibited little strain). Because strata in the Cold Creek syncline dip more gently than in the sharply folded anticlinal ridges, strain is therefore believed to be minimal in the reference repository location (RRL). Although the basalt strata in the synclines dip very gently, in-situ stresses determined by hydraulic fracturing of several intervals in a few boreholes indicated relatively high values of horizontal stress. Detailed studies are under way to assess the relationship of tectonic strains to the measured high stresses and the possible effects of high horizontal-to-vertical stress ratios on the design, construction, and operation of a repository.

The reference repository location is in a minimally deformed part of the Cold Creek syncline near the eastern extent of the Yakima Fold Belt. Present at the site are four flows that are laterally continuous and have sufficiently thick, dense interiors for a repository (Figures 5-1 and 5-2): the Rocky Coulee, the Cohassett, the McCoy Canyon, and the Umtanum flows. At present, the Cohassett flow is the preferred horizon.

A preliminary assessment of the tectonic stability of the site indicates that the deformation of the basalt in the Pasco Basin area has been under way for at least 15 million years under a regime of approximately north-south, nearly horizontal compression that has produced a system of nearly east-west and northwest-trending first-order asymmetrical anticlines and synclines known as the Yakima Fold Belt. Thrust and reverse faults are developed in these folds, especially on the steeper (north) sides. Deformation appears to have been essentially continuous under a regime of long-term, low-average rates of strain. This suggests that the same pattern of deformation is likely to continue over the next 10,000 to 100,000 years (Caggiano and Duncan, 1983).

The historical record of felt earthquakes and the instrumental record of earthquakes recorded over 14 years in the central plateau indicate that the area of the site is of moderate seismicity. The largest instrumentally recorded earthquake in the Pasco Basin had a magnitude of 3.8 and occurred about 9 miles north of the site. Events of magnitude 4.5 have been instrumentally recorded to the north and south of the Pasco Basin. Swarms of shallow (2.5 miles or less), low-magnitude (magnitude 3.5 or less) earthquakes have been recorded in and along the margins of the basin, but none have been recorded at the site. These swarms are temporally and spatially restricted. They may range from a few events to 100 or so (above magnitude 1) and occur in a small volume of rock (10-50 km^3 would be representative). A network of surface and borehole seismometers has been installed to gather data on the mechanism, recurrence, and ground motion of earthquakes (Rohay and Davis, 1983).

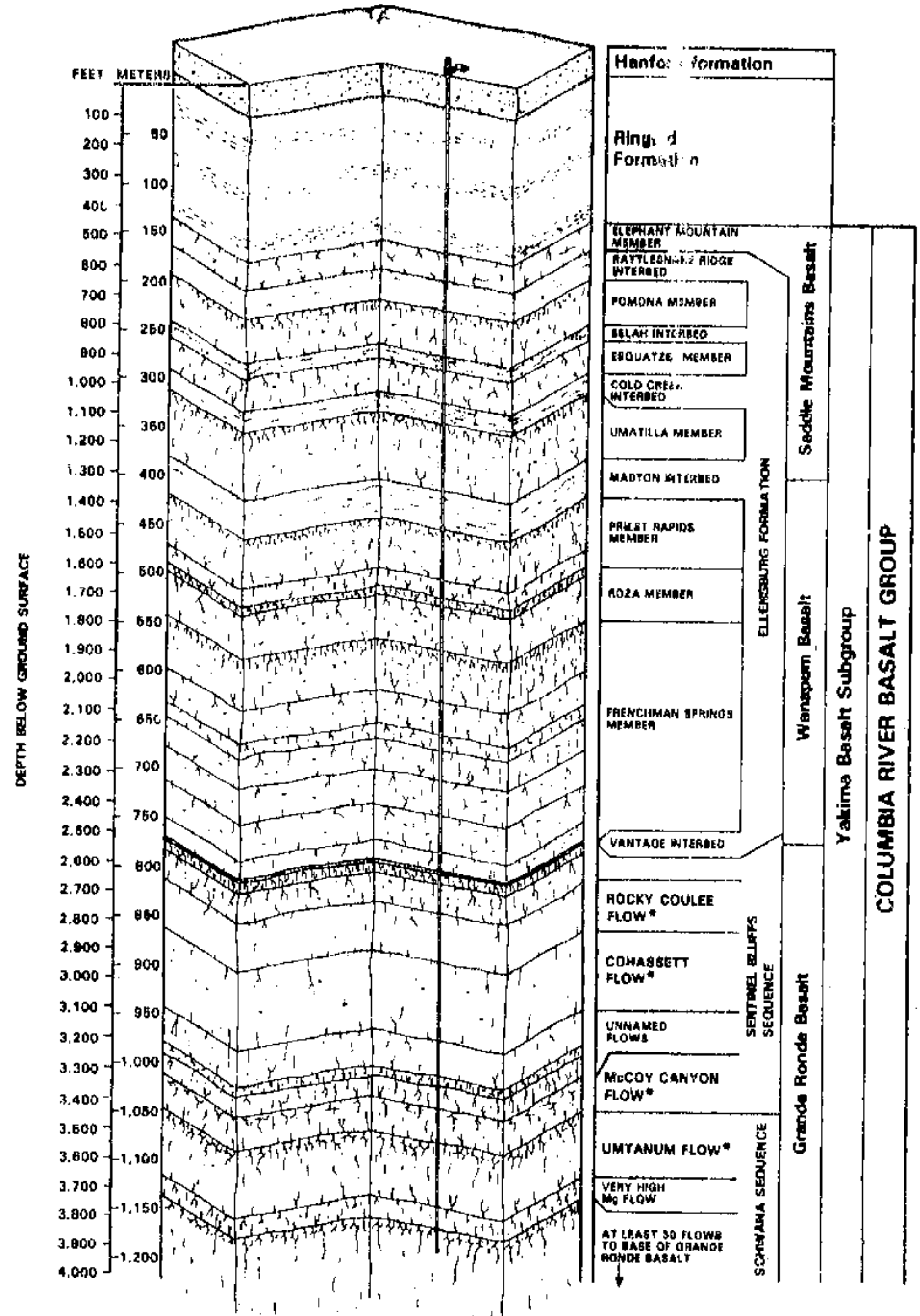

Figure 5-1. Generalized stratigraphy of the proposed location for a repository in basalt.

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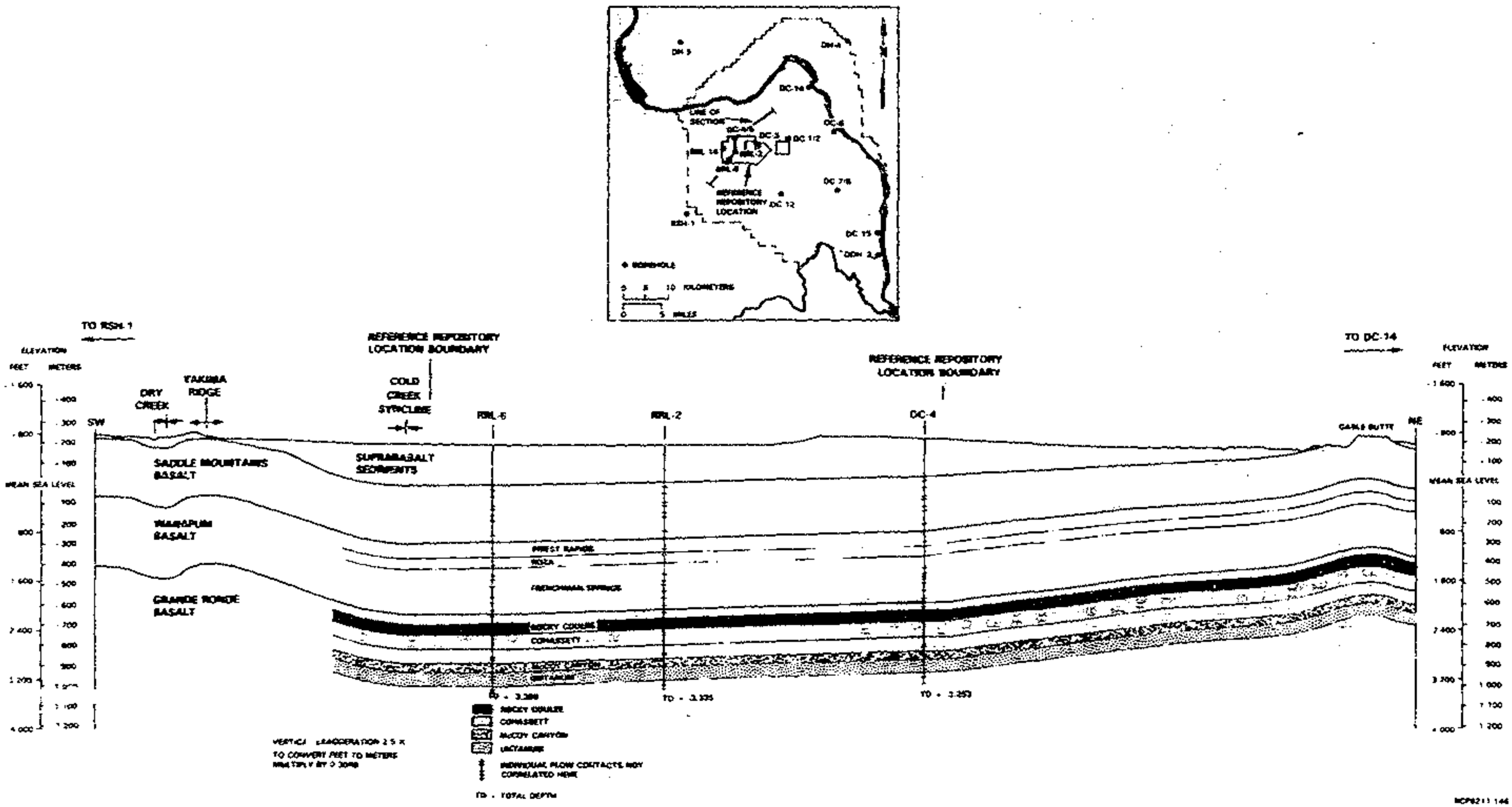


Figure 5-2. Generalized geologic cross section through the reference repository location, Hanford Site, Washington.

An assessment of tectonic stability is ongoing, but has not been completed, for the Hanford Site. It is therefore premature to give specific values of zero-period horizontal and vertical ground acceleration for use in the seismic design of surface facilities. However, the WNP-2 nuclear power plant, which is at the Hanford Site about 15.5 miles southeast of the reference repository location, has been licensed by the NRC and is designed for a free-field ground-surface acceleration of 0.25g. This acceleration is representative of values that have been used for locations at the Hanford Site.

The economic potential of mineral resources and ground water in the basalt and overlying sediments for the Pasco Basin has been assessed (Rockwell Hanford Operations, 1981). No unique economic mineral resources have been identified. Ground water is available from an unconfined aquifer in surficial sediments overlying the basalt, as well as from within interbeds and basalt flow tops where it is under confining pressure. Ground water is developed from shallow confined aquifers in the Saddle Mountains and Wanapum Basalts outside the Hanford Site, where it is used principally for irrigation. Water in aquifers in the Grande Ronde Basalt in the Pasco Basin is deeper and of significantly lower quality (it contains high levels of chloride and fluoride) and would be uneconomical to develop at present. The potential for hydrocarbons in rocks beneath the basalt is being explored by private energy companies by deep drilling in the Saddle Mountains and in other wells beyond the Pasco Basin.

5.2.2 SALT

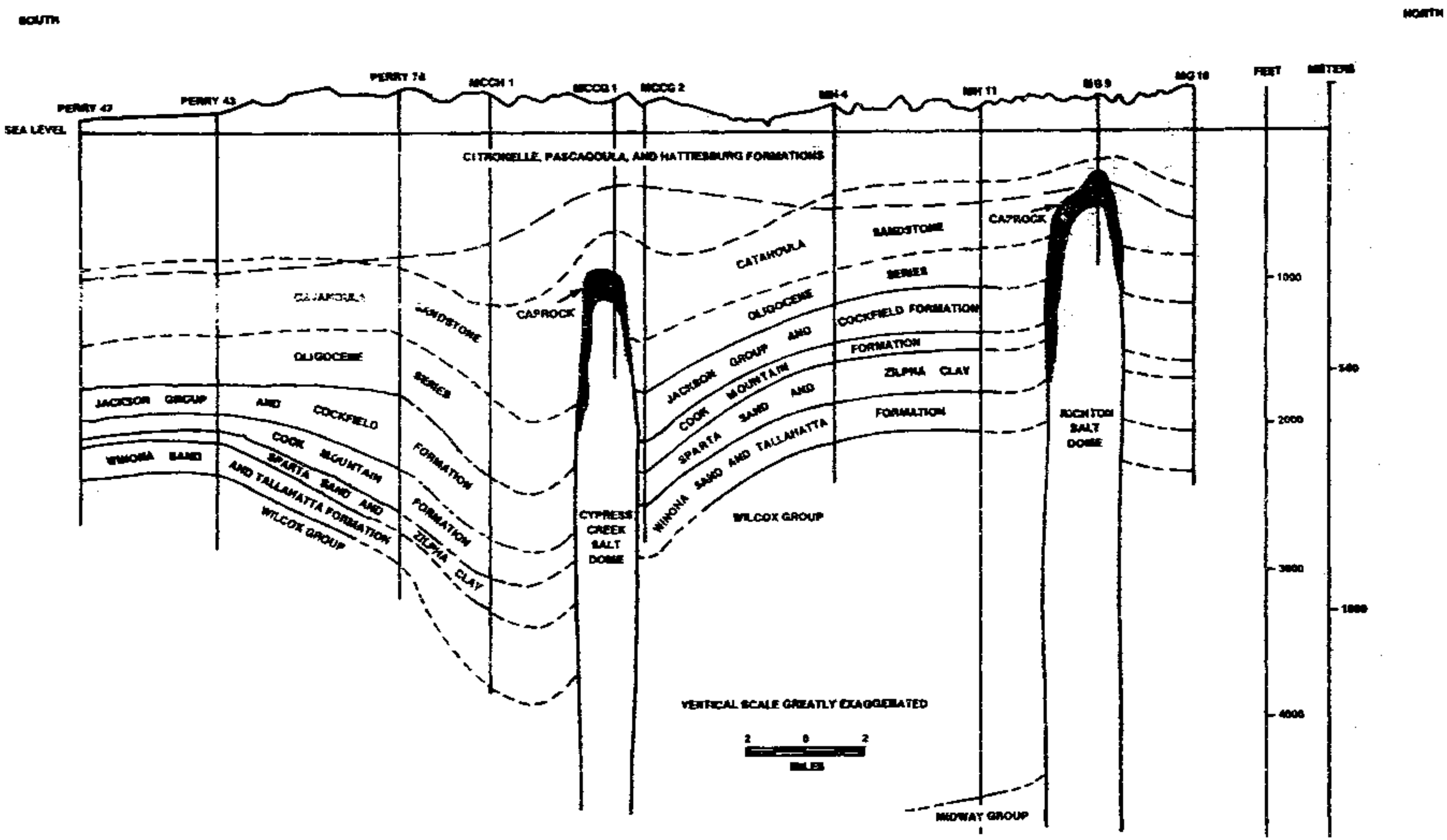
5.2.2.1 Salt Domes

Three salt domes have been identified as potentially acceptable sites: the Richton and Cypress Creek Domes in Mississippi and the Vacherie Dome in Louisiana. Their locations are shown in Figures 7-5, 7-6, and 7-7.

The salt for all three domes was deposited more than 200 million years ago, in early Jurassic time. Most of the upward growth of the domes occurred approximately 100 to 35 million years ago from late Cretaceous through early Oligocene time, with the vertical movement ceasing before early Pliocene, about 5 million years ago. Some faults near the Richton dome have been hypothesized to have had movements during the last 2 million years (the Quaternary Period). Faults with similarly questionable activity are likely to be identified at the other two domes.

At the Richton site, the dome is about 2 miles wide and 4.5 miles long at the potential repository level (2000 feet below mean sea level (MSL)). Shallow penetration of the dome by drilling shows high-purity halite (90 percent or more) and typical associated minerals. Seismic lines and gravity surveys indicate the shape of the dome (Figure 5-3), but studies are continuing. Caprock 20 to 213 feet thick covers the top of the dome. Geologic formations around the dome are virtually horizontal except near the flanks of the dome, where the beds are bent upward (see Figure C-1).

The Cypress Creek Dome lies about 12 miles south of Richton Dome and is in a similar geologic environment (Figure 5-3). The dome is roughly circular



EXPLANATION

- - - - - FORMATION BOUNDARY INFERRED WHERE NOT CLEARLY DEFINED

— — — — BASE OF FRESH WATER INTERPRETED (DISSOLVED SOLIDS OF 1000 mg/LITER)

Figure 5-3. Geohydrologic cross section of the Cypress Creek and the Richton salt domes.

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and about 2.5 miles in diameter at the potential repository horizon (2000 feet below MSL). One boring penetrated caprock at Cypress Creek and encountered about 200 feet of caprock. Near-surface ground water is present, and parts of the surface are swampy.

The Vacherie Dome is roughly elliptical, about 0.8 by 3.7 miles at the potential repository horizon (2500 feet below MSL). A deep core hole has sampled salt to 5043-foot depth. The host rock is 90 percent halite and 10 percent anhydrite, salt layers are steep, and no shear zones were encountered. Seismic lines and gravity data have been used to interpret the shape of the dome (Figure 5-4). High-resolution seismic lines show sharply upturned formations around the flanks and suggest the need for further work to fully characterize the near-dome geologic structure. The caprock is 80 to 270 feet thick and may drape the sides of the dome.

Published results of first-order geodetic surveys show that a large part of east-central Mississippi is being uplifted at about 2 to 4 mm/yr, whereas Louisiana near the Vacherie Dome is subsiding at about 1 mm/yr. However, the interpretations may very well be influenced by subtle systematic errors that exaggerate the true movements. A careful reanalysis is necessary.

Historically, earthquakes have been infrequent and of small magnitude in the Gulf Coast States. However, several small shocks have occurred during the past few years near a fault about 40 miles northeast of the Richton Dome. The region around the dome has experienced mild shaking (intensity VI on the modified Mercalli scale). Estimated maximum earthquakes would produce free-field ground-surface accelerations no greater than about 0.15g or 0.20g at the site.

The production of hydrocarbons in the vicinity of the Richton Dome is confined to the Glazier Field to the south and the Tiger Field to the northwest. Both fields are about 4 miles from the dome. Several oil-exploration wells have been drilled at the dome and abandoned. The potential for hydrocarbons is rated as speculative (LETCo, 1982a). Mineral exploration directly over the dome has included a sulfur-exploration program, which involved drilling boreholes into the caprock and salt stock (LETCo, 1982a). No deposits of any economic potential were reported. Other available resources are sand, gravel, and salt, each of which exists in abundance in many areas. The likelihood of human intrusion in pursuit of minerals has been rated as low (ONWI, 1982).

There is a small producing oil field on the edge of the Cypress Creek Dome. There are indications of previous sand and gravel production over the dome, though none exists at present. The potential for the production of hydrocarbons is rated as poor to fair. The potential for other resources, such as gravel, asphalt, and lignite, appears to be poor.

There is no production of hydrocarbons from the Vacherie Dome, although the flanks have been drilled (LETCo, 1982b), and the hydrocarbon potential appears to be poor (Ertec, 1983a). There currently is no mining over or near the dome. No appreciable lignite deposits are known to exist nearby. The projections of mineral availability indicate that the mining of salt or any other commodity in or near the Vacherie Dome will not be economic (Ertec, 1983b), partly because the salt is so far below the surface (about 800 feet).

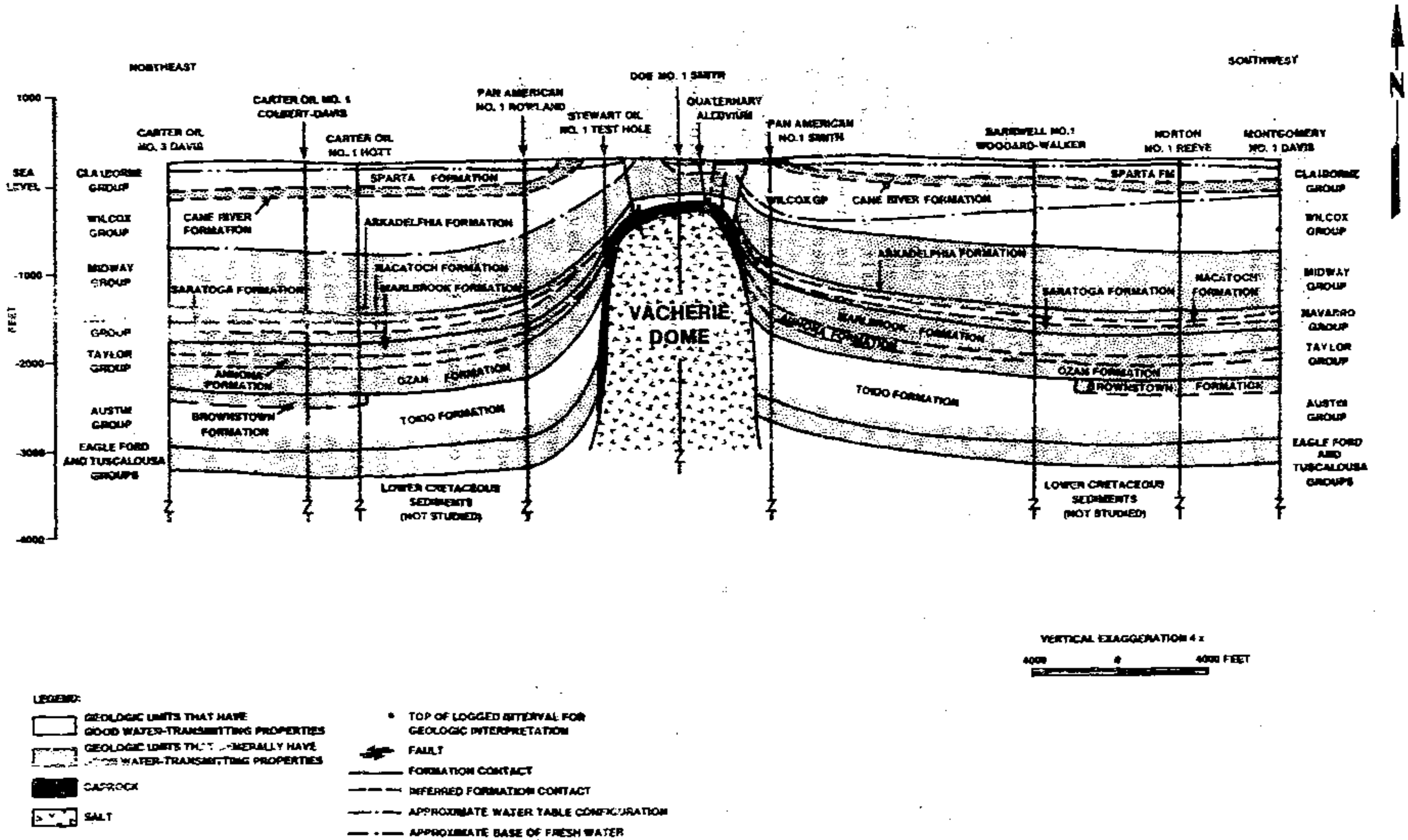

Figure 5-4. Geohydrologic cross section of the Vacherie dome.

Salt domes have greater than average value for underground mined-storage facilities for oil, gas, and geothermal energy systems (ONWI, 1983) since a similar facility could not be drilled or mined in the sediments that make up the bulk of the geologic setting.

5.2.2.2 Bedded Salt

Bedded Salt in the Paradox Basin

As shown in Figure 7-3, the two bedded-salt sites in the Paradox Basin, Davis Canyon and Lavender Canyon, are only a few kilometers apart. The rocks beneath both sites consist of a sequence of bedded strata, dipping gently 1 to 2 degrees to the northeast. At the Davis Canyon site, several potentially acceptable salt beds are present within the Paradox Formation evaporite sequence. The Salt Cycle 6 salt seems optimum in terms of depth, thickness, and purity. Seismic lines and drilling, including a deep borehole (GD-1) about 2.5 miles from the site, indicate that the Salt Cycle 6 salt will be about 2800 feet deep and 200 feet thick at the site. This salt is interbedded with undulatory anhydrite laminae, whose frequency and distinctness range widely.

The near-site stratigraphic and hydrostratigraphic units are shown in Figure 5-5. Only gentle structures are expected to be found in the Salt Cycle 6 salt near the site. The Paradox Formation has experienced dissolution at certain locations within the Paradox Basin. The closest known dissolution is at Lockhart Basin (about 12 miles from the Davis Canyon site), and the closest suspected, but not proved, potential dissolution feature is the Grabens; the closest graben is about 11 miles from the Davis Canyon site.

The Lavender Canyon site is about 4 miles south of the Davis Canyon site, in similar geologic conditions. The GD-1 borehole is about 5 miles from the Lavender Canyon site. The nearest borehole (an oil-and-gas exploration borehole) is 1.6 miles away. At Lavender Canyon the Salt Cycle 6 salt is expected to be about 60 meters thick and at a depth of about 2900 feet. There is no apparent geologic structure near the site, only gentle, 1- or 2-degree dips to the northeast.

The Paradox evaporite section was deposited during Pennsylvanian time (330 to 290 million years ago) and has experienced little deformation near the sites except for regional uplift. Tectonic activity is mild; there is little or no recent uplift and no young volcanism. Moderate earthquakes occur in the region. The Shay Graben faults, about 5 miles south of the Lavender Canyon site, are potential sources of earthquakes. Free-field ground-surface accelerations of 0.35g at Lavender Canyon and at Davis Canyon are probable upper bounds for estimates to be developed from detailed analyses.

Hydrocarbons, potash, uranium, and vanadium are the major resources present in the area surrounding both sites. Potash mining is not likely to be feasible because the potash-rich zones occur at depths greater than 4300 feet and the shallower zones are not thick enough for mining to be economical. No oil or gas has been produced in the vicinity of either site, although some potential for oil and gas exists, and the subject will be studied

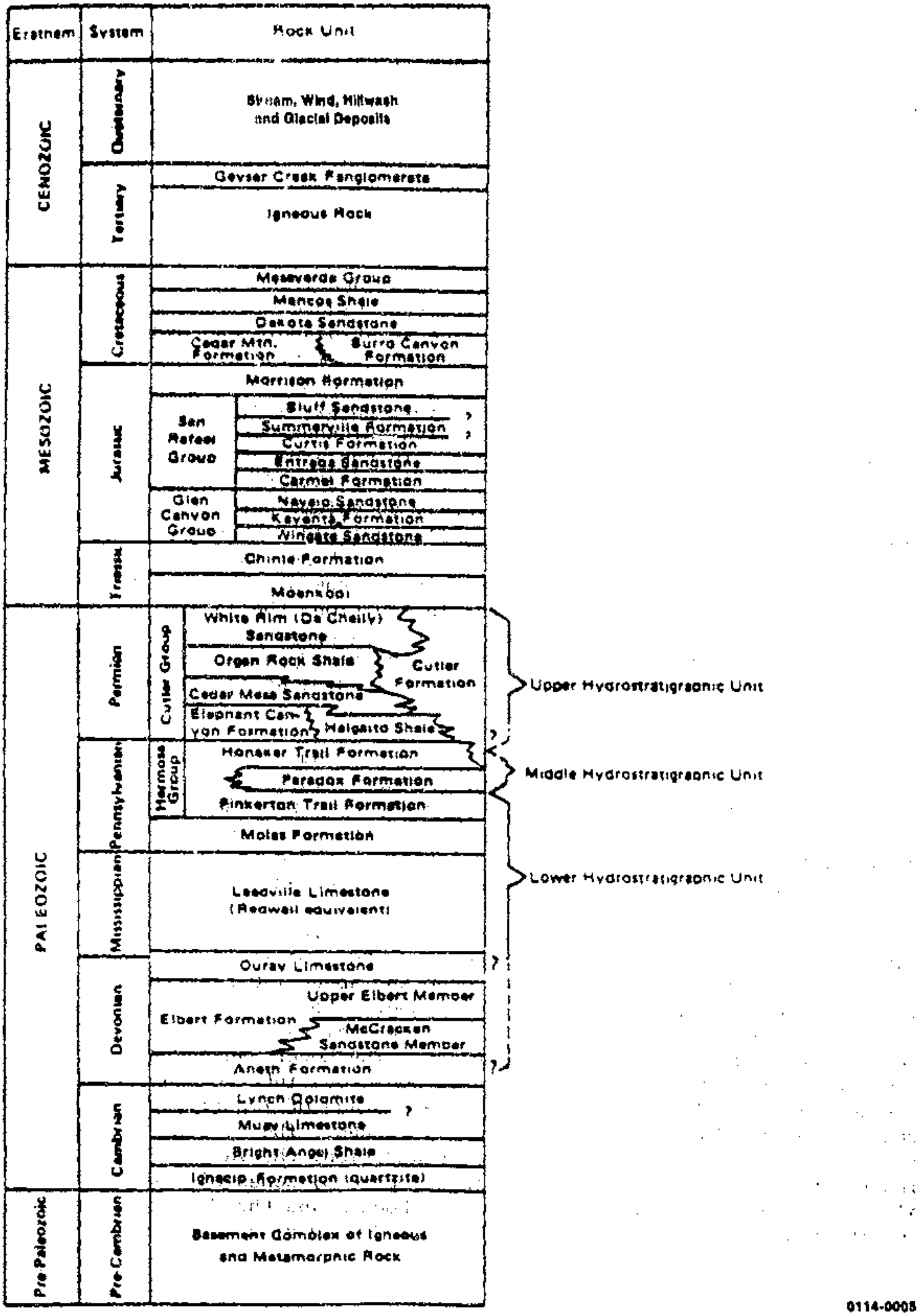

Figure 5-5. Composite stratigraphic section of the Paradox Basin.