Additional Information on
Monitored Retrievable Storage

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

EXECUTIVE SUMMARY

On March 31, 1987, the Department of Energy (DOE) submitted to the Congress, in response to Section 141 of the Nuclear Waste Policy Act of 1982 (the Act), a proposal for the construction of a facility for monitored retrievable storage (MRS). The proposed MRS facility would be fully integrated into the overall waste-management system to serve as a centralized facility for receiving spent fuel from commercial reactors, for preparing spent fuel for permanent disposal in a geologic repository, and for temporarily storing a limited amount of the prepared waste pending shipment to the repository.

The integrated MRS facility offers important advantages that would benefit both development and operation of the overall waste management system. The MRS facility would improve system development by providing a stepwise approach to moving from the current state of experience to full-scale operation of a disposal system including a repository. It would allow DOE to proceed immediately to plan for, and implement a major part of, the waste-management system independent of the remaining issues to be resolved about the repository. The siting and construction of an MRS facility would also yield major institutional benefits by making a significant step forward that would give added momentum for implementing the entire system and provide experience at interactions with a host State and local community that would benefit later relations with the repository host.

The MRS facility would enhance the operation of the waste-management system in several important ways. It would accelerate waste acceptance, thus reducing the need for new temporary storage facilities at reactors and the attendant spent-fuel-handling operations, licensing efforts, and costs. The buffer-storage capacity of the MRS facility would provide improved system reliability and flexibility by allowing the functions of spent-fuel acceptance from reactors and spent-fuel emplacement in the repository to proceed independently, so that interruptions in one would not affect the other. It would simplify facilities and operations at the repository by shifting a major part of waste-package preparation to another site. Finally, it would improve transportation by allowing the longest leg of the journey from the reactor to the repository to take place in very large casks on dedicated trains, thereby reducing the costs and impacts of waste transportation.

These benefits can be obtained at a reasonable cost. Recent estimates show that the overall cost for the development and operation of a waste-management system that includes an MRS facility would be approximately $1.5 to $1.6 billion higher than that for a system without an MRS facility. This difference is less than 5 percent of the total-system life-cycle costs for the current reference system without an MRS facility.

Since the DOE developed the MRS proposal for the Congress, a number of questions have been raised by the General Accounting Office (GAO), the State of Tennessee, and others concerning the need for the MRS facility and the feasibility of achieving comparable performance for the overall waste-management system without an MRS facility. This report was prepared to provide additional information to address these questions.

This report reviews potential modifications to the currently authorized system (the "reference no-MRS system"); describes and compares alternative no-MRS systems that incorporate these potential modifications to varying degrees; and provides a summary comparison of a modified no-MRS system with a similar system that includes an MRS facility. Also included are additional information on the views of some U.S. utilities on the need for the MRS facility and preliminary estimates of institutional costs identified but not quantified in the DOE's proposal to the Congress.

Nothing in this analysis indicates the need for any substantive changes in the conclusions reached in the DOE's proposal about the system benefits and costs of an integrated MRS facility. The research and development programs described in the DOE's proposal to the Congress may yield technological advances that can improve the waste-management system with or without an integrated MRS facility. However, none of these advances appears likely to significantly alter the net relative advantages offered by the MRS facility or the relative costs of adding that facility to the system.

In particular, the system-development and institutional benefits of the MRS facility can best be obtained by the construction and operation of a large-scale centralized waste-management facility--the MRS facility--several years before the first geologic repository. Without an MRS facility, many of the first-of-a-kind technical and institutional challenges of waste management and disposal will be faced at the first repository. With the MRS facility in the system, many of the pertinent issues, except for the issue of long-term disposal, will have been addressed before the final development efforts for the first repository.

Of the operational benefits identified for the MRS facility, it would appear that only the transportation improvements can be obtained by modifications to the no-MRS system, and then only to a lesser degree than would be possible if the same modifications are applied to the system that includes an MRS facility.

The views of the utility industry--as represented by testimony before the Congress and determined in a limited DOE study of several utilities--indicate strong support for an MRS facility and similarly strong opposition to performing at reactor sites several waste-preparation operations that would be performed at the MRS facility.

The discussions that follow briefly describe the evaluations performed in this study and summarize the results.

Achieving comparable performance without the MRS facility

The GAO and others have contended that the MRS proposal to the Congress does not compare an improved waste-management system without an MRS facility with a system that includes an MRS facility. According to these commenters, such a comparison is needed to determine the true value of an MRS facility to the system.

Assessment of alternative no-MRS cases. This report presents the benefits and costs associated with five alternative modifications to the reference no-MRS system that incorporate various combinations of technologies. The technological options considered include large-capacity transportation casks; dual-purpose storage-and-transportation casks for the at-reactor storage of spent fuel; at-reactor preparation of spent-fuel canisters that are compatible with the rest of the waste-management system; and at-reactor spent-fuel consolidation. The alternatives evaluated represent increasing degrees of transfer of waste-management activities from the Federal waste-management system to reactor sites. They range from an alternative system that involves only modifications to the Federal waste-management system to one in which the preparation of a repository-ready disposal canister--a key function planned for the MRS facility--is performed at reactor sites instead.

The evaluation of the five no-MRS alternatives identified one option that has significant advantages over the current reference no-MRS system and all of the other options. This option--alternative 1--involves the use of large-capacity transportation casks and DOE guidance and advice to encourage utilities who choose to consolidate spent fuel to use a canister that is compatible with the rest of the waste-management system. These modifications can be implemented in the Federal waste-management system with little intrusion into utility activities. They would reduce overall system costs by $400-$500 million and also reduce the occupational and public risk of radiation exposure, primarily as a result of the transportation improvements resulting from the use of large-capacity casks.

The comparison indicates that involvement by the utilities in waste-preparation activities beyond those they would voluntarily undertake to deal with their own storage problems would lead to cost impacts that range from only minor cost reductions to substantial cost increases compared with performing those activities at the repository. For example, the analysis indicates that DOE action to encourage or require the consolidation of spent fuel at reactors (a function now planned for the MRS facility or for a repository if an MRS facility is not authorized) would have at most a marginal cost benefit. Furthermore, once the large-capacity transportation casks are employed, at-reactor consolidation yields only minimum additional reductions in transportation costs. In sum, the small net cost benefits resulting from the promotion of at-reactor consolidation would not offset the negative impacts associated with the increased Federal intrusion into utility operations and the associated risks of interference with reactor operations.

The evaluation of cases involving differing degrees of preparation of disposal-ready waste packages at the reactors showed the same results for each case: overall system costs would increase; significant institutional and utility opposition to widespread utility involvement in spent-fuel preparation would be expected; and substantial technical feasibility issues would need to be resolved. In fact, the alternatives involving the performance of most or all MRS functions at reactor sites have costs that are comparable to, or higher than, the costs of the system with an MRS facility and provide none of the substantial system-development benefits of the MRS facility.

Comparison of no-MRS and MRS cases. The no-MRS case that was identified as having advantages compared to the current reference no-MRS system was compared with an updated MRS case that incorporates the same improvements made in the no-MRS case. The comparison showed that the only significant change from the analysis presented in the MRS proposal is the large reduction in transportation costs and impacts resulting from the use of large-capacity transportation casks for shipments from the reactors to the MRS facility or the repository. While the large-capacity transportation casks do improve transportation substantially in the MRS case, the benefit is greater in the no-MRS case because in the latter case the benefits accrue over the entire distance from the reactors to the repository.

The larger reduction in transportation costs for the no-MRS case compared with the MRS case increases the calculated cost difference between the two cases to $1.6-$1.9 billion (about 13 percent higher than previous estimates), although the absolute cost of both cases is reduced. However, the updated MRS case still shows net improvements in transportation compared with all of the no-MRS cases simply because the 150-ton casks that will be used to ship from the MRS facility to the repository--the longest portion of the journey from the reactor to the repository--have a substantially larger capacity than the largest rail cask that can be used at a reactor. Furthermore, the MRS case will reduce the number of separate jurisdictions affected by transportation by restricting shipments to a single cross-country route rather than the several that would be involved in the no-MRS case.

In summary, a qualitative examination of various modifications to the no-MRS system shows that no realistic combination of technological modifications and varying degrees of shift of waste-preparation functions from the DOE to the utilities will result in equivalent advantages or in any substantive way alter the advantages that would accrue to the waste-management system as a result of the MRS facility. Many of the major advantages of the MRS facility can be obtained only by the construction and operation of a central waste-management facility before the repository--so that no conceivable improvements to a no-MRS option, in which activities are performed instead at separate reactor sites, can provide comparable benefits.

<u>Views of the utility industry on the need for the MRS facility</u>

The benefits of an MRS facility are considered to be sufficient to warrant the small percentage increase in the overall system cost. This conclusion has been endorsed by various utility companies or organizations representing the utility industry. From the testimony of utility representatives before the Congress, the GAO findings, and the results of a limited DOE study, the following observations about the views of the utility industry can be made:

- The nuclear utility industry supports the addition of an MRS facility to the waste-management system.

- The utility industry can and will implement technological solutions to the problem of spent-fuel management until the spent fuel is transferred under the Act to the Federal Government. The solutions are, however, likely to vary among the utilities in the absence of significant Federal intervention.

- The utilities are not inclined to commit to substantially greater waste-preparation operations at reactor sites than those required to sustain the safe operation of the nuclear power plant. This attitude stems mainly from concerns about institutional, liability, and licensing issues rather than simply technical concerns.

- Any waste-management option that requires extensive at-reactor consolidation or other at-reactor operations that are beyond those otherwise needed to safely and efficiently store spent fuel pending acceptance by the DOE would require facility modification and operations that encroach on the primary function of reactors--the generation of electricity.

Costs unquantified in the MRS proposal

The DOE has been asked to provide estimates for certain costs that were identified but not quantified in the MRS proposal. These costs fall into the general categories of impact mitigation, consultation-and-cooperation (C&C) agreements, payments equivalent to taxes, and licensing and permit fees.

These costs were not quantified in the MRS proposal because the DOE felt that including them in the proposal was not appropriate. As explained in the DOE's comments on the GAO report, such costs were not specified in the proposal "to allow the DOE flexibility in the consultation-and-cooperation process that will be initiated if Congress approves the MRS proposal." An estimate of State and local taxes (or payments in lieu thereof) was nonetheless included in the proposal documents. The DOE's comments also pointed out that some of these costs should be determined by the Congress "as a matter of national policy and of the value of the MRS to the waste-management system, as opposed to a DOE estimate." The authority for these expenditures would come from the legislation authorizing the MRS facility. Only funds for impact mitigation have already been approved by the Congress, as they are included in the Act. Other payments to the affected State and local jurisdictions, although proposed by the DOE, are yet to be approved by the Congress. Consequently, the costs for these items may be as low as zero. This report contains an estimate of the range of costs that could be expected if the Congress approves these expenditures.

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1. INTRODUCTION

1.1 PURPOSE

In March 1987, the Department of Energy (DOE) submitted to the Congress a proposal[1] to construct a facility for monitored retrievable storage (MRS). This facility would be fully integrated into the waste-management system being developed by the DOE's Office of Civilian Radioactive Waste Management. The resulting waste-management system--consisting of an MRS facility, a transportation system, and two geologic repositories--was designated the "improved-performance system" in the DOE's 1985 Mission Plan[2] because, in comparison with the system that consists only of the transportation element and geologic repositories (i.e., the "authorized system"), it offers several distinct advantages.

Since the proposal was prepared, several parties have raised various questions about the MRS facility and the DOE proposal. One of these was the General Accounting Office (GAO), which had been requested by the Congress to review the MRS proposal in order to assess whether it provides sufficient information for a decision to authorize the integration of an MRS facility into the waste-management system. The GAO and others criticized the DOE's proposal on the grounds that it did not include a comparison of an optimized no-MRS system with the MRS system, nor did it provide the information necessary for such a comparison.

The report[3] prepared by the GAO makes two principal recommendations:

1. The DOE should identify the best configuration of the authorized system, "combining the most feasible alternatives for maximizing the effectiveness, efficiency, and safety of the system in lieu of an MRS."

2. The DOE should prepare an estimate of the cost of all elements associated with the MRS facility, including costs not reported in the proposal, such as payments equal to taxes and the costs of mitigating the impacts of MRS construction and operation.

This report examines various ways in which the transportation and the storage of spent fuel can be managed without an MRS facility and then compares these alternative waste-management systems with a system containing an MRS facility; the comparison is made in terms of several criteria (e.g., system development, operations, cost, risk, feasibility). It also discusses the costs not quantified in the proposal. In addition, it summarizes the views of several U.S. electric utilities and representative groups on both the MRS facility and various at-reactor options that have been proposed for spent-fuel management.

1.2 THE MRS FACILITY AND ITS ADVANTAGES

As described in the DOE proposal[1] and the 1985 Mission Plan,[2] an MRS facility would be fully integrated into the waste-management system being developed by the Civilian Radioactive Waste Management Program. Its principal functions would be to prepare the spent fuel discharged from commercial nuclear power reactors for disposal in a geologic repository and to serve as the central receiving station for the waste-management system. The preparation for emplacement may include removing the spent-fuel rods from the metal grids that hold them together in a square array and consolidating them into a more closely packed array. Consolidation offers several advantages, such as a reduction in the number of waste shipments to a repository and a reduction in the number or the size of the "waste packages" requiring handling and emplacement in a repository. Whether consolidated or not, the spent fuel would be sealed in canisters that are uniform in size and free of surface contamination with radioactive material. Such canisters would facilitate handling, shipping, and further processing at the repository.

In addition to its waste-preparation function, an MRS facility would provide temporary storage for a limited quantity of spent fuel (up to 15,000 metric tons of uranium). (The quantity of spent fuel to be emplaced in the first repository is 70,000 metric tons of uranium.) The canisters of spent fuel would be stored at the surface, in concrete casks equipped with monitoring instruments and designed for easy retrieval of the spent fuel for shipment to the repository.

The integrated MRS facility proposed by the DOE is not a temporary expedient designed to alleviate problems in spent-fuel storage. Its principal purpose is to facilitate the development and operation of the overall waste-management system, including the repositories and transportation, and it thus could provide significant advantages. Briefly summarized, these advantages are as follows:

- Improvements in system development. An MRS facility would allow the DOE to separate a major part of the waste-management process (acceptance, transportation from the reactor sites, consolidation, and sealing in canisters) from uncertainties about the repository and to proceed immediately with detailed planning for, and implementation of, that part. Early accomplishment of these separable steps would significantly enhance confidence in the schedule for the operation of the total system.

- Accelerated waste acceptance. An MRS facility would allow the system to begin receiving spent fuel 5 years earlier than the system without an MRS facility, thus significantly reducing the need for new temporary storage capacity at reactor sites and the attendant spent-fuel handling operations, licensing efforts, and costs.

- Improvements in system reliability and flexibility. Improvements in system reliability and flexibility would be realized by separating the function of spent-fuel acceptance (from the reactors) from the function of spent-fuel emplacement in the repository and by adding significant operational storage capacity to the system.

- Advantages for the repository. An MRS facility would simplify waste-handling facilities and operations at the repository.

- Transportation improvements. The MRS facility would facilitate the use of dedicated trains, reduce the number of shipment-miles and cask-miles,* reduce the number of individual shipments in transit, and serve as a hub for transportation operations.

- Institutional benefits. The MRS facility would provide institutional benefits through the experience gained from interactions with the host State. Institutional benefits would also result from the opportunity to demonstrate earlier that in developing and operating waste-management facilities the DOE is prepared to be a responsible corporate citizen and neighbor. Progress in waste management, starting with the designation of a specific site and facility construction, would help to provide momentum for implementing the entire system.

Of these advantages, only the above-mentioned transportation improvements can be accomplished in the Federal waste-management system without an MRS facility. Under particular circumstances, some advantages for the operation of the repository might be gained by performing certain operations (e.g., spent-fuel consolidation) at the reactor sites, but such operations would be performed outside the Federal waste-management system as defined at present. None of the advantages listed above could be gained from the various other waste-management functions that could be performed at the reactor sites, such as the reracking of storage pools to accommodate more spent-fuel assemblies, and the provision of dry at-reactor storage. Nonetheless, the alternative waste-management options that have been suggested as potentially beneficial have been identified and evaluated in this report.

1.3 APPROACH

In order to provide comparisons of waste-management systems with and without an MRS facility, the DOE used the following approach:

- Review the status of technology developments in spent-fuel storage and transportation that may result in technological improvements.

- Evaluate a number of no-MRS system configurations that embody potential technological and operational improvements.

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*Cask-miles are defined as the distance traveled times the number of casks transported; shipment-miles are defined as the distance traveled times the number of shipments made. When a shipment consists of only one cask, the shipment-miles are equal to the cask-miles. With multiple-cask shipments, the cask-miles are a multiple of the shipment-miles.

- Identify the no-MRS system and an operational scenario that might maximize the effectiveness, efficiency, and safety of the waste-management system and that can be reasonably considered to be feasible both technically and institutionally.

- Examine how the identified technological improvements in transportation and storage might provide comparable benefits to the proposed waste-management system with an integral MRS facility.

- Compare the resulting system benefits for a system with an MRS facility and one without.

For convenience and brevity, the terms "reference no-MRS system" and "reference MRS system" will be used in lieu of the terms "authorized system" and "improved-performance system," respectively. The systems designated by these terms are those described in the DOE's proposal to the Congress,[1] but with the waste-acceptance schedules given in the Mission Plan Amendment.[4]

The remainder of this report is divided into seven sections. Section 2 describes and evaluates potential modifications to the waste-management system and waste-management options that could be implemented at reactor sites. Section 3 describes and evaluates the various alternative system configurations that are possible without an MRS facility. Section 4 describes and evaluates the reference MRS system and explains how it could be updated, and Section 5 presents a comparison of the identified no-MRS and the MRS systems. Section 6 discusses the views and attitudes of several U.S. nuclear utilities about the MRS facility and about the various waste-management functions that could be performed at reactor sites in the absence of an MRS facility. To address the second GAO recommendation, Section 7 presents estimates of the potential institutional costs of the MRS facility. The conclusions of the report are presented in Section 8.

Also included in the report are two appendixes that provide supporting information for the no-MRS and the MRS systems. Appendix A contains details concerning the assumptions and calculations performed to estimate the system-cost impacts of various alternatives. Appendix B reviews the description and evaluation presented in the DOE proposal of various potential options for modifying the no-MRS system and provides some additional information on these and other potential options.

2. REVIEW OF POTENTIAL MODIFICATIONS TO THE WASTE-MANAGEMENT SYSTEM

As mentioned in the introduction, questions have been raised about spent-fuel handling, packaging, storage, and transportation modifications that could be implemented in the reference no-MRS system to improve its effectiveness, efficiency, and safety.

The suggested options can be grouped into four main categories:

- Expanded storage capacity at reactor sites.
- Transportation.
- Use of Federal interim storage.
- Expanded lag storage at the repository.

This chapter briefly reviews various options for modifications in each category. Those judged to be feasible were considered in defining alternative no-MRS systems (Section 3.1). Much of the information presented here is based on the descriptions and evaluations included in the DOE's MRS proposal to the Congress (Appendixes A and D to Volume II of the MRS proposal[1]). The remainder is based on additional information that has recently become available from research, development, and demonstration activities conducted in the DOE's waste-management program. More-detailed descriptions and evaluations of these options are given in Appendix B of this report.

2.1 EXPANDED STORAGE AT REACTOR SITES

The quantity of spent fuel that could be stored at reactor sites could be increased by the following methods: by "reracking"--that is, installing new racks in the spent-fuel storage pools to accommodate more spent fuel; by consolidating spent-fuel rods into more-compact arrays; and by providing facilities for dry storage. The first two involve expanding in-pool capacity, while the third requires storage outside the pool. For this analysis--and in all DOE analyses examining the need for additional storage--it was assumed that the storage pools at all reactors have already been "reracked" to the maximum extent possible, and therefore this option will not be discussed further.

2.1.1 At-Reactor Consolidation and Canistering

In consolidation, the fuel-bearing components (spent-fuel rods) are separated from the hardware (non-fuel-bearing components) that holds them together in an assembly and loaded into a canister in a more tightly packaged array, reducing by about one-third the space required in a storage pool for the spent-fuel rods and the assembly hardware. At reactor sites, the consolidation operation would be performed under water. Consolidation can also be used to provide a more compact waste form for dry storage. Although generally at-reactor consolidation is considered a means to alleviate the problem of insufficient spent-fuel-storage capacity at reactor sites, it has also been suggested as an alternative to consolidation in the Federal waste-management system.

If the DOE chose to promote large-scale at-reactor consolidation, there is no assurance that all utilities would be willing or able to perform this function. The feasibility of consolidating spent fuel and storing it in a particular spent-fuel storage pool depends on the capacity, structural, thermal, and seismic constraints for that pool. In addition, since at a reactor site the process would be performed in the storage pool, at-reactor consolidation would create the potential for increasing contamination in the water in the storage pool and increasing the background radiation level of the pool area. As indicated below, it is unlikely that consolidation would be a feasible or attractive option for all utilities.

Recent small-scale demonstrat[illegible] indicate that at-reactor consolidation may be both feasible and economi[illegible] tractive as a means of providing additional storage space; however, [illegible] experience at present is insufficient to confidently estimate either the cost or the feasibility of a large-scale application of consolidation. Confident estimates will require data from larger-scale projects.

To date, all of the development work has [illegible] directed at spent fuel from pressurized-water reactors. No efforts to co[illegible]te spent fuel from boiling-water reactors have been undertaken. [illegible] companies have designed equipment for in-pool consolidation, and each has teamed up with one or more utilities to test and refine the equipment. In all cases the equipment was designed for an optimum consolidation ratio of 2:1 (i.e., to load the spent fuel from two assemblies into a canister the size of a single assembly), but its use so far has had mixed success. Where a 2:1 consolidation ratio has been achieved, the tradeoffs have been low production rates, substantial labor requirements, and/or high costs. However, a more recent demonstration by the Combustion Engineering Company at the Millst[illegible] 2 plant of Northeast Utilities is encouraging: a consolidation ratio of 2:1 [illegible] achieved with reasonable production rates.

At present, planning for at-reactor consolidation entails uncertainty about the licensing requirements of the Nuclear Regulatory Commission (NRC). The position taken by utilities--and to date not disputed by the NRC--is that consolidation itself does not need to be licensed because the operations involved would be within the envelope of technical operations approved for the nuclear power plant in most cases. However, a license amendment is required if a utility plans to increase, through consolidation, its in-pool storage beyond the approved capacity. Since this is the principal reason for undertaking at-reactor consolidation, a utility's decision to consolidate will have to include an assessment of the factors associated with an operating license amendment. In this regard, the experience of the Maine Yankee Atomic Power Company in attempting to attain a license amendment for this purpose is not encouraging (see Appendix B, Section B.2.1). As a result, Maine Yankee has abandoned its plans to pursue consolidation, although it believes that consolidation and in-pool storage of consolidated spent fuel are technically and economically feasible. Similarly, Northeast Utilities applied to the NRC for a license to consolidate (and store in the spent-fuel pool) the entire spent-fuel inventory at its Millstone 2 plant. The NRC, however, granted this utility the very limited authority to consolidate (and store) only up to 10 assemblies. The licensing problems encountered by Maine Yankee and Northeast Utilities are probably not unique.

In regard to the views of the utilities, the results of a recent limited study[5] performed for the DOE by the Nuclear Assurance Corporation (NAC) showed that some utilities are willing to consider consolidation to meet their storage requirements prior to the inception of spent-fuel acceptance by the Federal waste-management system (see Section 6 for more details). However, the NAC study also indicated that the interviewed utilities had strong objections to voluntary consolidation for the purpose of achieving benefits elsewhere in the waste-management system, even if substantial incentives are provided. Large-scale at-reactor consolidation would require the utilities to obtain a license for, construct facilities, and install equipment for predisposal spent-fuel-preparation operations. It would shift these operations from a Federal facility specifically designed for that purpose (either the MRS facility or the repository) to many different reactor sites that are not equipped for the operation and may have difficulties in accommodating it.

For purposes of this evaluation, three different options for large-scale at-reactor consolidation have been postulated, depending on the type of storage canister that is used. The choice of canister would at least partly depend on the purpose of consolidation (to alleviate at-reactor storage problems or as an alternative to consolidation at a Federal facility) and the status of the DOE's repository-development program. The types of canister that might be used are as follows:

- A utility-selected canister.

- A repository-specific canister.

- A repository-compatible canister that is also compatible with existing spent-fuel-pool racks.

The utility-selected canister could, and probably would, differ in size from reactor to reactor. If such canisters are used, the repository will eventually receive a variety of canisters, and additional operations may be required to accommodate these canisters at the repository. (At the repository, the spent-fuel canisters will be encapsulated in a site-specific disposal container before emplacement in the underground disposal area.)

The repository-specific canister would be a large cylindrical canister that is specifically designed to fit inside the repository disposal container. Such a canister is not compatible with existing spent-fuel-pool storage racks, which accept square spent-fuel assemblies; it would thus complicate at-reactor spent-fuel management and may be counterproductive with regard to extending at-reactor storage capacity. Furthermore, specifications for this canister will not be available for several years--until a repository site is selected and more-advanced site-specific repository and waste-package designs have been completed. Any spent fuel that is consolidated before the specifications for the repository-specific canister are available may need to be reloaded into a different canister.

The third alternative is to use canisters that are compatible with the spent-fuel-pool storage racks and also compatible with the repository disposal containers (compatible in that their use would entail minimal reduction in the efficiency of the disposal containers). For example, one alternative that is being investigated is a combination of standard-size square and half-square canisters, where a single square canister or two half-square canisters are the nominal size of an assembly. These canisters are compatible with the existing racks in the spent-fuel pools and can be loaded into repository disposal containers with a fairly high packing efficiency. Two square and two half-square canisters can be arranged in a cylindrical disposal container in such a way that very little void space is left. This alternative would permit at-reactor consolidation while limiting the risk that the canisters will be incompatible with either the repository disposal container or the spent-fuel-pool storage racks.

2.1.2 Dry Storage

The dry storage of spent fuel in out-of-pool modular containers is used in several nuclear installations in Europe and by some nuclear utilities in the United States. Two dry-storage methods, using metal casks and horizontal concrete vaults, have been licensed to date for use at specific U.S. reactor sites. Dry storage in concrete casks, a third storage option, has been selected by one U.S. utility and is the preferred storage mode for the proposed MRS facility. A fourth option, that of dual-purpose metal casks used for both storage and transportation, is used in Europe and has been under study for several years in this country.

The costs of dry storage are higher at individual reactor sites than in a central storage facility like the MRS facility because economies of scale favor a central facility and because storage at many different sites entails duplication of equipment. However, with no central facility available, several utilities are taking steps to solve their storage problems by implementing dry storage. Brief descriptions of dry-storage options are given below.

Dry storage in metal casks

The storage of spent fuel in metal casks is the most mature and best accepted of any dry-storage technology, with more than 40 years of development and experience in shipments of nuclear fuels and other radioactive materials. This technology is being enhanced through extensive testing and demonstration programs being conducted by the DOE, both through its contractors and in cooperative programs with utilities. The Virginia Power Company has a license for storing intact spent-fuel assemblies in metal storage casks at its Surry plant and has initiated the transfer of spent fuel to dry storage.

Dry storage in concrete casks (silos)

At-reactor storage in concrete casks is similar to storage in metal casks. It entails lower capital costs, but the concrete casks require more-extensive support facilities. Concrete casks have been used in experimental storage programs; they have also been used in other countries (e.g., Canada). They have been proposed as the primary storage modules for the MRS facility.

Storage in concrete casks has not yet been licensed at any site, although no impediments to licensing are evident.

Dry storage in horizontal vaults (NUHOMS system)

The NUHOMS system is licensed for use at the Robinson site of the Carolina Power & Light Company. The Duke Power Company also recently announced its intention to investigate the use of a form of the NUHOMS system for spent-fuel storage at its Oconee site. In the NUHOMS system, intact spent-fuel assemblies are encapsulated, in the the spent-fuel pool, in large canisters. A canister is then loaded into a transfer cask that moves the spent fuel out to an out-of-pool storage vault. The transfer cask is coupled to the vault, and the canister is transferred to and sealed inside the concrete vault.

The canister used in this system is not compatible with transportation-cask designs. Unless specialized casks are developed, the spent fuel in the canisters may have to be removed and either shipped as integral assemblies or reloaded into transport-compatible canisters before shipment from the reactor.

Dry storage in dual-purpose casks

The concept of the dual-purpose storage cask, which has been under study by the DOE for several years, is a variant of the metal-storage-cask concept, in which the cask used for storing spent fuel is later used to transport the fuel to a Federal facility. In essence, this option amounts to using the metal cask for storage and then, if necessary, using it as part of the transportation fleet or for lag storage at the repository or the MRS facility.

The major feasibility issue related to the dual-purpose cask is certification for transportation after extended periods of use for spent-fuel storage. Current NRC interpretations of its regulations could preclude certification under those circumstances. There is no evidence as to whether such certification could be expected in the future. The integration of the dual-purpose casks into the transportation-cask fleet also depends on their availability when needed for shipment from reactors to the repository. The casks must be made available early in the acceptance schedule, in order to reduce the need for transportation-only casks. The use of such casks for lag storage at the repository may reduce the need for some in-process lag storage that is currently envisioned and may provide increased flexibility in the surge capabilities of the system.

The most advantageous use of the dual-purpose casks would be their integration into the transportation-cask fleet. The potential benefits resulting from their later use for lag storage at a Federal facility do not appear to be significant. An analysis presented in Appendix A indicates that fewer than 20 dual-purpose casks would be needed to meet the requirements of the transportation system for 125-ton casks. The potential benefits are therefore limited to a relatively small number of casks, and the overall effect of dual-purpose casks on the costs of waste management would not be significant.

2.2 TRANSPORTATION

A number of options for modifying the transportation system have been evaluated. The primary effect of these options is a reduction in the number of shipments required to move the spent fuel from the reactors to the Federal waste-management facilities. Many of these modifications could be applied to the reactor-to-MRS portion of the MRS system, with similar effects as those associated with the reactor-to-repository shipments in the no-MRS system. It should be noted that, because of the reduction in the number of shipments, the implementation of many of these options would reduce the potential transportation benefits associated with at-reactor consolidation.

The potential options for modifying the transportation system are briefly described in the sections that follow.

2.2.1 Larger-Capacity Standard Casks

Responses from commercial vendors to the DOE's recent request for proposals for transportation-cask designs have indicated that it is possible to develop a new generation of truck and train casks that would have a much higher capacity than previous designs of the same weight and size. These larger-capacity standard casks would decrease the size of the cask fleet that would be needed, and the receiving facilities would need to handle fewer cask arrivals.

2.2.2 Extra-Large Rail Casks

The use of extra-large rail casks (125 to 150 tons loaded) in the no-MRS system would increase the capacity of rail casks and thus reduce the total cask-miles* traveled as well as the total number of cask-shipments* required. The actual percentage reduction that may be obtained in cask-miles and in the number of shipments is directly proportional to the relative cask capacities. Only the reactors that are currently listed as having rail-cask-handling capabilities (i.e., capabilities to load a rail cask under water in the storage pool) can handle rail casks with a loaded weight of 100 to 125 tons. As a result, the use of these casks would be limited unless modifications are made in the rail-cask-handling capabilities of the rest of the reactors currently operating in the United States. Alternatively, the facilities needed for out-of-pool cask loading would have to be provided at the reactor sites.

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*Cask-miles are defined as the distance traveled times the number of casks transported. Cask-shipments are simply the numbers of shipments of casks.

2.2.3 Overweight Truck Casks

The capacities of truck casks are generally limited by the gross vehicle weight limits. Thus, the size and capacity of truck shipments could be increased, with corresponding reductions in the number of such shipments, by using overweight, rather than legal-weight, shipments.

One complication with this option is that the regulations and statutes governing overweight truck shipments are not consistent throughout the United States, but vary from State to State. This requires complex scheduling and interactions with many State officials to ensure that the overweight shipments are consistent with the regulations of the various States along the transportation routes. Overweight shipments might also be constrained to operate only during certain times of the day or at reduced speeds, resulting in a net reduction in shipment speed. Some States also do not allow overweight truck shipments during the winter months because of possible damage to highways. A sensitivity analysis in Appendix A shows that, if all truck shipments use legal-weight truck casks, the costs of transportation would be about $200 million higher than the costs of using a near-optimum mixture of legal-weight and overweight casks.

2.2.4 Multicask Shipments

The total number of shipments and shipment-miles* can be reduced by combining single-cask shipments into multicask shipments. Several options for combining shipments have been considered, including truck convoys, marshalling rail shipments, multicask shipments from individual reactors, and pick-up trains.

Inherent in each of these options is the added amount of nontransport time or idle time that is required for individual casks. This increased nontransport time is incurred either at the reactor, where loaded casks are idle while awaiting the loading of subsequent casks, or at the marshalling yards, where early-arriving casks remain while awaiting the arrival of other casks to be added to the shipment. The increased nontransport time lengthens the average total time required for a trip for casks and requires a larger cask fleet to ship the same amount of spent fuel in the same time. These extra casks will add to the overall cost (capital and maintenance) of shipping the spent fuel.

All of these multicask options entail various degrees of additional planning, scheduling, and control of operational parameters. No new technology is required for the implementation of any of these options. In the case of marshalling shipments, public opposition to the siting of a marshalling yard is possible.

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*Shipment-miles are the distance traveled times the number of shipments made. When a shipment consists of only one cask, the shipment-miles are equal to the cask-miles. With multiple-cask shipments, the cask-miles are a multiple of the shipment-miles.

2.2.5 Increased Use of Rail Transport

Recent studies of the cask-handling capability at existing reactors have shown that about half of the reactor sites are limited in their ability to handle large rail casks. These limitations stem from such factors as inadequate crane-lifting capacity, the lack of a railspur onto the site or into the fuel-handling building, limitations associated with the pathway to the storage pool, and the structural limits of the pool (the casks are loaded in the pool). Three options for increasing the use of rail transport for shipments originating from reactors are discussed in this section:

- Upgrading reactor facilities to provide direct rail access (e.g., by adding railspurs and modifying crane capacities).
- Using trucks in the "heavy-haul" mode (special flatbeds capable of accommodating heavy weights, very slow speeds, etc.) to transport rail casks from the site to a rail access, provided crane and storage-pool capabilities are adequate.
- Using smaller casks loaded in the storage pool to transfer spent fuel to large rail casks outside the pool.

The first of these options can be accomplished without new technology development or application. Upgrading reactor-handling capabilities would require retrofitting or recertifying present equipment to handle heavier rail casks. Also, reactors that do not have rail service into the reactor site would need that service. Moreover, changes to a reactor facility might require an amendment to the NRC license, a process that utilities may be reluctant to undertake because it is costly and time consuming. Heavy haul has been used many times to move heavy components like reactor vessels onto sites without rail access, but it has not been used for spent-fuel shipments and may require special permits. The third option would require the development and NRC certification of dry-cask transfer methods. This technology is currently being investigated, especially for its use as a method for loading storage units that could be used at reactor sites. The cost, risk, and feasibility of this option are uncertain at this time. A sensitivity analysis presented in Appendix A shows that the costs of upgrading at-reactor facilities to accommodate rail shipments would about equal the savings that would be realized in transportation costs if the reference casks are used; if the improved-capacity casks under development are used, these upgrading costs would be about 10 times larger than the transportation-cost savings. Regarding the transfer of spent fuel from a smaller cask to a larger cask outside the pool, this operation at a reactor site would probably require a license amendment and may meet public opposition. For the various reasons given above, these options were not deemed practicable and were not included in further analyses.

2.2.6 Use of Dedicated Trains for Shipments from Reactors

Rail shipments could be made in dedicated trains that carry no other commodity. These trains would go directly from a reactor to the repository. Dedicated trains would simplify system operations by allowing the scheduling and routing of trains to meet the needs of the waste-management system rather than the convenience of the railroads.

System costs might be slightly increased by dedicated trains, although the higher over-the-rail cost could be partially offset by higher average speeds and reduced stopped times. The increased control over the arrival and departure of trains would allow the receiving facilities to be designed for a lower surge capacity.

2.3 USE OF FEDERAL INTERIM STORAGE (FIS)

The Nuclear Waste Policy Act of 1982 includes provisions for Federal interim storage to assist those utilities that are unable to provide adequate at-reactor storage capacity when needed to ensure the continued orderly operation of their reactors. This Federal interim storage is limited to no more than 1900 MTU.

The Act makes it clear, however, that the primary responsibility for providing interim storage for spent fuel rests with the individual utility owning reactors by maximizing, to the extent practicable, the effective use of existing onsite storage facilities and by adding new onsite storage capacity in a timely manner where practicable. Those utilities that have pursued all the above licensable alternatives for additional spent-fuel storage without solving their storage difficulties may seek the required determination from the NRC that all such alternatives have been exhausted and, after receiving this determination from the NRC, apply to transfer their spent fuel to Federal storage facilities. Such arrangements in the form of contracts with the DOE are required to be enacted not later than January 1, 1990. There is no evidence at present that any utility plans to apply for Federal interim storage.

The costs of Federal interim storage must be fully paid by assessments against utilities using the services. Costs will depend heavily on such factors as the site, the storage technology, and the capacity required.

2.4 EXPANDED LAG STORAGE AT THE REPOSITORY

Expanded lag storage capability at the first repository might provide to the waste-management system some of the same benefits that would be provided by the MRS facility. For example, waste acceptance and the orderly transfer of spent fuel from the utilities could be insulated from disruptions in repository emplacement. If such storage could be licensed separately from the underground portion of the repository, spent fuel could also be received earlier and contingency storage could be provided in case of some types of delays in repository startup or diminished emplacement capability. Present designs for repository surface facilities provide a 3-month operational buffer (750 MTU), which is sufficient to ensure smooth functioning during normal emplacement operations, to unload the transportation system during slowdowns or brief stoppages in emplacement activities, and to maintain emplacement operations at a steady rate during brief disruptions in transportation.

If expanded lag (buffer) storage at the repository could be provided, it could accelerate the initial spent-fuel-acceptance rates in the no-MRS system. The spent-fuel-acceptance rate at the repository during the first 5 years of operation is limited by the rate at which the underground emplacement excavations and operations progress after NRC licensing. (The completion of repository surface facilities will also affect the acceptance rate but to a lesser degree.) The amount of storage that could be provided to accelerate acceptance of spent fuel while not impeding repository construction cannot be predicted at present. The Act prohibits the construction and operation of an MRS or FIS facility in a State in which a repository is located. Also, to avoid characterization as a separate facility, the lag storage would have to be licensed in the same licensing action as the repository. Thus, spent-fuel acceptance in meaningful quantities could not begin much in advance of repository disposal activities; in other words, lag storage could not effectively separate the DOE's acceptance of spent fuel from the schedule of spent-fuel acceptance at the repository.

3. DESCRIPTION AND EVALUATION OF THE REFERENCE AND ALTERNATIVE NO-MRS SYSTEMS

This section briefly describes and evaluates the reference no-MRS system and five alternative no-MRS systems. The alternative systems represent various combinations of the options identified in Section 2. The discussion begins by explaining the approach used to develop the suite of systems examined.

3.1 APPROACH

In the 1985 Mission Plan,[2] the authorized system was defined as consisting of a geologic repository, the necessary transportation system for moving the wastes to the repository, a provision for Federal interim storage as authorized by the Nuclear Waste Policy Act, and a program to encourage and expedite the most efficient use of existing storage facilities and the addition of new capacity in a timely fashion. This authorized system is the reference no-MRS system discussed in this document.

Five alternatives to the reference no-MRS system were identified and evaluated. Of these alternatives, only two, alternatives 1 and 2, represent modifications that could be made to the Federal waste-management system, and even these alternatives involve some operations at some reactor sites. The others depend on waste-management operations performed by the utilities, and as such they represent increasing DOE involvement in, or intrusion into, utility operations. These at-reactor alternatives were identified and evaluated in response to suggestions that certain waste-preparation functions could be performed more cost effectively at reactor sites than at the MRS facility. In developing the modifications, the approach was to group together potential system improvements that had similar system-wide impacts, so that each alternative represented a significant change from the other alternatives.

Table 3-1 provides an overview of each alternative no-MRS system, with the progression from left to right in the table corresponding to the progression of performing increasing waste-preparation functions at the reactor.

3.2 DESCRIPTION OF THE NO-MRS SYSTEMS

Presented below are brief descriptions of the reference no-MRS system as well as five alternative systems. Evaluations of these no-MRS systems are given in Section 3.3.

3.2.1 Reference No-MRS System

The reference no-MRS system is the authorized system described in the DOE's 1985 Mission Plan[2] but with the waste-acceptance schedule presented in the Mission Plan Amendment.[4] Spent fuel is shipped directly from reactors to the repositories. The first repository begins to receive and emplace spent

TABLE 3-1

DESCRIPTION OF ALTERNATIVE NO-MRS SYSTEMS

No-MRS System Reference	No-MRS System Alternative 1	No-MRS System Alternative 2	No-MRS System Alternative 3	No-MRS System Alternative 4	No-MRS System Alternative 5
Reactors					
-- Extra handling or packaging of fuel is limited to that required to solve on-site storage problems. Activities consist of a mix of consolidation and out-of-pool dry storage, with method chosen strictly up to the utilities. Rest of fuel is transferred to DOE as discharged.	-- Extra handling or packaging of fuel is limited to that required to solve on-site storage problems. Activities consist of a mix of consolidation and out-of-pool dry storage. DOE provides guidance, advice, and encourages utilities to choose those options which provide overall waste-management benefits (e.g., repository-compatible canisters for consolidated fuel). Rest of fuel is transferred to DOE as discharged.	-- DOE provides incentives and takes other action to influence utilities in their technology choices to solve storage problems. DOE influence aimed at system-wide optimization of reactor storage choices (e.g., consolidation into repository-compatible canisters, dry storage in dual-purpose casks, etc.) Rest of fuel is transferred to DOE as discharged.	-- DOE takes action to require utilities to consolidate majority of fuel into unsealed repository-compatible canisters. DOE also compensates utilities for operations performed.	-- DOE takes action to require utilities to consolidate majority of fuel into repository-compatible canisters end seal and decontaminate the canisters. DOE also compensates utilities for the operations performed.	-- DOE takes action to require utilities to consolidate majority of fuel into repository site-specific (round) canisters and seal and decontaminate the canisters the DOE also compensates utilities for operations performed.
Transportation					
-- Legal weight truck and 100 ton rail casks with capacities identified in proposal.	-- Improved transportation system (e.g., higher capacity casks, overweight truck casks, 125 ton rail casks, etc.)	-- Improved transportation system plus utilize dual-purpose cask to supplement fleet.	-- Same as Alternative 2.	-- Same as Alternative 2.	-- Same as Alternative 2, with casks designed for site-specific canisters.
Repositories					
-- Lag storage provide inside facility.	-- Same as Reference.	-- Utilize dual-purpose casks to supplement lag storage.	-- Same as Alternative 2.	-- Same as Alternative 2.	-- Same as Alternative 2.
-- Receive majority of fuel as discharged and consolidate at repository.	-- Same as Reference.	-- Same as Reference.	-- Receive canisters from reactors.	-- Receive from reactors canisters that have been cleaned of surface contamination.	-- Receive from reactors canisters that have been cleaned of surface contamination.
-- Load and seal repository consolidated fuel into site-specific containers.	-- Same as Reference.	-- Same as Reference.	-- N/A	-- N/A	-- N/A
-- Reactor-consolidated fuel handled as a special case (due to non-uniform canisters used by utilities).	-- Load and seal reactor consolidated fuel into modified site-specific containers (modified to accommodate canisters).	-- Same as Alternative 1.	-- Same as Alternative 1.	-- Same as Alternative 1.	-- Load and seal reactor consolidated fuel into site-specific containers (due to site-specific canisters).

fuel from the reactors in the year 2003. Until the first repository begins to receive spent fuel, there are no Federal activities for the management of commercial spent fuel; all Federal activities--acceptance, transport, and disposal--happen at once after repository startup.

Until the first repository starts to accept spent fuel, the utilities must store their spent fuel at their reactor sites. A number of reactors are projected to discharge more spent fuel than can be stored in the spent-fuel storage pools even if the storage pools are reracked to the maximum extent possible. Additional storage at reactors is required for about 9500 metric tons of uranium (MTU), distributed over approximately 50 sites.* The DOE does not take explicit action to influence the methods used by the utilities to solve their spent-fuel-storage problems. It is expected that each utility with a storage problem will choose from available options of dry storage and possibly in-pool consolidation the option it deems best for its particular needs. Although it is recognized that some at-reactor consolidation may occur, in the cost analysis for this case it is assumed that no spent fuel will be consolidated at the reactors.

Once the first repository begins operations, spent fuel is shipped from the reactors in legal-weight truck casks or 100-ton rail casks. All reactors capable of shipping by rail are assumed to do so. The spent fuel is assumed to be transported and received by the repositories as intact assemblies.

The repositories in the reference no-MRS system receive the spent fuel shipped from reactors, prepare it for disposal by consolidating and packaging it in disposal containers, and emplace the loaded disposal containers in the underground repository. Depending on the host rock of the repository, the consolidated rods may be loaded into a thin-walled canister that is then filled with an inert gas like argon and welded closed before being placed in a thicker-walled disposal container, which is also closed by welding. The loaded disposal container is transferred underground and emplaced. A portion of the spent fuel that is assumed to present difficulties in consolidation, such as failed or damaged spent fuel, is not consolidated at the repository. Instead, it is packaged and emplaced intact.

3.2.2 No-MRS System: Alternative 1

Alternative 1 is basically the reference no-MRS system described above with two general modifications that are currently envisioned as occurring independently of a decision to develop the MRS facility. One is a modification of the transportation system, and the other is increased coordination between the DOE and the nuclear utilities with respect to the management of at-reactor spent-fuel storage.

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*All projections of spent-fuel inventories in this report are based on the spent-fuel data base for 1986.[6]

The transportation modifications included in alternative 1 are increases in the capacities of the legal-weight truck and 100-ton rail casks and the use of overweight truck and 125-ton rail casks where feasible. Many of the other transportation options discussed in Section 2.2 are still under study by the DOE, and the results to date do not clearly indicate that these options will improve the performance of the transportation system. While the specific list of transportation options may not be complete, the modifications incorporated into alternative 1 are reasonably available and their effects can be predicted with reasonable assurance.

As the waste-management system is further developed and uncertainties are resolved, the effects on the waste-management system of various options for at-reactor storage will become better understood. The DOE should then be able to foster the adoption of the preferred options by the utilities and to assist in their implementation. For example, the DOE could develop specifications for dry storage and in-pool consolidation that will standardize the spent-fuel shipments received by the DOE. In alternative 1, it is therefore assumed that the DOE provides the utilities with specifications for a repository-compatible canister, as described in Section 2.1.1 (i.e., a canister that minimizes negative impacts on repository operations). This canister is assumed to be compatible with at-reactor consolidation and the existing spent-fuel-pool racks as well as the repository disposal containers. The spent fuel shipped in these canisters will require minimal handling at the repository.

It is difficult to specify how the DOE would express a preference for, or foster the use of, at-reactor options that might be beneficial to the waste-management system. However, as in the case of the transportation modifications in this alternative, the general implications of such efforts can be reasonably assessed. For the purposes of this assessment it is assumed that a few reactors choose consolidation as a means of accommodating spent fuel that exceeds their current pool storage capacity. For costing purposes only, it is further assumed that about 25 percent of the 9500 MTU requiring storage beyond the current pool capacity in the reference no-MRS system is accommodated by in-pool consolidation. As a result, about 7000 MTU still requires out-of-pool storage and about 2500 MTU is accommodated in the spent-fuel pools. With the limited space in the pools, the spent fuel in existing inventories must first be consolidated to make space for additional spent-fuel storage (regardless of whether the additional spent fuel is consolidated). Assuming a fuel-rod consolidation ratio of 2:1, that the volume of the non-fuel-bearing components is reduced by a factor of 6, and also assuming that all additional spent fuel stored in the pool is consolidated, it is necessary to consolidate approximately three times the amount of spent fuel that is added to the pool. For example, to provide in-pool storage for the additional 2500 MTU, the actual amount of spent fuel that must be consolidated is about 7500 MTU (see Appendix A for further details).

Alternative 1 was chosen because it represents the modifications that the DOE can implement in the Federal waste-management system without significantly affecting its interfaces with the utilities. This alternative still permits utilities to elect supplemental storage options that best meet their individual needs.

3.2.3 No-MRS System: Alternative 2

Alternative 2 involves the same transportation modifications as alternative 1. However, it assumes a higher level of DOE and utility integration in the management of at-reactor storage, with the DOE providing incentives and taking other actions to convince the utilities to choose options that are most beneficial to the waste-management system. For example, this alternative assumes for purposes of analysis that the DOE encourages at-reactor consolidation as a means for utilities to reduce requirements for out-of-pool storage. The canisters used by the utilities for the consolidated rods are specified by the DOE and are compatible with existing reactor-pool racks; at the repository, several canisters are loaded into specially designed disposal containers. The canisters used in alternative 2 are assumed to be basically identical with those specified by the DOE in alternative 1 (described in Section 2.1.1 as repository-compatible canisters).

In spite of the DOE's encouragement of at-reactor consolidation, most utilities are still assumed to use out-of-pool storage. In alternative 2, therefore, it is assumed that the DOE also takes action to influence out-of-pool storage, specifically by promoting dual-purpose casks (see Section 2.1.2), which are assumed to be used to provide maximum benefit. That is, at the reactors the casks are used to store spent fuel in a storage yard until the repository begins operations; the casks are then shipped directly to the repository, where they are unloaded; and finally they are integrated into the transportation cask fleet and are used to make many shipments each year, or the casks are used for lag storage at the repository.

In order to assess the cost impacts of alternative 2, it is assumed for costing purposes that the the amount of out-of-pool storage that is accommodated through in-pool consolidation increases from 25 percent to 50 percent. As a result, about 4800 MTU is accommodated in out-of-pool storage and about the same amount is accommodated by consolidating both some of the newly discharged spent fuel and some of the spent fuel already stored in the pools. As discussed for alternative 1 (Section 3.2.2), approximately three times the amount of spent fuel that is added to the pools must be consolidated to provide the needed space. Therefore, in this alternative about 15,000 MTU of the spent fuel already stored in the pools is consolidated to provide the needed space (see Appendix A for further details).

The at-reactor operations discussed above would be applied only to the spent fuel that presents a storage problem to the utility. The remainder of the fuel discharged from the reactors, which represents most of the spent fuel, is shipped to the repositories as intact assemblies. Thus, the repositories receive spent fuel in two forms: fuel consolidated in repository-compatible non-sealed canisters and intact assemblies. Because their design has been integrated with the Federal waste-management system, these canisters are encapsulated in special disposal containers as a normal repository operation. As in the reference no-MRS system, the intact assemblies are consolidated at the repositories and encapsulated into disposal containers.

Alternative 2 was selected for evaluation for two reasons. First, in comparison with alternative 1, it represents a significant increase in the involvement of the DOE in at-reactor operations. Second, this involvement is limited to storage problems that the utilities must address and is based on voluntary responses to incentives provided by the DOE. In short, in alternative 2 the DOE takes steps toward influencing the utilities, but limits its influence to problems that the utilities must in any case deal with.

Another alternative system that was considered and rejected was a system in which the DOE continues to provide incentives to utilities to persuade them to consolidate spent fuel beyond the amount required to overcome their spent-fuel storage problems. The potential benefits to the DOE would be reduced transportation requirements (since more consolidated spent fuel can be shipped in each cask) and reduced repository operations. However, in order for the benefits to be realized, a large number of reactors must consolidate a significant portion of their total spent fuel; otherwise, this alternative would not allow the elimination of consolidation at the repository. Since only about 12 percent of the projected total spent fuel from reactors has been discharged to date and less than 50 percent will be discharged by the startup of the first repository, this alternative would require at-reactor consolidation well beyond the starting date for the first repository, and the only reason for consolidating would be the incentives provided by the DOE. The results of a limited study sponsored by the DOE[5] indicate that in some cases utilities may not continue consolidation beyond their storage management needs and that utilities without storage problems are very unlikely to volunteer for consolidation in response to DOE incentives. This alternative system was therefore deemed improbable.

3.2.4 No-MRS System: Alternative 3

For this no-MRS system, it is assumed that the utilities are required to perform waste-preparation activities beyond those needed to alleviate their storage problems. This system differs from alternative 2 in that the utilities are required to perform waste-preparation activities, whereas in alternative 2 they are provided incentives to perform these activities. The institutional problems associated with this alternative as well as alternatives 4 and 5 are not addressed in this report. It is simply assumed that, because of Congressional action or some other reason, utilities are required to perform additional functions for the waste-management system.

Alternative 3 incorporates the same modifications as alternative 2 and also assumes that the DOE is authorized to require at-reactor consolidation for all spent fuel, using nonsealed repository-compatible canisters. Some spent fuel that is deemed too difficult to consolidate is excluded, as are some reactors with constraints that would preclude consolidation for licensing or economic reasons. However, most of the spent fuel is consolidated at the reactor site. Even with in-pool consolidation, some reactors will be unable to accommodate all of their spent-fuel discharges in the spent-fuel pool. It has been estimated (see Appendix A) that about 2000 MTU of spent fuel will still require out-of-pool storage. For this alternative, it is assumed that all this spent fuel is first consolidated and then placed in out-of-pool storage. As in alternative 2, the DOE also influences utility decisions about out-of-pool storage by promoting the use of dual-purpose casks; the transportation-system modifications are the same as in alternatives 1 and 2.

In alternative 3, the repository receives most of the spent fuel consolidated in unsealed repository-compatible canisters. Consolidation is no longer needed at the repositories, as the canisters received from the reactors need only encapsulation in disposal containers. Thus the surface-facility operations of the repository are reduced from those assumed in the preceding no-MRS alternatives.

3.2.5 No-MRS System: Alternative 4

Alternative 4 is very similar to alternative 3, except that the repository-compatible canisters are filled with an inert gas, welded closed, and decontaminated at the reactor sites. The functions of the repository are also similar to those in alternative 3, but sealed and decontaminated canisters are shipped to the repository, simplifying the unloading of the shipping casks and handling at the repository. Out-of-pool storage requirements are similar to alternative 3 as well.

Alternative 4 was developed because it represents the next major step beyond alternative 3 with respect to the relationship between the Federal waste-management system and utility operations. In this alternative, the reactors are producing and shipping to the repositories disposal-ready canisters, as the MRS facility would (except for the size and shape).

3.2.6 No-MRS System: Alternative 5

Alternative 5 represents the extreme case, where all the functions performed by the MRS facility are performed at reactor sites. It differs from alternative 4 in that the spent fuel is consolidated at the reactor sites into repository-specific (round) canisters, as described in Section 2.1.1. Since these canisters are not compatible with existing spent-fuel-pool racks, reracking is required to accommodate them. As in alternative 4, the canisters are filled with inert gas, welded closed, and decontaminated at the reactor sites. The functions performed at the repository are similar to those performed at the repository with an MRS facility in the system. The sealed, decontaminated canisters are unloaded, and a single canister is loaded into each disposal container and sealed.

Alternative 5 represents the maximum involvement of at-reactor operations with the Federal waste-management system--it requires the production of repository-specific disposal-ready canisters by the utilities.

3.3 EVALUATION OF REFERENCE AND ALTERNATIVE NO-MRS SYSTEMS

Section 3.2 has described a suite of alternative no-MRS systems that are based on the various spent-fuel-management options discussed in Section 2. This section evaluates each of these alternative systems individually and then compares them with the reference no-MRS system. It begins by defining the criteria used in the evaluations and comparisons.

3.3.1 Evaluation Criteria

The evaluation of the alternative no-MRS systems and the comparison with the reference no-MRS system were based on the following criteria:

- Technical feasibility: Availability and status of the technology needed for implementing the alternative.
- Effects on system development and licensing: Effects on the design and development of the total waste-management system or its elements (the repository or transportation), licensing and regulatory requirements, and public acceptability.
- Effects on system operation: Effects on the waste-acceptance schedule, the operation of the transportation system, the operation of the repository, and the overall operation and efficiency of the total waste-management system once it is implemented.
- Effects on system cost: Effects on the total-system life-cycle cost of implementing a safe and environmentally acceptable waste-management system, including at-reactor costs for alternatives involving at-reactor spent-fuel management.
- Effects on system risk: Effects on the estimated radiation exposure that may result from waste-management operations, including the exposure of both the public and the workers in waste-management facilities.

These criteria were used as qualitative measures of the overall technical, economic, and institutional feasibility of each alternative, including impacts on the utilities.

3.3.2 Alternative 1

Alternative 1 to the no-MRS system consists of various modifications to the transportation system that would reduce the number of spent-fuel shipments. Its implementation is technically feasible without the development of new technologies. There would be an improvement in the operation of the transportation system, but the effect on the operation of the total system would not be significant. System costs, including affected reactor costs, would be decreased by about \$400 to \$600 million (see Appendix A). Most of this decrease is attributable to transportation-system modifications and would also occur with an updated MRS system, as discussed later. The reduction in the number of shipments would reduce public risks for both transportation and the system as a whole, and the reduction in the exposure of the public to radiation should result in institutional advantages. Even though the use of overweight trucks might raise institutional issues and increase regulatory complexity, the overall institutional effects of this alternative are expected to be positive. No significant effect on the development of the waste-management system is expected.

In summary, alternative 1 shows some overall advantage in comparison with the reference no-MRS system and represents the current direction of the waste-management program regardless of the MRS decision (i.e., implementing modifications to from-reactor transportation as their advantages are demonstrated and continuing to support the development of various at-reactor storage options with the expectation of encouraging their implementation when, and to the extent that, such actions can be shown to be advantageous to the overall system). For a comparison of this alternative with the MRS system, see Section 5.

3.3.3 Alternative 2

This system incorporates the same transportation-system modifications as alternative 1 along with a higher level of DOE involvement in the management of out-of-pool storage, with the DOE providing incentives to utilities to choose options that are most beneficial to the waste-management system (e.g., consolidation into repository-compatible canisters and the use of dual-purpose casks for out-of-pool storage). A number of technical and institutional issues are associated with this alternative. For example, the capability of at-reactor consolidation has not been fully demonstrated. Furthermore, as discussed in Section 7, many utilities may be unwilling to assume the risks and liabilities of in-pool consolidation. Moreover, the incentives that the DOE might offer have not been established and might elicit some public opposition. The use of dual-purpose casks for dry at-reactor storage also raises some regulatory issues. While the casks appear to be technically feasible, there is a major licensing uncertainty--the uncertainty that the NRC will certify a cask for transportation after it has been used for storage for an extended period. The overall system benefits of dual-purpose casks also depend on whether these casks can be made available to the waste-management system on a timely basis (see Section 2.1.2 for details).

It is not expected that voluntary incentives provided by the DOE will significantly increase the number of utilities that choose to consolidate in comparison with the reference no-MRS system or alternative 1, and therefore the overall effects of alternative 2 on system development and operation are not expected to be significant. In terms of total-system operation, the waste-preparation functions performed at reactors should decrease the waste-handling workload at the repository, but the waste-management operations of the utilities choosing consolidation would become considerably more complicated and could interfere with normal reactor operations.

In terms of system cost, alternative 2 is expected to reduce overall costs by approximately $600-$700 million, primarily through the modifications in transportation, the same as in alternative 1. The incentive program increases at-reactor consolidation and otherwise reduces the costs of at-reactor storage. Any savings are likely to be somewhat offset by the DOE's additional administration costs for the incentive program.

In terms of system risk, alternative 2, like alternative 1, would reduce public exposure to radiation because of the decreased number of shipments. (It should be noted, however, that the exposure of the public to radiation from waste-management operations anywhere--at reactor sites, at the MRS facility, in transportation, or at the repository--would be extremely low in all cases. It would be dominated by the exposure resulting from transportation, although the exposure would be very low in an absolute sense.) However, the additional waste-management operations that would be performed at the reactor sites would increase the occupational exposure.

In summary, the potential development and operation issues that would result from an active DOE role in influencing utility storage choices do not appear to be justified by the marginal benefits. In comparison with the reference no-MRS system, the transportation modifications would produce some benefits, but the same benefits are obtained from alternative 1. Overall, the institutional problems outweigh the potential benefits, and alternative 2 is, as a result, less attractive than alternative 1.

3.3.4 Alternative 3

In alternative 3, the technical-feasibility issues are much more complex than those of the preceding alternatives--namely, the feasibility of consolidating all spent fuel at all reactor sites has not been established. In addition, substantial licensing activity for these reactor sites would be required for such extensive consolidation. Institutional issues would become considerably more significant than they are in alternatives 1 and 2 because of the requirement that utilities consolidate all of their spent fuel. In addition to problems concerning authority for compensation for at-reactor operations, alternative 3 could require legislation to make this requirement mandatory. Opposition to local waste-preparation operations can be expected at many of the reactor sites, especially as it would generate low-level waste that would not be acceptable for disposal at the repository because of its form (e.g., liquid) or composition (e.g., organic-matter content). In short, the institutional barriers associated with the DOE requiring full-inventory consolidation at reactor sites are very formidable.

In terms of effects on system development, alternative 3 entails significant issues, especially as it requires an integration of at-reactor activities with the Federal waste-management system and the development and implementation of this system at many reactor sites owned by many different utilities. The surface facilities of the repository could be simplified because of the elimination of facilities for consolidation; however, the overall system development would be complicated by more complex requirements for reactor interfaces with both the transportation system and the repository. Moreover, opposition at many locations might adversely affect the public acceptability of other portions of the total system (i.e., transportation and the repository).

In regard to system operations, alternative 3 would shift a significant waste-preparation function to reactor sites. One effect of this shift would be the complexity of coordinating operations at nearly 100 different sites. There would be commensurate reductions in the number of cask receipts at the repository and the elimination of rod consolidation operations, thus simplifying the repository surface facilities.

Many indeterminate costs would be incurred by the utilities if they undertake large-scale consolidation and canistering. Examples of such indeterminate costs are the costs of replacement power in the event at-reactor consolidation causes a forced plant shutdown, the costs of facility modification, and the costs of liability insurance. These costs, which are discussed in more detail in Appendix A, could be very significant. A rough estimate (see Appendix A) shows that they could range from $1.2 to $1.6 billion. In comparison with the reference case, this would increase total-system costs, including at-reactor costs, by $200-$700 million, although the overall effect on system costs is unclear because of the uncertainty associated with these estimates. Because in alternative 3 a significant portion of the cost of waste management would be shifted to the utilities, the costs of the Federal waste-management program would decrease by about $1.6-$1.7 billion, but the utility costs would increase by $1.9-$2.3 billion.

In alternative 3, the radiation-exposure risk to the public would be nominally decreased because at-reactor consolidation would decrease spent-fuel shipments. (As mentioned in Section 3.3.3, the exposure of the public in all cases would be very low in an absolute sense.) On the other hand, extensive at-reactor consolidation would increase the occupational risk because more workers would be involved and because at-reactor consolidation would result in more exposure to radiation than would consolidation at a centralized facility in a shielded "hot" cell equipped with remote-control equipment.

In summary, the overall feasibility of alternative 3 is significantly less certain than that of the reference no-MRS system. This alternative would represent a significant intrusion by the DOE into utility operations. The institutional problems are formidable, and opposition from both the State and the public can be expected. The licensing that would be required for each reactor site also constitutes a considerable complication. In addition, utility opposition could be widespread and strong. As a result, this alternative was judged to be highly undesirable in comparison with the preceding alternatives.

3.3.5 Alternative 4

The overall feasibility of alternative 4 is even more questionable than that of alternative 3, because of the additional at-reactor operations that would be required to consolidate spent fuel in sealed and decontaminated canisters (i.e., filling the canisters with inert gas, closing the canisters by welding, and decontaminating the canisters). All of the technical, licensing, and institutional problems of alternative 3 apply to alternative 4 as well, and there are additional difficulties. Performing these operations at reactor sites presents different technical problems from those of consolidation only, including the necessity of developing specialized equipment for welding the canisters closed, and technical feasibility on a production basis has not been demonstrated. Thus, considerable difficulty might be found in the development of the at-reactor portion of the waste-management system. Like the technical difficulties, licensing can also be expected to be more complicated and potentially affected by State and public opposition. Both State and public opposition to performing these additional operations at reactors can be expected to be greater than in alternative 3. The attitude of the utilities can also be expected to be more negative.

Like no-MRS alternative 3, alternative 4 entails significant indeterminate costs, including the considerable additional costs of seal-welding the canisters at reactor sites. The overall system costs, including the costs incurred by the utilities, are estimated to increase by \$2.0-\$2.6 billion over those of the reference no-MRS system. The costs of the Federal waste-management program are reduced by about \$1.6-\$1.7 billion, but the costs incurred by the utilities increase by \$3.7-\$4.2 billion.

In comparison with the reference no-MRS system, the additional at-reactor operations will entail the higher at-reactor occupational risk predicted for alternative 3 with further increases expected from the additional spent-fuel handling. As in alternative 3, the risk to the public is negligible.

In summary, increasing the waste-preparation functions performed at the reactor sites to include seal-welding canisters increases the negative effects of large-scale at-reactor consolidation on system development, system operations, and system cost. Thus alternative 4 is considered to be even less technically and institutionally feasible than alternative 3.

3.3.6 Alternative 5

In alternative 5, the requirement of producing sealed and decontaminated repository-specific canisters at the reactor sites presents another major technical-feasibility issue beyond those associated with alternative 4. The difficulty stems from the requirement to consolidate the spent fuel in sealed repository-specific cylindrical canisters, which are incompatible with the existing spent-fuel-pool storage racks and handling equipment. Thus, the technical feasibility of implementing alternative 5 is even more uncertain than that of alternatives 3 and 4. This alternative also presents the potential scheduling problem of specifications for repository-specific canisters not being available when the utilities start consolidation operations. Canisters of some other design would have to be used until the design of the repository-specific canisters is firmly established. In addition to technical problems, alternative 5 presents extra management difficulties imposed by the requirement for repository-specific canisters and therefore even greater opposition by the utilities can be expected. Public and State opposition would probably be the same as for alternative 4. Other licensing concerns are expected to be similar as in alternative 4.

The added burden of handling and storing repository-specific canisters increases the costs incurred by utilities beyond those predicted for alternative 4. Some reduction in repository costs is achieved through the use of the repository-specific canisters. The overall system costs, including all costs incurred by the utilities, increase by \$2.6-\$3.3 billion over those of the reference no-MRS system.

In terms of occupational exposure, alternative 5 is also less attractive than alternative 4 because the additional at-reactor operations associated with repository-specific canisters will increase at-reactor occupational exposure. Public risk would be essentially the same as in alternatives 3 and 4; as already mentioned in Section 3.3.3, it would be extremely low in an absolute sense in all cases.

Overall, alternative 5 presents the greatest number of technical, licensing, and institutional issues of all the alternative no-MRS systems analyzed and thus is judged to be the least feasible of all.

3.4 OVERALL COMPARISON

Presented below is an overall comparison of the five alternatives to the no-MRS system. Its purpose was to identify the alternative that would best meet the objectives of the waste-management system and would therefore be the more likely alternative that the DOE would pursue if the MRS facility is not approved by the Congress. This no-MRS system will be compared with the MRS system in Section 5. The comparisons presented in this section are summarized in Table 3-2.

The summary evaluations in Section 3.3 indicate that alternative 1 to the reference no-MRS system has the greatest technical and institutional feasibility. This alternative incorporates transportation modifications that reduce system costs and risks. In addition, the voluntary integration that is achieved between the DOE and the utilities improves the overall efficiency of out-of-pool storage management. Alternative 1 maintains the waste-management structure identified in the Nuclear Waste Policy Act, with the DOE providing to utilities research and development support for increasing storage capacities.

Alternative 2 increases the DOE's influence in utility out-of-pool storage to an active role of providing incentives and taking other actions to affect utility choices in the management of spent fuel. Because the choices are voluntary, the DOE's incentives are not likely to exert a significant effect on the choices of utilities; however, the system development and operations difficulties make the alternative less feasible than alternative 1 from both a technical and an institutional perspective.

Alternatives 3, 4, and 5, by requiring utilities to perform widespread spent-fuel consolidation, would produce significant negative impacts on the development, operation, cost, and overall feasibility of the total waste-management system. While the negative impacts increase with the number of operations performed at reactor sites (i.e., alternatives 4 and 5), all of these no-MRS alternatives are judged to be significantly less desirable and likely than the reference no-MRS system to meet the objectives of the waste-management system.

Overall, alternative 1, which incorporates transportation modifications and the DOE/utility integration needed to efficiently manage the utility spent-fuel storage problem, was found to be the best estimate as to how the Federal waste-management system could be improved so as to function most efficiently, effectively, and safely if an MRS facility is not included in the system.

TABLE 3-2

COMPARISON OF ALTERNATIVE NO-MRS SYSTEMS TO THE REFERENCE NO-MRS SYSTEM

System Development	System Operations	System Cost	System Risk	Technical Feasibility
No-MRS System: Alternative 1				
Minor development activities required for transportation system improvements and DOE-utility integration.	Some improvements in transportation system associated with fewer shipments.	System costs reduced by $400-$600 million due to transportation modifications.	Reduction in both public and occupational risk associated with fewer cask shipments.	No new technologies require development.
No-MRS System: Alternative 2				
Additional development required for DOE incentive program. Potential development work necessary for NRC licensing of dual-purpose casks. Public opposition to incentive program may occur.	Increased level of coordination of systems operations necessary between DOE and utilities. Minor simplication of DOE operations resulting from consolidation at reactors. Significant increase in operations at reactors that are consolidating.	System costs reduced by $600-$700 million, due to transportation modifications and dual-purpose casks.	No significantly difference from the benefits achieved in Alternative 1. Higher occupational risk associated with additional at reactor consolidation.	No new technologies require development, however, the capability of at-reactor consolidation has not been fully demonstrated.
No-MRS System: Alternative 3				
Additional development required for integration of utilities waste-preparation functions into waste-management system. Significant institutional barriers will exist with utilities and opposition is expected from a large number of affected States and localities. Legislative action would be necessary to require utilities to consolidate fuel.	Shift of waste-preparation functions from DOE to many reactor sites. Significant demands placed on at-reactor operational schedules for fuel handling and preparation. Coordination and control problems associated with consolidation at many reactor sites. Repository consolidation operations eliminated, simplifying repository operations.	Costs shift from the Federal waste-management system to the utilities. Overall system costs increase by $200-$700 million, due largely to indeterminate utility-related costs.	Further reduction in public risk due to fewer shipments associated with consolidated fuel. Occupational risk increases due to reactor consolidation.	Significant technical issues associated with widespread consolidation at reactors.
No MRS System: Alternative 4				
Same issues as Alternative 3 plus major development, licensing, and institutional issues of seal-welding canisters on a production basis at reactors.	Same issues as Alternative 3 plus difficulties associated with widespread sealing and decontaminating canisters at reactors. Higher demands placed on reactor operational schedules for the handling and preparation. Added coordination and control problems.	Similar to Alternative 3, there is a shift in costs from Federal waste-management system to utilities. Overall system costs increase by $2.0-$2.6 billion.	Same as Alternative 3 plus further increase in occupational risk due to additional handling at reactors.	Same issues as in Alternative 3 plus new technology development required for widespread sealing and decontaminating canisters at reactors.
No-MRS System: Alternative 5				
Same issues as Alternative 4 plus significant development issues at-reactors for incorporation of additional in-pool equipment and modifications for repository-specific canisters.	Same issues as Alternative 4 plus difficulties associated with widespread storing and handling of repository-specific canisters at reactors. Potentially unacceptable demands placed on reactor operational schedules for fuel handling and preparation.	Similar to Alternative 4, with overall system costs increasing by $2.6-$3.3 billion.	Same as Alternative 4 plus further increase in occupational risk due to additional complexity in handling operations at reactors.	Same issues in Alternative 4.

4. DESCRIPTION AND EVALUATION OF THE REFERENCE AND UPDATED MRS SYSTEMS

4.1 REFERENCE MRS SYSTEM

For the purposes of this analysis, the reference MRS system is the waste-management system called the "improved-performance system" in the Mission Plan[2] with the waste-acceptance schedule given in the Mission Plan Amendment.[4] It consists of geologic repositories, a transportation system, and a facility for monitored retrievable storage (MRS) that is integrated into the system. A detailed description of the MRS facility is given in the DOE's proposal to the Congress.[1] As discussed in the Mission Plan Amendment,[4] the MRS facility would start receiving spent fuel in the first quarter of 1998.

Before the start of operations at the MRS facility, a number of reactors will have spent-fuel discharges in excess of their pool capacity. With the MRS facility starting in 1998, the amount of out-of-pool storage required is significantly reduced from the 9500 MTU required in the reference no-MRS system to about 3000 MTU, distributed over about 30 reactor sites. Although it is recognized that some at-reactor consolidation may occur, in the cost analysis for this case it is assumed that no spent fuel will be consolidated at the reactors.

The MRS facility will receive and prepare spent fuel for future emplacement at the geologic repository. The spent fuel will arrive by truck or rail. The principal waste-preparation function will be spent-fuel consolidation into repository-specific canisters. After being loaded with the consolidated fuel rods, the canisters will be filled with an inert gas and closed by welding. Being uniform in size and free of surface contamination with radioactive material, these canisters will facilitate handling, shipping, and further packaging at the repository (i.e., loading into disposal containers). The canisters containing consolidated spent fuel and the non-fuel-bearing hardware removed from the spent-fuel assemblies during consolidation will be loaded into high-capacity 150-ton rail casks and shipped to the repository in dedicated trains.

The spent-fuel-consolidation operations will be performed in a specially designed waste-handling building that will also have facilities for receiving the spent fuel and for storing a limited number of canisters pending shipment to the repository. For the consolidation operations, the waste-handling building will contain "hot" cells with radiation shielding and remote-control equipment in order to protect workers from exposure to radiation. All operations at the MRS facility will be performed in a dry environment rather than under water. One of the advantages of this approach is that the outer surface of the canister produced at the MRS facility will be kept free from contamination with radioactive material.

To accommodate spent fuel received before the repository starts operating in 2003 and until the repository reaches its design throughput rate, the MRS facility will include a storage yard in which canisters of spent fuel will be stored in sealed concrete casks. The casks will allow radiation monitoring and easy retrieval for eventual shipment to the repository.

The MRS facility will operate at an estimated throughput of 2650 MTU per year for most of its operating lifetime. The total throughput is estimated at about 65,000 MTU during an operating lifetime of 31 years. The onsite spent-fuel inventory will be limited to 15,000 MTU.

4.2 UPDATED MRS SYSTEM

In order to provide an equitable basis for comparison with alternative 1 to the no-MRS system, the options reviewed in Section 2 have been assessed for potential benefits in a system with an MRS facility. This evaluation indicated that, where applicable, the modifications involved in alternative 1 to the no-MRS system would be of value in the MRS system as well. These modifications pertain mainly to the transportation system. In addition, increased coordination between the DOE and the utilities in the management of spent-fuel storage would also be beneficial.

The transportation modifications that would be beneficial to the reference MRS system are applicable to the transportation of spent fuel from reactors to the MRS facility. They include the use of overweight trucks, heavy rail casks, and increased-capacity standard-weight casks.

As in the case of alternative 1 to the no-MRS system, it is assumed that increased coordination between the DOE and utilities results in the use of limited in-pool consolidation as a means to reduce requirements for out-of-pool storage. It is assumed that about 25 percent of the 3000 MTU requiring out-of-pool storage is accommodated through in-pool consolidation. Therefore, about 2300 MTU is accommodated in out-of-pool storage and about 700 MTU is accommodated by consolidating some of the newly discharged fuel and some of the spent fuel already stored in the pools. As discussed in Section 3.2.2, approximately three times the amount of fuel that is added to the pools must be consolidated in order to provide the required space. Therefore, for the updated MRS system it is assumed that about 2000 MTU of the fuel already stored in the pools is consolidated to provide the required space (see Appendix A for further details).

The system cost and operating advantages of these modifications to the reference MRS system would be similar to those identified in Section 3 for alternative 1 to the no-MRS system. Overall system costs, including the costs incurred by the utilities, are reduced by about $300 million. Most of this saving is attributed to the transportation-system modifications. Appendix A presents the assumptions and calculations performed to estimate these cost impacts.

Both occupational and public risk would be reduced by the postulated modifications to the transportation system. As in alternative 1 to the no-MRS system, the reduction in risk is attributable mainly to the reduction in the number of cask shipments. As already mentioned, the exposure of the public to radiation from the waste-management system would be extremely low in all cases.

5. COMPARISON OF THE NO-MRS SYSTEM WITH THE MRS SYSTEM

This section compares the alternative no-MRS system with modifications for the best overall performance (i.e., no-MRS alternative 1) and the MRS system, which has been updated to include similar applicable changes. This comparison is based on the evaluation criteria described and used in Sections 3.2 and 3.3.

5.1 TECHNICAL FEASIBILITY

In the proposal to the Congress,[1] the DOE concluded that the MRS facility is feasible because it is based on established technologies and its design, licensing, and construction are typical of, but less demanding than, activities that have been well demonstrated with many other nuclear facilities. Similarly, the waste-preparation facilities in both the modified no-MRS system and the updated MRS system would use current technology that has been demonstrated. The potential modifications in transportation and utility management of at-reactor storage are equally feasible in both the modified no-MRS system and the updated MRS system.

The technical feasibility of modified no-MRS system and the updated MRS system is therefore considered to be equivalent.

5.2 SYSTEM DEVELOPMENT AND LICENSING

In comparing the system development and licensing aspects of the modified no-MRS system with the modified MRS system, a number of significant differences are found. From an overall system position, the MRS facility becomes a clear focal point for integrating all predisposal functions, including the transfer of responsibility for spent fuel from nuclear utilities to the DOE. It provides earlier experience with key institutional interactions between the DOE and State and local governments; those interactions can benefit the repository program.

Because the MRS facility can be licensed and constructed much earlier than the repository, it provides a more definitive basis for spent-fuel acceptance schedules from utilities. Also, the MRS facility lessens the likelihood that the licensing and the startup of the repository would be affected by delays in developing the predisposal functions because the MRS facility would be developed much earlier and at a site independent of the repository.

The modified no-MRS system does not provide the development and licensing benefits that would be obtained with an MRS facility in the waste-management system. The benefits provided by the updated MRS system make it clearly preferable with respect to system development and licensing.

5.3 SYSTEM OPERATIONS

As in the case of system development and licensing, the updated MRS system has distinct advantages over the modified no-MRS system with respect to system operations. From an overall system perspective, the MRS facility would provide improvements in system reliability and flexibility. These improvements would be realized by separating spent-fuel acceptance from reactors from the function of spent-fuel emplacement in the repository and also by adding significant operational storage capacity to the system. Thus it would provide flexibility to accommodate changes in the repository schedule or changes in repository operations without affecting waste acceptance. Another important improvement would be the increased control over the rate of spent-fuel transfer to the repository, which would enhance the efficiency of repository operations. In addition, the MRS facility eliminates the requirement for continued expansion of at-reactor storage capacity.

The MRS facility does require a canister in which the spent fuel is consolidated for storage and shipment to the repository; this canister provides an extra barrier for permanent waste isolation. Without the MRS facility this canister may not be required. Conversely, the MRS facility reduces surface-facility operations at the repository by providing fuel for emplacement in large rail casks containing sealed and decontaminated canisters of consolidated fuel rather than in smaller truck and rail casks containing intact fuel assemblies. In comparison with the modified no-MRS system, the updated MRS system improves the efficiency of emplacement operations by providing the capability to select fuel from the MRS facility inventory on the basis of its heat emission.

The application of the transportation improvements made in the modified no-MRS and updated MRS systems would affect operations by reducing shipment receipts at any of the DOE facilities. This would reduce facility operations for cask handling and unloading in both systems.

The above comparison of the modified no-MRS and updated MRS systems indicates that the system with an MRS facility provides major system-operation benefits.

5.4 SYSTEM COSTS

The 1987 total-system life-cycle cost (TSLCC) analysis[7] published by the DOE indicates that for the same reference-case repository-site combination (i.e., sites for the first and the second repository), the incremental cost of the reference MRS system over the reference no-MRS system ranges from $1.5 billion to $1.6 billion, depending on the repository site. The TSLCC analysis also points out that in the reference MRS system the utilities realize cost savings in at-reactor out-of-pool storage because of the earlier acceptance of spent fuel at the MRS facility, and these savings were estimated to range up to $1 billion.

As discussed in Section 3 and Appendix A, modification 1 to the no-MRS system reduces the overall system cost by about $400-$600 million, most of which is attributable to transportation modifications. Similarly, Section 4 discusses the cost benefits associated with the updated MRS system, identifying an overall system-cost reduction of about $300 million, most of which is also attributable to transportation modifications. A comparison of these estimates shows that the overall savings accruing to the modified no-MRS system are about $100-$300 million greater than the overall savings to the updated MRS system.

As a result of the modifications described in Sections 3 and 4 for the no-MRS and MRS systems, the difference in overall system costs between these systems is $1.6-$1.9 billion (versus the $1.5-$1.6 billion estimated in the 1987 TSLCC report[7]). To put this difference in perspective, the estimated life-cycle costs for the total waste-management system (TSLCC 1987) range from approximately $30 billion to approximately $38 billion, depending on the host rock and the location of the repository and depending on whether an MRS facility is included in the system. Thus, the estimated incremental cost of including an MRS facility in the overall waste-management system is on the order of 5 percent of the total-system cost. This incremental cost difference is smaller than the cost differences among repository host rocks and locations.

5.5 SYSTEM RISK

The system risk evaluated in this section refers to the public and the occupational radiation doses that would result from the spent-fuel-handling operations at the reactors, the MRS facility, surface facilities at the repository, and transportation between those facilities. The transportation improvements made to both the no-MRS and the MRS systems will contribute to the objective of keeping both public and occupational exposures to radiation as low as is reasonably achievable. The reduction in the number of shipments that results from the transportation improvements reduces the public exposure, and the corresponding reduction in handling requirements at the system facilities reduces the occupational exposure. A comparison of the modified no-MRS system with the updated MRS system indicates that the occupational exposure will be slightly higher in the updated MRS system, and the public exposure will be higher in the modified no-MRS system.

Although the updated MRS system requires a slightly larger number of shipments, the average length of each shipment is significantly shorter, and the resulting number of cask-miles and shipment-miles is significantly lower than in the modified no-MRS system. The number of cask-miles is estimated to be more than 60 percent greater in the no-MRS system. Because the MRS-to-repository shipments are made in multiple-cask dedicated trains, the number of shipment-miles in the modified no-MRS system is over 140 percent greater than that in the updated MRS system. These differences cause the increase in the public exposure that is predicted for the modified no-MRS system.

As already mentioned, the exposure of the public to radiation from waste-management activities at reactor sites, in transportation, at the MRS facility, and at the repository would be extremely low in all cases. Public exposure would be dominated by the exposure resulting from transportation, although this exposure would be very low in an absolute sense.

The radiation exposures received by the public from the MRS facility--including from normal operations, postulated accidents, and spent-fuel transportation to and from the MRS facility--are below the regulatory limits set by the Nuclear Regulatory Commission in 10 CFR Part 72 (0.025 rem annually for the maximally exposed individual for normal operations and 5 rem for any design-basis accident). The population doses are consistently estimated to be less than 1 percent of the radiation dose received by the same population group from naturally occurring background radiation. In summary, the improvements to the no-MRS and MRS systems have not significantly changed the risk comparison from that presented in the MRS proposal.[1] The occupational risk is slightly higher and the public risk is significantly lower with an MRS facility in the waste-management system.

6. VIEWS OF THE UTILITIES

Certain parties have questioned whether the construction of an MRS facility is supported by the U.S. electrical utilities. This section provides information on the views expressed by various utilities or representative groups at Congressional hearings and in other forums. It also discusses the concerns expressed by certain utilities about performing certain spent-fuel-management activities at reactor sites rather than the MRS facility.

6.1 SUPPORT FOR THE MRS PROPOSAL

In November 1985, before the MRS proposal to the Congress[1] was completed, the GAO asked the 74 utilities that either own or operate nuclear power plants for their views of the DOE's plans for an MRS facility and their plans to accommodate growing inventories of spent fuel.[8] After receiving 54 completed responses covering 71 utility companies, the GAO published the results in a fact sheet.[9] Of the completed responses, 44 percent supported an MRS facility and 31 percent opposed it, with 20 percent taking a neutral position. Almost all of the responding utilities said that they could provide storage for their spent fuel until 1998, but the provision of storage would be more difficult after 1998. If a repository is not available by 1998, 52 percent of the responses said that spent-fuel storage at an MRS facility would be preferable to at-reactor storage, and 70 percent indicated that the utility was willing to pay a share of the MRS costs.

The GAO viewed the results of this survey as indicating that the utilities' opinions vary on the need for an MRS facility. However, it acknowledged that the survey was conducted before the DOE had made its proposal and since that time nuclear-industry positions indicate "strong support for DOE's MRS proposal." In particular, the GAO mentions MRS support by the Edison Electric Institute (EEI) and notes that the EEI cites several advantages of integrating the MRS facility into the waste-management system. According to the EEI, the principal advantage is the requirement to mobilize the DOE's waste-management development efforts several years before they would be required for a system with only a repository. The GAO report says that the EEI believes this early focus is essential because of the duration and cost of the program.[10]

To better understand the views and attitudes of the utilities about spent-fuel management, the DOE in 1987 sponsored a limited study involving eight utilities that operate about 20 percent of the nuclear power plants in the United States. The results, published in a draft report,[3] outline the benefits of using a central facility, such as the MRS facility that is specifically designed for waste-management operations and economy of scale, as opposed to performing these operations at multiple reactor sites not designed for such activities.

More recently, various representatives of the utilities and/or their trade associations have explicitly supported the construction of an MRS facility in testimony at Congressional hearings. The testimony was given on behalf of the American Nuclear Energy Council, the Edison Electric Institute, the utility Nuclear Waste Management Group, and the Electric Utility Companies' Nuclear Transportation Group.[11,12]

These organizations regard the MRS facility as a vital addition to the waste-management system--and an addition that would provide a variety of benefits, such as providing needed flexibility in the planning, design, construction, and operation of the disposal system and allowing the DOE to focus its efforts more efficiently and effectively by separating the functions of waste preparation on the surface from those of emplacement underground for permanent disposal.

These organizations have also requested that the Congress act on the DOE's proposal by not only authorizing and funding the MRS facility but also by providing incentives to the host State, affected Indian Tribes, and local communities.

6.2 UTILITY VIEWS ON AT-REACTOR OPTIONS

As already mentioned, in 1987 the DOE sponsored a limited study of utility views on spent-fuel management. The eight utilities selected for this study* operate about 20 percent of the nuclear power plants in the United States and represent a wide range of experience in reactor operations and spent-fuel management. The principal purpose of the study was to ascertain attitudes and concerns about performing certain spent-fuel-management activities at reactor sites as part of the Federal waste-management system; these activities include spent-fuel consolidation and dry at-reactor storage. The results of the study are summarized below.

The interviewed utilities expressed the following general concerns about performing new spent-fuel operations at their reactor sites:

- The supervision of additional waste-management functions would distract management personnel from their responsibilities in reactor operation.
- New operations create concerns about engineering, safety, the exposure of workers to radiation, and the frequency of maintenance operations or equipment breakdowns.
- Additional spent-fuel-handling and storage-pool operations are likely to increase the efforts needed to keep the storage pools and equipment free of contamination with radioactive material.

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*The utilities interviewed in this study were the Duke Power Company, the New York Power Authority, Northeast Utilities, the Portland General Electric Company, the Public Service Electric and Gas Company, the Southern California Edison Company, Southern Company Services, Inc., and the Wisconsin Electric Power Company.

- In the event of a release of radioactive material or other incidents that must be reported to the Nuclear Regulatory Commission (NRC), it may be necessary to shut down the reactor, and downtime is of great concern: because of the need to buy replacement power, it may cost as much as $500,000 per day. In addition, the utility might be faced with adverse public reaction and an NRC fine.

In view of these concerns, the interviewed utilities felt that indemnification by the DOE would be necessary for any liability arising from DOE-mandated activities, including the reimbursement of costs of replacement power, NRC fines for operational irregularities, and the cleanup for contamination.

The interviewed utilities were also concerned about regulatory requirements and the responses of their public utility commissions (PUCs). For example, they stated that license amendments for large numbers of reactors for perhaps more than one activity or facility modification might be difficult to obtain in a timely manner; they also said that full compensation from the DOE for costs incurred would be required to satisfy PUC requirements. In addition, utilities expect varying degrees of public concern about waste-management activities not previously licensed and pointed out that a license amendment makes the local communities more conscious of the presence of a nuclear power plant.

The utilities explained that, because of the differences in physical facilities among the reactor plants, it would be difficult, and in some cases prohibitively expensive, to mandate that certain operational activities be performed by the utilities on behalf of the waste-management system. Specific concerns about rod consolidation included the following:

- Conflicts in the use of in-pool or pool-side space would arise.
- The floor-loading limits of the spent-fuel storage pools will limit the quantity of consolidated spent fuel that can be stored.
- Pool equipment is not designed for some of the operations that may be necessary, with the potential for creating operating problems.

The general attitude of U.S. utilities on performing additional spent-fuel-management activities at reactor sites was summarized at recent Congressional hearings:[11,12]

> We question whether electric utilities that operate nuclear energy plants should be required to perform functions as part of the high-level radioactive waste-disposal system. There are tremendous technical, operational, regulatory and institutional barriers to having electric utilities perform these unctions. Also, it only makes sense to concentrate these activities at a single location rather than at 72 locations across the country.

7. COST UNQUANTIFIED IN THE MRS PROPOSAL

The GAO[3] and others have stated that the cost estimates in the MRS proposal to the Congress[1] are not complete because they do not include the cost of certain elements that have been identified, but not quantified, by the DOE. These cost elements include the following:

1. Aid to affected localities for mitigating the impacts of the MRS facility.

2. Consultation-and-cooperation agreements.

3. Payments equal to State and local taxes.

4. Fees for local, State, and Federal permits and licenses.

5. Costs for transporting spent fuel from reactors to the MRS facility.

6. Costs of site acquisition.

In regard to item 4, most licensing and permit fees, which are spread over about 35 years during the licensing and operational phases, are easily covered by the 25-percent contingency established for design and operation. In regard to item 5, the costs of transporting spent fuel are more properly evaluated from a total-system perspective. Transportation costs are included in the total-system cost analyses. Costs for upgrading roads, railroads, and bridges are not appropriate since the transportation of spent fuel to and from the MRS facility will be accomplished through commercial transport; however, included in the estimate for the consultation-and-cooperation agreements is the cost of improvements in the transportation infrastructure. In regard to item 6, the DOE did provide an estimate in the MRS proposal of $2 million.

The other costs listed above (items 1, 2, and 3) were not quantified in the MRS proposal because the DOE felt that including them in the proposal was not appropriate. As explained in the DOE's comments on the GAO report,[3] such costs were not specified in the proposal "to allow the DOE flexibility in the consultation-and-cooperation process that will be initiated if Congress approves the MRS proposal." An estimate for State and local taxes (or payments in lieu thereof) was nonetheless included in the proposal documents. The DOE's comments also pointed out that some of these costs should be determined by the Congress "as a matter of national policy and of the value of the MRS to the waste management system, as opposed to a DOE estimate." However, additional information on of these costs is presented in this report.

For an MRS facility, the Act does not authorize the DOE to fund C&C agreements, make payments equal to taxes, or to mitigate impacts (except for limited impacts on public services). The authority for these expenditures would come from the legislation authorizing the MRS facility. The legislation that has been drafted for this purpose directs the DOE to "implement the monitored retrievable storage proposal and program plan submitted to the Congress in March 1987, including but not limited to provisions relating to financial assistance and measures designed to be responsive to the concerns and recommendations of the State of Tennessee and affected local governments."

In response to the above-mentioned comments, the DOE has prepared preliminary estimates of the costs unquantified in the MRS proposal. These estimates are given in Table 7-1. The assumptions on which these preliminary estimates are based are briefly discussed in the text that follows. The authority for these expenditures would come from the legislation authorizing the MRS facility. Only funds for impact mitigation have already been approved by the Congress, as they are included in the Act. Other payments to the affected State and local jurisdictions, although proposed by the DOE, are yet to be approved by the Congress. Consequently, the costs for these items may be as low as zero. The table below presents the low estimates and the estimated range of costs for the items unquantified in the MRS proposal.

Table 7-1. Estimated MRS Life-Cycle Costs

Item	Estimated cost (millions of dollars)
Impact mitigation/preoperational financial assistance	10-150
Payments equal to taxes	0-400
Consultation-and-cooperation agreements*	0-150
Total	10-700

*This item covers the special provisions discussed in Section 7.3. It should be noted that all of the items listed in this table will be included in the negotiation of consultation-and-cooperation agreements.

7.1 IMPACT MITIGATION/PREOPERATIONAL FINANCIAL ASSISTANCE

The impact aid authority in Section 141(f) of the Act is restricted to public services. More general authority is requested in Section 4.3 of the MRS proposal. During the operational phase, impact mitigation would be authorized "as under Section 116(c)(2)." For the preoperational phase, the DOE has proposed to provide financial-assistance payments to address State and local concerns regarding socioeconomic impacts.

Impact mitigation covers both direct and indirect impacts, such as postulated negative effects on tourism and industrial recruitment. The items listed below are examples of the types of programs the State, regions, or local community might implement in order to offset any indirect negative impacts. These programs are not meant to be all inclusive. They represent ideas and should be considered only as possible projects subject to applicable laws and regulations and any policy guidance that may be provided by the Congress if it decides to approve the MRS facility.

- Provide funding for the upgrading of services like sewer and water lines.
- Allocate impact-mitigation monies to area chambers of commerce.
- Fund a distinguished fellowship program.
- Fund a job-training program at local technical institutes.
- Conduct public education programs for area officials.

The MRS proposal[1] also proposes that, during the preoperational phase, financial-assistance payments be made to State and local governments to "approximate the taxes that would eventually be paid to those governments by a fully operational MRS facility valued at $1 billion." The level of preoperational assistance would be established by agreement but could range up to $15 million per year for each of the 10 preoperational years. If authorized, the life-cycle cost would be up to $150 million.

The total costs for this category would depend on the type of financial assistance approved by the Congress during the authorization of the MRS facility. Should preoperational assistance payments be approved, then impact-mitigation payments would be incorporated within those payments. Should preoperational payments not be approved, then impact-mitigation payments would be limited under Section 141(f) of the Act to mitigating public-services impacts related to the siting, construction, and operation of the MRS facility. The socioeconomic analysis contained in the MRS proposal (Volume 2, "The Environmental Assessment") indicates that expenditures for impacts defined within the limits prescribed in Section 141(f) would probably not exceed $10 million for the life of the facility.

7.2 PAYMENTS EQUAL TO TAXES

Section 4.3.2 of the MRS proposal[1] requests that the Congress authorize the DOE, during the operation of the MRS facility, to make payments equal to the taxes that State and local governments would receive if the MRS facility were treated like other real property and industrial activity. Such payments are authorized for repositories in Section 116(c)(3) of the Act.

Under existing law, MRS contractors would pay use taxes equal to the sales taxes that would be paid by a private owner. Thus, these taxes fall outside payments equal to taxes. The considerations used to arrive at preliminary estimates for the important tax-related payments are described below.

<u>Property taxes paid to local governments - $250 million</u>

If such payments are authorized, future property taxes are assumed to be bounded on the high side by a case for which current tax rates are constant and on the low side by a case for which current local government revenues are constant. Using an initial value of $1 billion for capital cost, a statutory assessment ratio of 40 percent, and an assumed straight-line depreciation to a salvage value of $250 million at the end of operation and staying constant during decommissioning, the life-cycle property taxes are about $300 million in the constant-rate case and about $150 million in the constant-revenue case. The midpoint is about $250 million.

Other taxes - up to $100 million

If authorized, this category would include State and local taxes paid on taxable activities conducted at the MRS site by the Federal Government--that is, taxes that, in the absence of sovereign immunity, would be paid by a private corporation.

When combined, the payments equal to taxes are estimated at up to $350 million. With an uncertainty of plus or minus 15 percent, the costs may be up to about $400 million over the life of the facility.

7.3 CONSULTATION AND COOPERATION (C&C) AGREEMENTS

The authority to enter into a consultation-and-cooperation (C&C) agreements with the State is derived from Section 117, which is referenced by Section 141(h) of the Act. The purpose of the C&C agreements is to resolve the concerns of the State or affected Indian Tribes regarding the "public health and safety, environmental, social, and economic impacts." In addition, the MRS proposal states that "DOE would fully reimburse the State for reasonable and direct expenses incurred in association with the MRS facility."

Steering Committee costs - up to $70 million

If the Steering Committee is authorized, it could have an independent staff. For a staff of eight to ten persons, basic office equipment and space, and the reimbursement of expenses incurred by the members of the MRS Steering Committee, the cost is estimated to range from about $500,000 to $1.5 million per year. The committee is assumed to meet over a period of 40 to 45 years, and hence the total cost would range between $20 and $70 million.

State inspection - up to $15 million

The proposal indicated receptiveness to State inspection. Depending on a number of items that would need to be discussed with the State, provision for State inspection is estimated to cost $1.5 million, from information provided by transportation specialists. The operating cost would be about $350,000 per year for 31 years, assuming three inspectors (to cover two shifts per day, 6 days per week), clerical support, and maintenance. An uncertainty of plus or minus 20 percent is assumed.

Emergency-preparedness training - up to $7 million

This estimate assumes that a five-person team travels throughout the State to conduct training programs in counties through which the spent fuel will move. The estimated cost is about $750,000 per year for the 5 years of facility construction. A higher cost estimate is also given; this estimate assumes additional training through the 31-year operating period at an annual cost of $100,000.

Improvements to the transportation infrastructure - up to $60 million

This estimate is based on ugrading the roadways affected by the MRS facility. As an example, if the Clinch River site proposed by the DOE is selected, the estimated cost ranges from $45 to $60 million. This estimate is based on estimates by the Tennessee Department of Transportation for providing four lanes and straightening State Route (SR) 58 and improving bridges. Because SR 95 is curvier and hillier than SR 58, the cost per mile for SR 95 has been estimated to cost 30 percent more than for SR 58. The cost of upgrading Bear Creek Road from its intersection with SR 95 to the Clinch River site is based on the same cost per mile as SR 58. The total cost for these projects is estimated to be about $50 million, and an uncertainty of plus or minus 15 percent is assumed.

These estimates total up to $150 million. The separate high and low estimates for each item above are added to obtain these totals.

8. CONCLUSIONS

This report was prepared to provide information to address questions raised by the General Accounting Office (GAO)[3], the State of Tennessee, and others after the submittal of the DOE's MRS proposal to the Congress.[1] The principal topics covered in this report are (1) the feasibility of achieving comparable overall waste-management performance without the MRS facility, (2) the views of the utility industry on the need for an MRS facility, and (3) estimates of costs unquantified in the MRS proposal. The principal conclusions are summarized below.

8.1 FEASIBILITY OF ACHIEVING COMPARABLE PERFORMANCE WITHOUT THE MRS FACILITY

The GAO and others have objected that the MRS proposal does not explain how the authorized waste-management system (the reference no-MRS system) could be modified to function most efficiently, effectively, and safely. Information on potential modifications to the authorized system was said to be necessary for a balanced comparison with the improved-performance system.

This report assesses the overall benefits that could accrue to the waste-management system through various modifications to the no-MRS system. Five alternative no-MRS systems were postulated by grouping together potential modifications with similar system-wide impacts. The alternative systems range from those limited to the Federal waste-management system (no-MRS alternatives 1 and 2) to those involving an increasing progression of waste-preparation functions performed at reactor sites. The extreme case (alternative 5) examines the impacts of performing at reactor sites all of the waste-preparation functions that would be performed by the MRS facility.

Each of the alternative no-MRS systems was then compared with the reference no-MRS system in terms of the following criteria: technical feasibility, effects on system development and licensing, effects on system operations, cost, and risk. The results of this comparison indicate that some potential modifications to the transportation system and the DOE's guidance to the utilities with respect to the efficient management of at-reactor spent-fuel storage would result in a no-MRS system (no-MRS alternative 1) that has some advantages over the reference no-MRS system. The transportation modifications include the use of higher-capacity standard-weight casks, the limited use of overweight truck casks, and the limited use of extra-large rail casks. The second modification entails increased participation by the DOE in providing guidance and advice to utilities in regard to at-reactor spent-fuel storage so that their technology choices are beneficial to the waste-management system. These modifications can be implemented in the Federal waste-management system without significantly affecting the DOE's interface with the utilities. These modifications would reduce the overall system costs by about $400 to $500 million and also reduce the occupational and public risk of radiation exposure.

Another alternative no-MRS system is one in which the DOE would provide incentives and take other actions to influence the utilities to choose storage options that are most beneficial to the waste-management system (no-MRS alternative 2). Two options that were considered are spent-fuel consolidation into repository-compatible canisters and the use of dual-purpose (transportation and storage) casks. Alternative 2 represents a significant increase in the integration of at-reactor operations with the Federal waste-management system. However, the evaluation of the benefits associated with this increased level of integration indicates that only marginal cost benefits beyond those predicted for alternative 1 can be expected, and these benefits are outweighed by the negative impacts associated with the intrusion of the DOE into the utilities operations.

Also examined were major increases in the levels of utility participation in the preparation of spent fuel for disposal (no-MRS alternatives 3, 4, and 5). The evaluations of each of these alternatives gave basically identical results: overall system costs would increase; significant institutional and utility opposition to widespread utility involvement in spent-fuel preparation can be expected; and substantial technical feasibility issues would need to be resolved. These alternatives were found to be less desirable than the reference no-MRS system.

No-MRS alternative 1--the system with transportation modifications and increased DOE participation in utility management of at-reactor storage--was then compared against an MRS system updated to include modifications in reactor-to-MRS transportation and increased DOE participation in utility storage choices. This comparison (Section 5) indicates that incorporating these modifications to the no-MRS system (and equally to the MRS system) would not significantly affect the conclusions reached in the MRS proposal about the need for, and the advantages of, an MRS facility. The advantages of the MRS facility, as outlined in Section 1 of this report, include improvements in system development, accelerated waste acceptance, improvements in system reliability and flexibility, simplification of repository operations, transportation improvements, and institutional benefits.

In summary, a qualitative examination of the question as to whether the advantages listed above might accrue from alternative no-MRS system configurations leads to the conclusion that no realistic combination of projected technological modifications and varying degrees of shift of waste-preparation functions from the DOE to the utilities will result in equivalent advantages or in any substantive way alter the advantages that would accrue to the waste-management system as a result of the MRS facility.

8.2 VIEWS OF THE UTILITY INDUSTRY ON THE NEED FOR THE MRS FACILITY

The case for an MRS as presented to the Congress was based on weighing benefits against costs. The benefits were judged to be sufficient to warrant the added costs relative to a no-MRS system configuration. This conclusion has been endorsed by the utility industry. Through Congressional testimony of utility representatives,[11,12] GAO findings, and the results of a limited DOE study, the following conclusions about the views of the utility industry can be made:

- The nuclear utility industry supports the need for an MRS facility in the waste-management system.
- The utility industry can and will implement technological solutions to the problem of spent-fuel management until the spent fuel is

transferred under the Act to the Federal Government. The solutions are, however, likely to vary among the utilities.

- The utilities are not inclined to commit to substantially greater waste-preparation operations at reactor sites than those required to sustain the safe operation of the nuclear power plant. This attitude stems mainly from concerns about institutional, liability, and licensing issues rather than technological concerns.

- Any waste-management option that requires extensive at-reactor consolidation or other at-reactor operations would require facility modification and/or operations that encroach on the primary function of reactors--the generation of electricity.

- Placing additional burdens on nuclear power facilities solely to decrease the costs of the government's spent-fuel disposal program would be inconsistent with the intent of the Nuclear Waste Policy Act.

8.3 COSTS UNQUANTIFIED IN THE MRS PROPOSAL

The DOE has been asked to provide estimates for certain costs that were identified but not quantified in the MRS proposal.[1] Most of these costs fall into the general categories of impact mitigation, consultation-and-cooperation (C&C) agreements, and payments equivalent to taxes.

These costs were not quantified in the MRS proposal to allow the DOE flexibility in the consultation-and-cooperation process that will be initiated if the Congress approves the MRS proposal. Furthermore, some of these costs should be determined by the Congress as a matter of national policy and of the value of the MRS facility to the waste-management system, as opposed to a DOE estimate. The authority for these expenditures would come from the legislation authorizing the MRS facility. Only funds for impact mitigation have already been approved by the Congress, as they are included in the Act. Other payments to the affected State and local jurisdictions, although proposed by the DOE, may not be approved by the Congress. Consequently, the range of possible costs for these items may be as low as zero. The table below presents the full range of estimated costs for the items unquantified in the MRS proposal.

Item*	Estimated cost (millions of dollars)
Impact mitigation/preoperational financial assistance	10-150
Payments equal to taxes	0-400
Consultation-and-cooperation agreements	0-150
Total	10-700

*It should be noted that all of the items listed in this table will be included in the negotiation of consultation-and-cooperation agreements.

8.4 SUMMARY CONCLUSIONS

This report has examined three issues related to the need for an MRS facility in the waste-management system: modifications to the no-MRS system, views of the utility industry, and unquantified costs in the DOE's proposal to the Congress.[1]

The DOE concludes that nothing in this analysis indicates the need for any substantive change in the DOE's proposal to the Congress. Technological advances being made through DOE and industry research and development programs may improve some waste-management operations, such as spent-fuel consolidation, spent-fuel storage, or transportation. These ongoing development programs were described in the DOE's proposal to the Congress and are expected to contribute to the optimization of the waste-management system. The incorporation of the expected advances into the system does not change the conclusions reached in the DOE's proposal about technical feasibility or system benefits and costs.

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11. E. M. Davis, statement on the monitored retrievable storage facility, hearing before the U.S. House of Representatives, June 11, 1987.

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APPENDIX A

DEVELOPMENT OF DETAILED COST ESTIMATES FOR NO-MRS AND MRS SYSTEMS

A.1 INTRODUCTION

This appendix contains the assumptions made and the calculations performed to estimate the cost impacts of the various alternative No-MRS and MRS systems analyzed in this report. It should be noted that the costs presented in this Appendix are preliminary estimates. Some of the equipment and operations examined in this report have not yet been designed or developed, and therefore the uncertainty in certain portions of the cost estimates is significant.

The proposed system modifications include consolidation of spent fuel at the reactor sites (at selected sites to assist utilities in meeting their individual storage needs, or at all sites to eliminate the need for a consolidation facility within the DOE waste management system), and the use of transport casks having capacities much larger than current reference casks. Other aspects examined include the cost differences associated with using dual purpose (storage/transport) casks versus using storage-only concrete casks for at-reactor dry storage. Those elements of the system life-cycle costs that are sensitive to how much consolidation is performed and to where within the system it is performed are estimated for the reference No-MRS and MRS systems and for the various alternative No-MRS and MRS systems, to permit evaluation of each system relative to each of the other systems. The cost estimates contained in this appendix are focussed on those elements of the waste system life-cycle costs that are sensitive to where within the system consolidation is performed and to how many assemblies are consolidated at any given location. Those elements of the system life-cycle costs that are not affected by these considerations (such as underground facilities and emplacement activities) are omitted from those analyses. In this regard, system development and engineering (D&E) costs were assumed to be insensitive to the various system alternatives analyzed. Also, only that fuel emplaced at the first repository is included in these analyses. As a result, the costs presented herein contain fewer elements than do the total system life-cycle costs (TSLCC) developed and reported annually by the Department. By omitting those large cost elements that are unaffected by the variations considered in this study, and by adding elements such as at-reactor storage, the sensitivities of system life-cycle costs to the proposed variations in system configuration and performance are more readily discerned and the large uncertainties associated with examining small differences between large numbers are reduced.

The system areas evaluated in this analysis of suggested system modifications, which include facilities and operations necessary for storage of spent fuel at the reactor sites, transport of the spent fuel through the federal waste management system, and preparation of the spent fuel for emplacement but including neither the actual emplacement packages nor the underground facilities and operations necessary to accomplish emplacement are illustrated in Figure A-1. The system areas encompassed by the TSLCC are also shown in the figure, to identify those areas that the TSLCC and this analysis have in common, and to illustrate those portions of the TSLCC that are excluded from this analysis, such as the emplacement activities at the first repository and the transport, preparation and emplacement activities associated with the second repository.

The reference No-MRS system cost elements are base-lined to Scenario 1 of the MRS Submission to Congress and the reference MRS system cost elements are base-lined to Scenario 4 of the MRS Submission to Congress.

The results of these analyses are summarized in Section A.2. The detailed bases and assumptions used in the analyses are discussed in Section A.3. The detailed analyses and results are presented in Section A.4. A discussion of a number of potential system costs that cannot readily be quantified is presented in Section A.5.

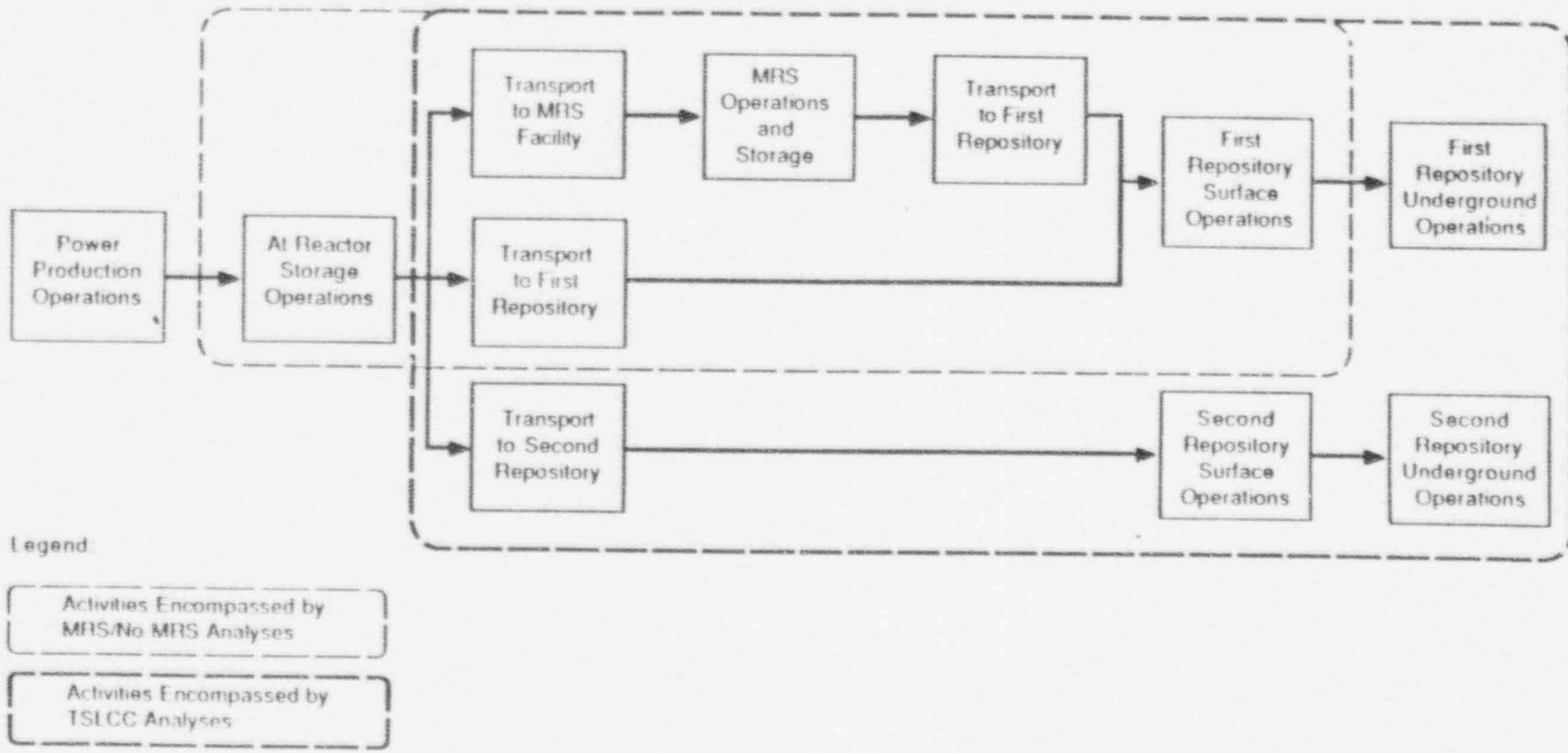

FIGURE A.1 Waste Management System Activities Encompassed By TSLCC and MRS/No-MRS Analyses

A.2 SUMMARY

The estimated life-cycle costs for packaging and transporting 65,360 MTU of spent fuel to the first repository are evaluated in this study for the reference No-MRS system, the reference MRS system, and for alternatives to those reference systems. The estimated system life-cycle costs, including both the determinate costs developed in Section A.4 and the indeterminate cost developed in Section A.5, and shipment-miles and cask-miles for these systems, are summarized for comparison in Table A-2.1. Thus, it can be seen that the alternative MRS system has fewer shipment-miles than any of the No-MRS cases, reflecting lower risk to the public from transport of the spent fuel. The total cost for the system (excluding underground activities at the repository) exhibits a very shallow minimum across Alternatives 1 and 2 where the improved cask capacities are applied. The differences in life-cycle cost between the lowest cost MRS and No-MRS systems (for the same repository) range from about $1.0 billion to $1.3 billion.

Providing at-reactor canister closure and decontamination (as in No-MRS System Alternatives 4 and 5) is clearly not cost-effective, compared to the MRS systems.

Alternatives 3, 4, and 5 also would require all reactors to consolidate, a situation that is beyond the control of DOE at the present time.

TABLE A-2.1 Comparison of the Reference and Alternative No-MRS and MRS Systems

Item	Basalt	Salt	Tuff
Reference No-MRS System			
Cost (billions 1985 $)	5.8	6.2	5.4
Shipment-Miles (millions)	86.0	58.4	80.2
Cask-Miles (millions)	86.0	58.4	80.2
No-MRS System Alt. 1			
Cost (billions 1985 $)	5.2	5.8	4.8
Shipment-Miles (millions)	39.9	27.1	37.1
Cask-Miles (millions)	39.9	27.1	37.1
No-MRS System Alt. 2			
Cost (billions 1985 $)	5.1	5.6	4.6
Shipment-Miles (millions)	38.3	26.1	35.7
Cask-Miles (millions)	38.3	26.1	36
No-MRS System Alt. 3			
Cost (billions 1985 $)	6.0-6.5*	6.5-6.9*	5.6-6.0*
Shipment-Miles (millions)	30.3	20.9	28.5
Cask-Miles (millions)	30.3	20.9	28.5
No-MRS System Alt. 4			
Cost (billions 1985 $)	7.8-8.3*	8.3-8.8*	7.4-7.9*
Shipment-Miles (millions)	30.3	20.9	28.5
Cask-Miles (millions)	30.3	20.9	28.5
No-MRS System Alt. 5			
Cost (billions 1985 $)	8.6-9.1*	8.8-9.3*	8.2-8.7*
Shipment-Miles (millions)	56.4	14.5	29.0
Cask-Miles (millions)	56.4	14.5	29.0
Reference MRS System			
Cost (billions 1985 $)	6.4	7.0	6.2
Shipment-Miles (millions)	32.2	31.7	32.1
Cask-Miles (millions)	39.6	36.5	39.2
Alternative MRS System			
Cost (billions 1985 $)	6.1	6.7	5.9
Shipment-Miles (millions)	16.0	15.7	16.0
Cask-Miles (millions)	22.0	19.6	21.4

*These costs include "indeterminate costs" which are discussed in Section A-5. These indeterminate costs may be higher than estimated herein.

A.3 BASES AND ASSUMPTIONS

The bases and assumptions utilized in the reference and alternative No-MRS systems and the reference and alternative MRS systems are presented in this section. Those bases and assumptions that are common to all systems are presented in Section A.3.1, those specific to the No-MRS systems are given in Section A.3.2, and those specific to the MRS systems are given in Section A.3.3.

A.3.1 Common Bases and Assumptions

The following bases and assumptions are common to all systems:

- All costs are developed in 1985 dollars, to facilitate comparison with the information developed in the MRS Submission to Congress (DOE 1987a).

- System life-cycle costs include: completion of maximum reracking where needed; fuel consolidation; canisters; canister closure and decontamination operations, when appropriate; dry storage of excess fuel; transport costs; and incremental repository cost differences.

- The system life-cycle throughput is 65,360 MTU of spent fuel which is 64 wt% PWR and 36 wt% BWR fuel. The average uranium content of fuel assemblies is 0.434 MTU/assembly (PWR) and 0.180 MTU/assembly (BWR). Only spent fuel and its associated hardware is included in this analysis. Shipment of process wastes other than hardware are not included.

- All cask-miles and shipment-miles calculations are made on a point to point basis using the methodology developed for the WASTES program (Shay 1986). Thus, the distances between each reactor site and the repository or the MRS are computed for each shipment. Similarly, the distances between the MRS and the repository (Basalt, Salt, and Tuff sites) are calculated using the same methodology. The WASTES methodology is also used to calculate the sizes of the cask fleets required to accommodate the postulated shipments, using cask turnaround times based on results from the transportation ALARA study (Schneider 1987).

- All pools are assumed to be re-racked to the maximum feasible capacity and are assumed to be able to accommodate canisters containing consolidated spent fuel and compacted hardware.

- Service lifetimes of the casks are 25 years (DOE 1986).

- Dual Purpose casks have capacities of 24 PWR/60 BWR intact assemblies or 40 PWR/96 BWR consolidated assemblies with compacted hardware, and cost $1.75 million without a carrier, impact limiters, etc. For transport, an additional $0.75 million will be required for these ancillary items.

- Metal storage-only casks are assumed to cost $0.08 million/MTU stored as intact assemblies and $0.053 million/MTU stored as consolidated fuel and hardware.

- Concrete storage casks are assumed to cost $0.06 million/MTU stored as intact assemblies and $0.037 million/MTU stored as consolidated fuel and hardware.

- All fuel inventory data are taken from the Spent Fuel Data Base for 1986 (Heeb 1987).

- All fuel acceptance rates and schedules are taken from the Mission Plan Amendment (DOE 1987).

A.3.2 Bases and Assumptions Specific to the No-MRS Systems

The following bases and assumptions are specific to the No-MRS systems:

Reference No-MRS System

- Dry storage at-reactor is required for 9200 MTU, none of which is consolidated. As a result of loading each cask at each site fully, the amount of fuel stored dry is 9410 MTU, distributed over 50 sites and stored in a 50/50 mixture of metal storage-only casks and concrete casks. The small amounts of fuel that might be consolidated at-reactor are neglected in the analysis of this system.

- Shipment to the repository is made in 100-ton rail casks, one cask/vehicle unit per train, via general freight, where rail shipment is possible. For those sites not rail-capable, shipment is in 25-ton truck casks, one cask/vehicle unit per shipment. The truck cask can carry two PWR or five BWR intact assemblies, and the rail cask can carry 14 PWR or 36 BWR intact assemblies.

- Fuel consolidation at the repository is into media-specific canisters or waste packages.

No-MRS System Alternative 1

- The transport cask fleet reflects designs currently being developed under the From-Reactors Cask RFP (DOE 1986). Legal weight truck cask capacities are 3 PWR/7 BWR intact or consolidated. Overweight truck cask capacities are 4 PWR/14 BWR intact or 6 PWR/14 BWR consolidated. 100-ton rail cask capacities are 21 PWR/48 BWR intact or 28 PWR/72 BWR consolidated. 125-ton rail cask capacities are 24 PWR/60 BWR intact or 40 PWR/96 BWR consolidated.

- Sites that would require dry storage for > 350 MTU in 2006 consolidate their excess fuel into square, rack-compatible canisters and store in their pools. This results in consolidation of 7400 MTU, distributed over 5 sites. The remaining sites store their excess fuel intact in dry casks. As a result of loading each cask fully at each site, the amount of fuel stored dry is 7050 MTU, which is stored in a 50/50 mixture of metal storage-only casks and concrete casks.

- All fuel consolidated at the reactor pools is placed into square canisters that are compatible with the storage racks for intact assemblies at both PWR and BWR sites. Thus, two sizes of basic canister are prepared, a PWR and a BWR size. All hardware is compacted into square canisters, with hardware from six PWR assemblies placed into one square canister and hardware from ten BWR assemblies placed into two square canisters. The resulting volume-reduction ratios are 1.5:1 and 1.4:1 for PWR and BWR assemblies, respectively.

- All canisters of consolidated fuel and compacted hardware are shipped unsealed and without decontamination.

No-MRS Alternative 2

- Cask Capacities are as given for No-MRS Alternative 1.

- Sites that would require dry storage for > 250 MTU in 2006 consolidate their excess fuel and store in their pools. This results in consolidation of 15,100 MTU, distributed over 13 sites. The remaining sites store their excess fuel (4500 MTU) intact in dry casks. To provide for the needs of the transportation system for 125-T casks, about 20 dual purpose casks, containing a total of about 200 MTU, are utilized. The balance of the fuel (4300 MTU) stored is in a 50/50 mixture of metal storage-only casks and concrete casks.

- All canisters of consolidated fuel and compacted hardware are shipped to the repository unsealed and without decontamination.

No-MRS Alternative 3

- All 65,360 MTU of spent fuel at all sites is consolidated at the reactor sites prior to shipment, into square/half-square canisters. Rods from two assemblies are placed into each full-square canister, and rods from one assembly are placed into each half-square canister, for each fuel type (PWR or BWR). The mix of full-square and half-square canisters is two half-squares to one full-square canister of fuel.

- All canisters of consolidated fuel and compacted hardware are shipped to the repository unsealed and without decontamination.

- As a result of fully loading each dry cask at each site, the total amount of consolidated fuel and hardware stored dry is 3100 MTU, distributed over 20 sites. To provide for the needs of the transportation system for 125-T casks, 10 dual purpose casks, containing about 150 MTU, are utilized. The balance of the fuel (2950 MTU) stored is in a 50/50 mixture of metal storage-only casks and concrete casks.

No-MRS Alternative 4

- All spent fuel is consolidated as per No-MRS Alternative 3.

- Dry storage requirements as per No-MRS Alternative 3.

- A pool-side device is installed to provide the capability to dry, inert, and seal-weld the closures on the canisters prior to shipment to the repository. In addition, provisions are made to decontaminate the exterior surfaces of the canisters after loading into shipping casks at the reactor sites by flowing a liquid decontamination agent of the LOMI type through the sealed casks, followed by a clean water rinse.

No-MRS Alternative 5

- All fuel is consolidated into media-specific canisters at the reactor sites prior to shipment, and are sealed and decontaminated as per No-MRS Alternative 4.

- The capacities of media-specific canisters for consolidated fuel are:

  Basalt 4 PWR/9 BWR
  Salt 12 PWR/30 BWR
  Tuff 2 PWR/5 BWR (square/half-square, one size).

- Cask capacities of the improved casks for the media-specific canisters are:

	LWT	OWT	100-T	125-T	150-T
Basalt	1/1	1/1	12/11	16/15	21/19
Salt	0/0	1/1	3/3	5/4	6/5
Tuff	1/1	2/2	14/14	20/20	37/37

A.3.3 Bases and Assumptions Specific to the MRS Systems

Reference MRS System

- Dry storage at-reactor is required for 2750 MTU of spent fuel, none of which is consolidated. By fully loading each cask at each site, the amount of fuel stored dry is about 2800 MTU, stored in a 50/50 mixture of metal storage-only casks and concrete casks, distributed over 30 sites.

- All (65,360 MTU) spent fuel is shipped to the MRS facility, using the casks specified under the reference No-MRS system.

- Consolidation of 65,360 MTU of spent fuel is performed at MRS into media-specific canisters which are sealed, inerted, and decontaminated prior to shipment. The media-specific canister capacities are:

  Basalt (4 PWR/9 BWR), Salt (12 PWR/30 BWR), Tuff (2 PWR/5 BWR).

- Shipment from the MRS to the repository is made in 150-ton steel rail casks, in dedicated trains consisting of five cask/vehicle units containing fuel and an average of about 2 additional cask/vehicle units containing canisters of compacted assembly hardware per train. The payload of each cask is the equivalent of 64 PWR or 135 BWR intact assemblies in Basalt canisters, (60/120) in Salt canisters, and (58/145) in 1 size square/half-square canisters.

Alternative MRS System

- From-reactor shipments are made in the increased capacity casks specified under No-MRS System Alternative 1.

- Sites that would require dry storage for > 300 MTU in 1997 consolidate their excess fuel into square/half-square canisters and store in their pools, resulting in consolidation of 1750 MTU, distributed over 2 sites. The remaining sites with excess fuel store their fuel intact in dry casks. By loading each cask fully at each site, the amount stored dry is 2200 MTU with about 100 MTU stored in 10 dual purpose casks and the remainder (1600 MTU) stored in a 50/50 mixture of metal storage-only and concrete casks.

- The at-reactor consolidated fuel canisters are sealed and decontaminated at MRS prior to shipment to the repository. Consolidation of the balance of the spent fuel (63,610 MTU) is performed at MRS into media-specific canisters which are sealed, inerted, and decontaminated prior to shipment.

- Shipment from the MRS to the Repository is made in 150-T uranium rail casks, in dedicated trains consisting of five cask/vehicle units containing fuel and an average of about 2 additional cask/vehicle units containing canisters of compacted assembly hardware per train. The payload of each cask is the equivalent of 80 PWR or 171 BWR intact assemblies in basalt canisters (72/150) in salt canisters, and (74/185) in single-size square/half-square canisters for tuff.

A.4 ESTIMATED COSTS FOR POSTULATED WASTE MANAGEMENT SYSTEMS

The analyses leading to the system life-cycle costs developed for the reference and modified No-MRS and MRS systems are described in this section. The costs estimated for installing improved storage racks in those pools still needing such modifications are developed in Section A.4.1. The costs for consolidation and canistering of spent fuel at the reactors are estimated in Section A.4.2. The costs estimated to provide and operate devices for sealing and inerting the consolidated fuel canisters at-reactor are presented in Section A.4.3. The estimated costs for providing exterior decontamination of the sealed canisters at-reactor are given in Section A.4.4. The estimated costs for dry storage of fuel in excess of pool rack capacities are given in Section A.4.5, for both Dual Purpose casks, for concrete casks, and for metal storage-only casks. The estimated costs for transporting the spent fuel from the reactors to the MRS facility (if appropriate) and to the repository, and the shipment-miles and cask-miles associated with each of the proposed systems are given in Section A.4.6. The estimated cost penalties associated with emplacing square/half-square canisters in the various repository media are given in Section A.4.7, and a summary compilation of all of these estimated costs for each proposed system and its alternatives is given in Section A.4.8.

The number of significant figures carried throughout the calculations in this section are for computational accuracy only, to avoid introducing significant rounding error into the final results, and do not imply a comparable precision or confidence in the values.

A.4.1 Estimated At-Reactor Reracking Costs

The costs associated with replacing current pool storage racks with maximum capacity racks at those sites where this action is needed are developed in this section.

To accommodate the heavier weight of canisters of consolidated fuel, many of the existing storage racks in the spent fuel storage pools at reactor sites will have to be replaced with stronger, neutron-absorbing racks. The estimated costs for re-racking a PWR and a BWR pool are given in Table A-4.1.

Information on pool racks contained in the Spent Fuel Data Base, maintained for DOE by PNL, suggests that of the 105 pools under consideration, 78 have either re-racked with high-density racks or plan to do so. There is no indication whether these racks will be suitable for storage of canisters of consolidated fuel. Thus, there is a range of from 27 to 105 pools that could require re-racking. For this analysis, it is assumed that 27 pools will require re-racking, with an average cost of $6.5 million each, for a total system cost of about $170 million in 1985 dollars.

For No-MRS Alternative 5, additional rack alternatives are needed at all 105 sites to accommodate temporary storage of one cask-load (125-Ton cask) of media-specific canisters. These alternatives are estimated to add about $60 million to the reracking costs, for a total of $230 million for Alternative 5.

TABLE A-4.1 Estimated Storage Pool Re-Racking Costs(a)

Item	PWR	BWR
Assumed Pool Area (sq.ft.)	1225	1000
Assumed initial capacity (assemblies/MTU)	660/360	1300/250
Re-Racked Capacity (assemblies/MTU)	1370/640	3020/580
New Rack Cost ($ million)	4.6	5.2
Licensing and Installation ($ million)	1.6	1.6
Total Estimated Cost ($ millions)	6.2	6.8

(a) Data from Table D.6, Appendix D, MRS Submission to Congress (DOE 1987a).

It may be necessary to perform a rather complex seismic/stress calculation on the re-racked pools and surrounding structures to assure that the additional weight of the canisters of consolidated fuel does not produce failure of the pool structures during a design-basis seismic event. The cost of these analyses and the costs of possible building structural reinforcements to satisfy the seismic criteria are not included in the above estimate.

A.4.2 Estimated At-Reactor Consolidation and Canistering Costs

For this analysis, it is assumed that consolidation/canistering equipment is purchased, installed, and operated in selected pools. Estimated capital and licensing costs have been reported (Beeman 1986) and are given in Table A-4.2, together with estimates of the associated operating costs. It should be recognized that these costs are highly site-specific. Experience at one site (Garrity 1984) suggests that litigation delays due to intervenors may effectively prevent a utility from proceeding with consolidation at a given site or, as a minimum, greatly increase the costs associated with obtaining the appropriate license amendments.

The 65,360 MTU of spent fuel with the characteristics postulated for this analysis (64 wt% PWR, 36 wt% BWR, 0.434 MTU/PWR assembly, 0.180 MTU/BWR assembly) consists of about 96,000 PWR and 131,000 BWR assemblies, respectively. Consolidating into the two-size square/half-square canisters, with 2 half-square canisters to each full-square canister for fuel, and all non-fuel-bearing assembly hardware compacted into square canisters (6 PWR/canister, 5 BWR/canister) results in about 72,000 fuel plus 16,000 hardware PWR canisters and 98,000 fuel plus 25,000 hardware BWR canisters, for a total of 212,000 canisters over the system life cycle. Consolidating into the single size

TABLE A-4.2 Estimated At-Reactor Spent Fuel Consolidation Costs

Item	Cost Basis	Estimated System Cost (millions of 1985 dollars)			
System		Alt 1	Alt 2	Alt 3,4,5	Alt MRS
No. of Sites		5	13	105	2
Capital Equipment	$2.5 million/site(a)	12.5	32.5	262.5	5
Licensing	$0.1 million/site(a)	0.5	1.3	10.5	0.2
Operations					
Direct Labor and Overhead	$6.30/kgU	46.5	95.1	441.8	11.0
Maintenance & Insurance	2.4% of capital cost, annually, for 16, 16, 26 and 12 years, respectively	4.8	12.5	163.8	1.9
Decommissioning	10% of capital cost	1.3	3.3	26.3	0.5
Subtotal(b)		66	145	905	19
Contingency (40%) (b)		26	58	362	7
Total Consolidation Cost (excluding canister costs)(b)		92	203	1267	26
Canister Costs					
(Square-Only)(b)		21	42	NA	
(Square/Half-Square)(b)				234	8
(Basalt)(b)				142	
(Salt)(b)				76	
(Tuff) (Single-Size/Half-Square)(b)				152	

(a) Beeman 1986
(b) Values rounded off to millions of dollars

square/half-square canisters (2 PWR/5 BWR) results in about 72,000 fuel plus 16,000 hardware PWR canisters and 39,000 fuel plus 10,000 hardware PWR canisters, for a total of 137,000 over the system life cycle. The cost of these canisters has been estimated to be $1100 each. While the PWR and BWR canisters and the square and half-square canisters differ in size, the fabrication and QA costs are judged to totally overshadow the small differences in materials costs. Therefore, a single value for all four canister sizes is a reasonable simplification.

Canister Costs

In the original MRS proposal, system costs were estimated for the three geologic-media-specific canister configurations for Basalt, Salt, and Tuff. The numbers of canisters and the associated costs for using each of these canisters and for using the one-size and two-size square/half-square canisters in the overall MRS system costs are evaluated here.

Formulae have been developed to calculate the numbers of canisters required for each canister type. These formulae have the following form:

$$\frac{\text{(No. of assemblies to consolidate)}}{\text{(No. of consol. assemblies/canister)}}\text{ fuel} \quad \text{plus}$$

$$\frac{\text{(No. of assemblies to consolidate)}}{\text{(No. of intact assemblies/canister x hardware compaction ratio)}}\text{ hdwr.}$$

In the square/half-square concepts, the fuel term is also multiplied by the following ratio:

$$\frac{\text{No. of square + No. of half-square canisters}}{\text{No. of square canisters}}$$

which in this analysis was equal to 3/2. The formulae for the various canisters are listed in Table A-4.3. The results of applying these formulae to the 96,000 PWR and 131,000 BWR assemblies assumed to be consolidated are also presented in Table A-4.3. The costs of providing these numbers of canisters are given in Table A-4.4.

TABLE A-4.3 Formulae and Numbers of Canisters Required for 65,360 MTU

Canister Type Required(b)	Formulae (a)		Numbers of Canisters(d)		
	PWR	BWR	PWR	BWR	Total
Basalt	N/3	7N/45	32,200	20,400	52,500
Salt	N/9	3.5N/75	10,700	6,100	16,800
Tuff (One-Size Square/Half-Square)	11N/12	19N/150	88,400	49,700	138,000
Two-size Square	2N/3	3.5N/5	64,300	91,600	156,000
Two-size Sq/H(c)	11N/12	19N/20	88,400	124,000	213,000

(a) Based on the consolidation and packing efficiencies discussed in Section A.4.2. N is the number of intact assemblies to be consolidated.
(b) Assumes every assembly of the 65,360 MTU system input is consolidated.
(c) Incorporates 2 half-square canisters per 1 full square canister, for fuel, and full-square canisters of hardware only.
(d) Values rounded to 3 significant figures.

TABLE A-4.4 Estimated Costs for Canister Configurations Containing 65,360 MTU

Canister Type	Number of Canisters	Cost/Canister (1985 dollars)	Canister Cost (millions of 1985$) Total Cost
Basalt	52,000	2,700	142
Salt	16,800	4,500	76
Tuff (One-Size Square/Half-Square)	138,000	1,100	152
Two-size Square	156,000	1,100	172
Two-size Sq/H	213,000	1,100	234

A.4.3 Estimated At-Reactor Canister Closure Costs

The costs associated with including canister closure and external decontamination in the MRS functions performed at the reactor site are presented below. It must be recognized that neither of these operations have been developed beyond the conceptual de sign stage. Thus, the estimated costs contain a larger degree of uncertainty than do the consolidation cost estimates.

Closure of a canister filled with spent fuel while in the storage pool includes the steps of removing the pool water from the canister, drying the canister interior and the contained fuel, evacuating and backfilling the canister with an inert gas, seal welding the closure, and leak-testing the weld. These operations require either that one end of the canister be elevated above the pool surface within a shielded enclosure or that the operations be performed in a dry underwater "bell". In either case, remote operation is required. For this analysis, a conceptual, shielded, poolside work station was assumed for these operations. A rough estimate of about $2.9 million per unit was made for the capital and installation costs of such equipment, based on preconceptual sketches. The total estimated costs associated with procuring, installing, operating, and decommissioning this equipment are given in Table A-4.5.

It must be recognized that installation of the conceptual closure equipment may not be feasible at some or many pools, due to the large weight of the shielded enclosure. If the enclosure could not be installed, construction of a small, dry hot cell might be required, with transfer casks to move the canisters from the pool to the cell. This latter concept would result in significantly higher costs and greater effort to accomplish canister closure.

TABLE A-4.5 Estimated At-Reactor Canister Closure Costs

Item	Cost Basis	Estimated Cost (millions of 1985 dollars)
Capital Equipment	105 pools @ $2.9 million	305
Licensing	105 pools @ $0.3 million	32
Operation		
Direct Labor	65,360 MTU @ $1.00/kgU	65
Overhead	40% of direct labor	26
Maintenance & Insurance	2.4% of capital cost, annually for 26 years	191
Decommissioning	10% of capital cost	31
Subtotal		650
Contingency (40%)		260
Total Estimated Canister Closure Costs		910

A.4.4 Estimated At-Reactor Canister Decontamination Costs

To provide a product comparable to that produced by the MRS facility, the sealed canisters must also be decontaminated on their exterior surfaces prior to shipment to the repository. This operation presents some interesting difficulties if attempted wit h the canisters still in the pool, since the pool water, which is normally contaminated, would have to be excluded from contacting the canister surfaces following decontamination. One approach would be to construct some kind of small hot cell at the site for performing the decontamination and subsequent loading into the shipping casks. This approach does not appear viable at most reactor sites. An alternative approach which might prove feasible is the following: The canisters are loaded into the shipping cask in the normal fashion, the cask closed and placed on a decontamination pad adjacent to the pool area. The pool water is removed from the cask interior, which is flushed with clean water. Subsequently, a stream of decontamination solution of the non-aggressive LOMI type (Bradbury 1983) is circulated throughout the cask interior for a time sufficient to remove the contaminants from the canister and cask interior surfaces. The solution is then removed, the cask interior is flushed again with clean water, drained, dried, inerted, and shipped to the repository.

Since many reactors are moving toward periodically decontaminating their primary piping systems and the reactor vessel interior using LOMI-type processes, the capability for providing and processing the decontamination solutions may be in place at many reactors when needed. If so, the incremental cost would be so small as to be negligible. However, if a dedicated system must be installed at each site to provide the solutions and provide the processing of those solutions after use, the incremental costs could be significant. Commercial systems are currently in use throughout the industry for decontaminating small segments of piping systems and portions of steam generators prior to maintenance activities. The costs of providing such a system at each of the reactor sites are estimated to be on the order of $1 to $3 million per installation, plus annual operating costs of about $50,000 over a 20-year period, for a total system cost for at-reactor canister decontamination in the range from $200 to $400 million (assume $300 million).

A.4.5 Estimated At-Reactor Dry Storage Costs

From examination of the data from the Spent Fuel Data Base (Heeb 1987), storage requirements and associated costs for casks, site alternatives, and licensing are estimated for all of the systems considered in this report.

Reference No-MRS System - Assuming the Mission Plan Amendment receipt rates and schedules (DOE 1987), the amount of fuel in excess of maximum reracked capacities peaks in the year 2006, with a total of 9200 MTU requiring dry storage, distributed over about 50 sites. For this analysis, the amount of fuel consolidated at the reactor sites is assumed to be negligible. Loading each storage cask at each site fully results in about 9400 MTU being stored. Using a 50/50 mixture of metal storage-only casks and concrete casks (@ $60,000 per MTU, ave.) the estimated cost is about $640 million. These estimates neglect any additional operating costs associated with storing and maintaining these casks on-site.

No-MRS System Alternative 1 - Sufficient fuel is consolidated at 5 sites to permit storing 25% of the total excess fuel in the pools at those sites. The balance of the excess fuel (7050 MTU) is stored in dry casks, distributed over 42 sites. Using a 50/50 mixture of metal storage-only and concrete casks, the estimated cost is about $490 million.

No-MRS System Alternative 2 - Sufficient fuel is consolidated at 13 sites to permit storing 50% of the total excess fuel in the pools at those sites. The balance of the excess fuel (4500 MTU) is stored in dry casks, distributed over 34 sites. Utilizing about 20 dual-purpose casks and a 50/50 mixture of metal storage-only casks and concrete casks, the estimated cost is $340 million.

No-MRS System Alternative 3 - Dry storage is required at about 20 sites, all of which is consolidated. Fully loading storage casks at each site would result in storing 3100 MTU. Utilizing about 10 dual purpose casks and a 50/50 mixture of metal storage-only casks and concrete casks, the estimated cost is $190 million.

No-MRS System Alternative 4 - Essentially identical with Alternative 3.

No-MRS System Alternative 5 - Since the media-specific canisters are loaded one cask-load at a time, consolidation is performed one cask load at a time. Thus, the fuel is stored intact until then, requiring approximately the same quantities of dry storage as in the reference No-MRS System, at a cost of about $640 million if a 50/50 mixture of metal storage-only casks and concrete casks are used.

Reference MRS System - With the MRS beginning to accept fuel in 1998 at the MPA rates, the quantity of fuel in excess of the maximum reracked capacities peaks in the year 1997. Loading the excess fuel intact into a 50/50 mixture of metal storage-only and concrete casks and filling each cask fully results in storing 2800 MTU distributed over 30 sites. The estimated cost is about $210 million.

Alternative MRS System - Dry storage for intact assemblies is required, at 28 sites. Filling each cask fully results in storing 2200 MTU. Storing 100 MTU in dual purpose casks and the remaining in a 50/50 mixture of metal storage-only casks and concrete casks, the estimated cost is about $180 million.

A.4.6 Estimated Transportation Costs for the Postulated Waste Management Systems

The costs of transporting the canistered spent fuel and compacted non-fuel-bearing hardware from the reactor sites to the repository were calculated using the WASTES program (Shay 1986) methodology. The criteria for acceptance for shipment from a given reactor site were: 1) the maintenance of Full Core Reserve capacity in the pool, and 2) Oldest Fuel First. The costs, cask-miles, shipment-miles, and cask fleet sizes were calculated for shipment to all three geologic media sites (Hanford, Basalt; Deaf Smith, Salt; Yucca Mountain, Tuff). The rail shipments were made in trains carrying 1 cask/vehicle unit, in general freight service.

Reference No-MRS System

Each rail cask contained 14 intact PWR assemblies or 36 intact BWR assemblies. The truck shipments consisted of single cask/vehicle units shipped in sole-use service. Each truck cask contained 2 intact PWR assemblies or 5 intact BWR assemblies. The shipping was initiated in 2003 at the rates defined in the Mission Plan Amendment (DOE 1987), and 65,360 MTU of spent fuel and associated non-fuel-bearing hardware were delivered to the first repository. The results of these calculations are shown in Table A-4.6.

TABLE A-4.6 Transportation Calculation Results for the Reference No-MRS System

Item		Basalt	Salt	Tuff
Number of Shipments	LWT	33,500	33,500	33,500
	100T	5,800	5,800	5,800
Shipment-Miles (millions)	LWT	72	49	67
	100T	14	9	13
	Total	86	58	80
Cask-Miles (millions)	LWT	72	49	67
	100T	14	9	13
	Total	86	58	80
Number of Casks in Fleet	LWT	61	41	59
	100T	32	28	31
Cask Fleet Cost (millions of 1985$)	LWT	61	48	59
	100T	80	70	78
	Total	141	118	137
Shipment Cost (millions of 1985$)	LWT	565	404	531
	100T	469	362	452
	Total	1034	766	983
Total System Transport Cost* (millions of 1985$)		1180	880	1120

No-MRS System Alternative 1

Approximately 7400 MTU (~11.3 wt%) of the 65,360 MTU system throughput is consolidated at-reactor into square canisters prior to shipment.

The casks used in the reference system are replaced with a fleet of casks having increased capacities, as given in the following listing.

Legal Weight Truck (LWT)	3 PWR/7 BWR intact,	3 PWR/7 BWR consolidated
Over Weight Truck (OWT)	4 PWR/14 BWR intact,	6 PWR/14 BWR consolidated
100-ton Rail Cask	21 PWR/48 BWR intact,	28 PWR/72 BWR consolidated
125-ton Rail Cask	24 PWR/60 BWR intact,	40 PWR/96 BWR consolidated

All shipments are made as single cask/vehicle units, in general freight service. The results of these calculations are given in Table A-4.7.

* Values rounded to tens-of-millions of dollars.

TABLE A-4.7 Transportation Calculation Results for the No-MRS System Alternative 1

Item		Basalt	Salt	Tuff
Number of Shipments	LWT	670	670	670
	OWT	14,150	14,150	14,150
	100T	440	440	440
	125T	2,930	2,930	2,930
Shipment-Miles (millions)	LWT	2	1	2
	OWT	30	20	28
	100T	1	1	1
	125T	7	5	7
	Total	40	27	38
Cask-Miles (millions)	LWT	2	1	2
	OWT	30	20	28
	100T	1	1	1
	125T	7	5	7
	Total	40	27	38
Number of Casks in Fleet	LWT	2	2	2
	OWT	23	19	22
	100T	3	3	3
	125T	17	15	17
Cask Fleet Cost (millions of 1985$)	LWT	2	2	2
	OWT	23	19	22
	100T	8	8	8
	125T	43	38	43
	Total	76	67	75
Shipment Cost (millions of 1985$)	LWT	14	11	14
	OWT	269	192	251
	100T	42	34	41
	125T	289	221	277
	Total	614	458	593
Total System Transport Cost* (millions of 1985$)		690	530	660

No-MRS System Alternative 2

Approximately 15100 MTU (~23.1 wt%) of the 65,360 MTU system throughput is consolidated at-reactor into square canisters prior to shipment in the increased capacity cask fleet. The results of these calculations are given in Table A-4.8.

* Values rounded to tens-of-millions of dollars.

TABLE A-4.8 Transportation Calculation Results for the No-MRS System Alternative 2

Item		Basalt	Salt	Tuff
Number of Shipments	LWT	670	670	670
	OWT	13,600	13,600	13,600
	100T	430	430	430
	125T	2,810	2,810	2,810
Shipment-Miles (millions)	LWT	2	1	2
	OWT	29	20	27
	100T	1	1	1
	125T	7	4	6
	Total	39	26	36
Cask-Miles (millions)	LWT	2	1	2
	OWT	29	20	27
	100T	1	1	1
	125T	7	4	6
	Total	39	26	36
Number of Casks in Fleet	LWT	2	2	2
	OWT	21	16	20
	100T	3	3	3
	125T	17	15	17
Cask Fleet Cost (millions of 1985$)	LWT	2	2	2
	OWT	21	16	20
	100T	8	8	8
	125	13*	11*	13*
	Total	44	37	43
Shipment Cost (millions of 1985$)	LWT	14	11	14
	OWT	254	179	236
	100T	41	33	40
	125T	277	211	265
	Total	586	434	555
Total System Transport Cost** (millions of 1985$)		630	470	600

*Cost of equipment for transport. Casks costed under dry storage.

**Values rounded to tens-of-millions of dollars.

No-MRS System Alternative 3 and 4

All 65,360 MTU of spent fuel is consolidated at-reactor into square/half-square canisters prior to shipment. The results of these calculations are given Table A-4.9.

TABLE A-4.9 Transportation Calculation Results for the No-MRS System Alternatives 3 & 4

Item		Basalt	Salt	Tuff
Number of Shipments	LWT	670	670	670
	OWT	11,000	11,000	11,000
	100T	330	330	330
	125T	1,850	1,850	1,850
Shipment-Miles (millions)	LWT	2	1	2
	OWT	23	16	22
	100T	1	1	1
	125T	4	3	4
	Total	30	21	29
Cask-Miles (millions)	LWT	2	1	2
	OWT	23	16	22
	100T	1	1	1
	125T	4	3	4
	Total	30	21	29
Number of Casks in Fleet	LWT	2	2	2
	OWT	21	16	20
	100T	3	3	3
	125T	11	9	10
Cask Fleet Cost (millions of 1985$)	LWT	2	2	2
	OWT	21	16	20
	100T	8	8	8
	125T	8*	7*	8*
	Total	39	33	38
Shipment Cost (millions of 1985$)	LWT	14	11	14
	OWT	217	153	203
	100T	33	27	33
	125T	185	142	178
	Total	449	333	428
Total System Transport Cost** (millions of 1985$)		490	370	470

*Cost of equipment for transport. Casks costed under dry storage.
**Values rounded to tens-of-millions of dollars.

No-MRS System Alternative 5

All 65,360 MTU of spent fuel is consolidated into media-specific canisters at-reactor prior to shipment. The results of these calculations are given in Table A-4.10.

TABLE A-4.10 Transportation Calculation Results for the No-MRS System Alternative 5

Item		Basalt	Salt	Tuff
Number of Shipments	LWT	750	0	660
	OWT	23,300	7,600	10,800
	100T	310	390	430
	125T	1,600	1,700	2,350
Shipment-Miles (millions)	LWT	2	0	2
	OWT	50	11	21
	100T	1	1	1
	125T	4	3	5
	Total	57	15	29
Cask-Miles (millions)	LWT	2	0	2
	OWT	50	11	21
	100T	1	1	1
	125T	4	3	5
	Total	57	15	29
Number of Casks in Fleet	LWT	3	0	2
	OWT	43	11	17
	100T	3	3	3
	125T	10	8	14
Cask Fleet Cost (millions of 1985$)	LWT	3	0	2
	OWT	43	11	17
	100T	8	8	8
	125T	25	20	62
	Total	79	39	89
Shipment Cost (millions of 1985$)	LWT	16	0	14
	OWT	457	107	191
	100T	30	31	40
	125T	166	130	218
	Total	669	268	463
Total System Transport Cost* (millions of 1985$)		750	300	550

*Values rounded to tens-of-millions of dollars.

Reference MRS System

All 65,360 MTU of spent fuel is shipped intact to the MRS facility where it is consolidated into media-specific canisters prior to shipment to the repository.

In the MRS system, two different transportation links are involved in delivering the spent fuel and associated hardware to the repository. The first transport occurs from the reactor sites to the MRS facility, and is performed using the same 25-ton and 100-ton casks as were utilized in the reference No-MRS analysis, with cask capacities limited to 2 PWR/5 BWR and 14 PWR/36 BWR assemblies in the truck and rail casks, respectively.

The second transport occurs from the MRS facility to the repository, and is performed using 150-ton rail casks, in dedicated trains carrying five cask/vehicle units containing fuel, and an average of about 2 additional casks containing compacted hardware, per train. The payload of each cask is the equivalent of 64 PWR or 135 BWR intact assemblies in Basalt canisters, (60/120) in Salt canisters, and (58/145) in Tuff (single-size square/half-square) canisters.

The costs of transporting the canistered spent fuel and compacted non-fuel-bearing hardware from the reactor sites to the repository were calculated using the WASTES program (Shay 1986) methodology. The criteria for acceptance for shipment from a given reactor site were: 1) the maintenance of Full Core Reserve capacity in the pool, and 2) Oldest Fuel First. The costs, cask-miles, shipment-miles, and cask fleet sizes were calculated for shipment to the MRS facility and then on to each of the three geologic media sites (Hanford, Basalt; Deaf Smith, Salt; Yucca Mountain, Tuff). The shipping was initiated in 1998 to the MRS and in 2003 to the repository, at the rates defined in the Mission Plan Amendment (DOE 1987). The results of these calculations are shown in Table A-4.11.

TABLE A-4.11 Transportation Calculation Results for the Reference MRS System

Item		Basalt	Salt	Tuff
Number of Shipments	LWT	33,500	33,500	33,500
Reactor/MRS	100T	5,800	5,800	5,800
MRS/Repository	150T	490	540	510
Shipment-Miles (millions)	LWT	26	26	26
Rx/MRS	100T	5	5	5
MRS/Repository	150T	1	1	1
	Total	32	32	32
Cask-Miles (millions)	LWT	26	26	26
Rx/MRS	100T	5	5	5
MRS/Repository	150T	9	6	8
	Total	40	37	39
Number of Casks in Fleet	LWT	28	28	28
Rx/MRS	100T	16	16	16
MRS/Repository	150T	20	20	20
Cask Fleet Cost (millions of 1985$)	LWT	28	28	28
	100T	40	40	40
	150T	55	55	55
	Total	123	123	123
Shipment Cost (millions of 1985$)	LWT	240	240	240
	100T	228	228	228
	150T	286	231	302
	Total	754	699	770
Total System Transport Cost (millions of 1985$)		877	822	893

Alternative MRS System

The cask capacities used in the alternative MRS system are: LWT (3/7); OWT (4/14) intact, (6/14) consolidated; 100-T (21/48) intact, (28/72) consolidated; 125-T (24/60) intact, (40/96) consolidated; 150-T (80/171) Basalt, (72/150) Salt, (74/185) Tuff.

The effects of using the increased capacity casks on the transport costs in the MRS system, plus the consolidation of 2.8% of the fuel at-reactor are reflected in the results of the WASTES calculations summarized in Table A-4.12.

TABLE A-4.12 Transportation Calculation Results for the Alternative MRS System

Item		Basalt	Salt	Tuff
Number of Shipments	LWT	670	670	670
	OWT	14,500	14,500	14,500
Reactor/MRS	100T	460	460	460
	125T	3,000	3,000	3,000
MRS/Repository	150T	390	440	400
Shipment-Miles (millions)	LWT	1	1	1
	OWT	12	11	12
Rx/MRS	100	1	1	1
	125T	2	2	2
MRS/Repository	150T	1	1	1
	Total	17	16	17
Cask-Miles (millions)	LWT	1	1	1
	OWT	12	12	12
Rx/MRS	100T	1	1	1
	125T	2	2	2
MRS/Repository	150T	7	5	6
	Total	23	21	22
Number of Casks in Fleet	LWT	3	3	3
	OWT	16	16	16
Rx/MRS	100T	3	3	3
	125T	11	11	11
MRS/Repository	150T	20	20	20
Cask Fleet Cost	LWT	3	3	3
(millions of 1985$)	OWT	16	16	16
	100T	8	8	8
	125T	28	28	28
	150T	15*	15*	15*
	Total	70	70	70
Shipment Cost	LWT	9	9	9
(millions of 1985$)	OWT	129	129	129
	100T	24	24	24
	125T	149	149	149
	150T	243	189	229
	Total	554	500	540
Total System Transport Cost (millions of 1985$)		624	570	610

*Cost of equipment for transport. Casks costed under dry storage.

Transportation Cost Sensitivity Analysis

Transportation cost sensitivity analyses were performed to assess the cost impacts of two transportation modifications discussed in Section 2. The first analysis examines the use of overweight truck shipments, the second examines the use of all rail shipments from the reactors. The results of these analyses are summarized below.

A sensitivity analysis was performed using the transportation calculations for the No-MRS scenario with no at-reactor consolidation, using the improved capacity casks and shipping to the basalt repository, to explore the changes in transport system costs that would result from making all truck shipments in legal weight truck casks. When all truck shipments are made using legal weight casks, the calculated cost for truck transport is about $550 million. Using overweight truck shipments from all of the truck-limited sites that can accommodate an overweight cask and using legal weight casks only at those sites that cannot handle the overweight casks, the transport costs are calculated to be about $350 million. Thus, exclusive use of legal weight truck casks from those sites limited to truck shipment would increase the transport system costs by about $200 million.

A sensitivity analysis was performed using the transportation calculations for the No-MRS scenario, using the reference casks and using the improved capacity casks, to explore the potential transport system cost savings if all fuel were shipped using rail casks. For the basalt repository (maximum shipping costs), making all shipments in rail casks, using the reference capacity casks, would reduce the transport system costs by about $200 million. Using the improved capacity casks presently under development and making all shipments in rail casks, the transport costs would be reduced by about $20 million. A review of an earlier analysis of site shipping capabilities (Konzek 1986) shows that upgrading those sites for which upgrading to rail transport appears feasible would cost at least $200 million. Thus, the upgrade costs, using the reference capacity casks, would be about equal to the transport system savings. Using the improved capacity casks, the upgrade costs would be about ten times larger than the transport system savings.

A.4.7 Estimated Cost Impacts on MRS and Repository Operations

It is anticipated that the packaging of the square and square/half-square canisters will be less efficient in the emplacement packages at the repository, and would result in an increased emplacement cost for those canisters as compared with the media-specific canisters. Estimates of these penalties were made by the repository projects during the Common Canister Study analyses (Weston 1986). Those estimates, adjusted for the slightly larger amount of spent fuel (65,360 MTU versus 62,000 MTU) considered in this analysis were:

Basalt (+ $231 million), Salt (+ $122 million), and Tuff (- $39 million)

Since Tuff has changed its configuration recently, this correction should be zero for Tuff. For those cases where small amounts of fuel are consolidated at the reactors, these estimates are scaled downward proportionately, and become:

Mod 1 (11.3 wt%) Basalt (+$26 M), Salt (+$14 M), Tuff ($0 M)

Mod 2 (23.1 wt%) Basalt (+$53 M), Salt (+$28 M), Tuff ($0 M)

Mod MRS (2.8 wt%) Basalt (+$6 M), Salt (+$3 M), Tuff ($0 M)

These estimated costs are based on the emplacement package designs that were current during the Common Canister study time period and may well change for different package designs.

The effect on the scope and cost of operations at the MRS and the repository are displayed in Tables A-4.13 and A-4.14 for the No-MRS systems and the MRS systems, respectively. For those cases where 100% of the consolidation was performed at the reactors, the costs of the consolidation function were deleted from the repository operating costs entirely. For those cases where lesser amounts (~11%, ~23% or ~3%) of the fuel is consolidated at the reactors, small reductions in consolidation costs were made to account for not having to supply canisters for that fuel as part of the consolidation operation. Since the canisters have to be closed and decontaminated at the facility (MRS or repository), the basic operating costs are unaffected.

TABLE A-4.13 Effects of Various Amounts of At-Reactor Consolidation on the Costs of Repository Surface Activities in the No-MRS System(a)

System	Cost (million $)(g)			
	Waste Handling	Balance of Plant	Emplacement Penalty	Total
Reference				
Basalt	1670	1780	NA	3450
Salt	2630	1510	NA	4140
Tuff	1740	1300	NA	3050
Alternative 1(b)				
Basalt	1650	1780	30	3460
Salt	2620	1510	10	4150
Tuff	1720	1300	0	3030
Alternative 2(c)				
Basalt	1640	1780	50	3470
Salt	2610	1510	30	4150
Tuff	1700	1310	0	3010
Alternative 3(d)				
Basalt	800	1440	230	2470
Salt	1520	1410	120	3060
Tuff	860	1200	0	2060
Alternative 4(e)				
Basalt	800	1440	230	2470
Salt	1520	1410	120	3060
Tuff	860	1200	0	2060
Alternative 5(f)				
Basalt	800	1440	NA	2240
Salt	1520	1410	NA	2940
Tuff	860	1200	NA	2060

(a) Data from spreadsheets supporting DOE 1987b.
(b) 11.3 wt% consolidated at-reactor into square canisters.
(c) 23.1 wt% consolidated at-reactor into square canisters.
(d) 100 wt% consolidated at-reactor into square/half-square canisters, unsealed.
(e) 100 wt% consolidated at-reactor into square/half-square canisters, sealed and decontaminated.
(f) 100 wt% consolidated at-reactor into media specific canisters, sealed and decontaminated.
(g) All values rounded off to tens-of-millions of dollars. Some rows may not sum exactly due to rounding.

TABLE A-4.14 Effects of 2.8 Weight-Percent At-Reactor Consolidation on the Costs of MRS and Repository Surface Activities in the MRS System(a)

	Cost (million $)(d)				
		Repository			
System	MRS Facility	Waste Handling	Balance of Plant	Emplacement Penalty	Total
Reference(b)					
Basalt	2730	800	1440	NA	4970
Salt	2730	1520	1410	NA	5670
Tuff	2730	860	1200	NA	4790
Alternative(c)					
Basalt	2730	800	1440	10	4980
Salt	2730	1520	1410	10	5670
Tuff	2730	860	1200	0	4790

(a) Data from spread sheets supporting DOE 1987b.
(b) 100 wt% consolidate at-MRS into media-specific canisters.
(c) 2.8 wt% consolidated at-reactor into square/half-square, 97.2 wt% consolidated at MRS into media-specific canisters.
(d) All values are rounded off to tens-of-millions of dollars. Some rows may not sum exactly due to rounding.

A.4.8 Summary of Estimated System Costs

The detailed cost estimates discussed earlier in this section for the No-MRS and MRS systems considered in these analysis are summarized in Tables A-4.15 and A-4.16.

TABLE A-4.15 Summary of Estimated Costs for The No-MRS Systems

Item	Estimated System Cost (millions of 1985 dollars)[(a)]					
System	Ref.	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Pool Re-Racking	170	170	170	170	170	230
Consolidation	0	90	200	1270	1270	1270
Canister Costs At-Reactor						
Square Only	0	20	40	NA	NA	NA
Square/Half-Square	0	0	0	230	230	0
Basalt	0	0	0	0	0	140
Salt	0	0	0	0	0	80
Tuff (One Size Square/ Half-Square)	0	0	0	0	0	150
At-Reactor Dry Storage	640	490	340	190	190	640
Transportation Costs						
Basalt	1180	690	630	490	490	750
Salt	880	530	470	370	370	300
Tuff	1120	660	600	470	470	550
Canister Closure	0	0	0	0	910	910
Exterior Decontamination	0	0	0	0	300	300
Repository Activities						
Basalt	3450	3460	3470	2470	2480	2240
Salt	4140	4150	4150	3060	3060	2940
Tuff	3050	3030	3010	2060	2060	2060
Totals						
Basalt	5440	4920	4860	4820	5740	6490
Salt	5840	5440	5380	5300	6210	6680
Tuff	4980	4460	4370	4400	5320	6120

(a) All values are rounded off to the tens-of-millions of dollars. Some columns may not sum exactly due to rounding.

TABLE A-4.16 Summary of Estimated Costs for The MRS Systems

Item	Estimated System Cost (millions of 1985 dollars)[a] Reference	Alternative MRS
Pool Re-Racking	170	170
Consolidation	0	30
Canister Costs At-Reactor	0	10
At-Reactor Dry Storage	210	180
Transportation Costs		
Basalt	880	620
Salt	820	570
Tuff	890	610
MRS and Repository Activities		
Basalt	4970	4980
Salt	5670	5670
Tuff	4790	4790
Totals		
Basalt	6230	5990
Salt	6870	6630
Tuff	6070	5790

(a) All values are rounded off to the tens-of-millions of dollars. Some columns may not sum exactly due to rounding.

A.5 INDETERMINATE COSTS OF WASTE SYSTEM NO-MRS ALTERNATIVES

The cost estimates in the foregoing subsections represent the definitive costs which can be estimated with reasonable accuracy based on the projected characteristics of the modified waste systems. There is, however, an additional class of system costs associated with system alternatives or new construction that cannot be fully quantified until both the system alternatives themselves and their interfaces with industrial, financial and governmental segments of the economy have been defined and evaluated.

The additional, "indeterminate" costs considered in this section are those which could, and likely would, be introduced by Federal imposition of responsibilities on utilities, impact mitigation payments, etc., which would be chargeable to the Nuclear Waste Fund.

It is normal practice in preparing cost estimates of large projects to allow for these indeterminate costs by including a contingency, usually expressed as a percentage of the total determinate costs. The size of the contingency is dependent on the degree to which the system can be defined. As the project development progresses and its system characteristics and interfaces become better known, some of the "indeterminate" costs can be identified and included in the definitive cost estimate; thus, a smaller contingency may be used at that point.

In the case of alternatives to the No-MRS system, the problem becomes more complicated. System alternatives take the form of alternatives at a large number of reactor sites, each of which may react differently with interfacing sectors of the national economy. Projection of the ancillary costs associated with projects of this nature becomes much more difficult.

The likely categories of indeterminate costs which may be experienced in alternatives to the No-MRS system are discussed in the following subsections, and approximate ranges of the cost impacts which might occur system-wide are estimated for each system modification included in this report, based on available information and engineering judgment. The magnitude of these cost effects can be expected to vary from reactor to reactor, and some may vary in magnitude from one year to the next. Furthermore, cost estimates could not be developed at this time, without added information, for several cost categories that could potentially add significantly to total costs. Thus, the system cost range projections given should be viewed only as first-order, system-wide estimates, and as probably lower than actual costs could be.

Cost ranges for the categories considered are discussed below. They are summarized in Table A-5.3, at the end of this subsection.

A.5.1 Replacement Power Costs

A major characteristic of the alternatives considered for the No-MRS system involves the progressively more intensive in-pool fuel handling and packaging operations at the reactor sites. These operations take up increasing proportions of the time available for use of the storage pools between refuelings of the reactor cores. Under these conditions, even minor scheduling delays in these operations at a reactor could delay the start of refueling operations, and thus extend the scheduled fueling shutdown of the reactor. These delays could arise from minor malfunctions that delay access to the pool to major mishaps including possible radioactive releases or major equipment breakdowns that result in suspension of pool operations.

Interferences such as this could even precipitate NRC-ordered shutdowns until the interference with operations is removed. At an individual reactor, such delays could extend from minimal times to several days or even weeks; system-wide, the delays might average from a small fraction of a day to one day per reactor per year.

An electric utility is obligated to meet the demands for electric power which are imposed upon it. Loss of generation from a reactor (as from any generating unit) must therefore be made up by replacing it with power generated elsewhere, either from another unit in the same utility or by purchase from another utility. Typically, this replacement power commands a premium price, considerably above that for power normally produced by the unit that is out of service. Thus, the costs of replacement power can mount quickly. McLeod 1987 has estimated these replacement power costs to range from $200,000 to $800,000 per day, averaging about $400,000 per day. The NRC periodically publishes compilations of replacement power costs for differing areas of the Unit ed States.

Over the lifetime of spent fuel consolidation operations in the system, the costs for replaced power from such reactor shutdowns can become significant. For example, assuming that 100 reactors undertake consolidation operations and that outages resulting from such interference with normal operations average 0.3 days per reactor per year, the total costs for replacement power could range from $150 million to $600 million, with an average value of $300 million. If the forced delays averaged one day per reactor each year, costs could be as high as $2 billion.

Interference with reactor operations would be increasingly likely as the fraction of fuel consolidated increases or when the handling operations become more complex. It is increasing likely, therefore, that additional waste management activities, such a s at-reactor canister closure and decontamination or the use of large, round, repository-specific canisters, would interfere with power production. Thus, the $150-600 million cost range estimated for full consolidation would drift higher when the additional responsibilities are imposed. While these costs cannot presently be quantified, the ranges of increased costs indicated in Table A-5.3 for these situations appear reasonable based on engineering judgment.

A.5.2 Federal Cost Obligations from Use of Dual-Purpose Casks

Alternatives 2 through 5 to the reference No-MRS system involve, among other things, the inducement of utilities to use dual-purpose casks "to their maximum benefit". For purposes of this analysis, the "maximum benefit" is assumed to be achieved when the dual-purpose casks are purchased from the utilities for use in transportation, eliminating the need for DOE to purchase an equal number of the 125-ton dedicated shipping casks, which are assumed to be identical in design to the dual purpose casks. Costs were explored for cases involving more intensive use of dual-purpose casks, up to a mandated 100% usage for all storage and shipment functions. However, the high costs of using casks qualified for shipment, but used only for single trips without re-use, would result in inordinately high system costs. Therefore, the use of these casks in numbers beyond those which could be assimilated into the transportation fleet was not considered.

Direct Assimilation of Casks Into Transportation Fleet

Transportation analyses for the waste system indicate that up to 20 of the 125-ton casks can be effectively used in the transportation fleet, if purchased at the right times. These casks, licensed for transportation, are assumed to cost $1.75 million each. The added equipment needed for transport (including impact limiters, personnel barriers, and rail cars) would cost an additional $750,000 for each cask; it is assumed that DOE would furnish this equipment directly. Thus, up to $50 million would be involved in the purchases and equippage. The DOE could save an equivalent amount by avoiding the purchase of an equal number of dedicated casks of the same capacity for the transportation fleet. However, a program would need to be implemented for assuring the expedited recertification of the dual-purpose casks for transportation use following the storage period. This program, involving demonstrations of adequacy for transportation use in lieu of normal recertification, is estimated to involve development costs of about $10 to $15 million.

It is assumed that the technology involved in cask recertification would be based on state-of-the-art techniques such as ultrasonic imaging. This technique is used, among other applications, in NRC-required inspection of reactor pressure vessels for assessment of integrity, for similar assessments of industrial pressure vessels, for "viewing" in liquid sodium-filled vessels, and for assessment of integrity and bearing capability of support columns in buildings undergoing renovation. It could be a likely candidate for cask recertification inspections. It is assumed that the techniques used, possibly including an ultrasonic imaging technique combined with other automated techniques, could be applied to verify both integrity of the cask and elasticity of the lid seals (therefore confirming ability to maintain a tightly-sealed condition).

The ultimate process chosen would need to compete economically with the manual processes of unloading the casks, performing the required examinations, and reloading; these are estimated at about $4.00 per kgU (intact fuel), or about $40,000 per cask. Additional costs may accrue because of competition for pool operations among the various tasks of reactor operation and of fuel consolidation and packaging. However, for this report, the automated inspection is assumed to be competitive with manual inspect ion and to cost about $40,000 per cask. An additional $2500 per cask in NRC fees would be required.

For the assumed use of 20 dual-purpose casks, the costs of recertification would thus amount to about $1.5 million, in addition to the $10-$15 million development cost.

A.5.3 Costs Associated with Mandated Facility Alternatives

Alternatives 3 through 5 to the reference No-MRS system involve Federally mandated fuel preparation functions including near-universal fuel consolidation, closure and decontamination of canisters, and use of large, repository-specific canisters at the reactors. The costs associated with these functions were included in earlier paragraphs, including capital costs of the required equipment and the operating costs involved.

The performance of these additional functions at-reactor would also involve alternatives to the reactor pools and associated structures and equipment. Costs for these alternatives, in a mandated situation, would be chargeable to the Waste Fund. Approximate costs for the majority of these activities were included in the costs estimates in Subsection A.4.

However, two cost categories cannot be definitively evaluated within the scope of this analysis. These are the costs of strengthening pool structures to safely carry the weight of a full load of consolidated fuel, and the more localized strengthening required to support the equipment for in-pool canister closure (the equipment for each pool is estimated to weigh about 25 tons). Added to these costs would be the costs, at each site involved, of the complex seismic/stress analyses required. Any pool modifications required, and the costs involved, are highly site-specific and must be determined by the detailed structural/seismic analyses as noted. Therefore, although the costs involved in these categories may be significant, no estimate could be developed.

A.5.4 Added Tax Payments by Utilities

The consolidation, packaging and storage of spent fuel at-reactor would result in significant additions to the capital valuation of the nuclear power plants and to annual expenses incurred at the plants, as indicated in Section A.4. The utilities performing these operations would be subject to added taxation by states and local jurisdictions based on the additional work performed.

The levying of taxes will vary considerably from state to state because of the wide variances in tax bases and differing financial structures among power plant owners. For illustrative purposes, taxes were assumed to be based on a property tax of 40 mills (4%) annually per (undepreciated) dollar of added capital valuation at the reactors for performance of the additional fuel preparation activities. Valuation bases for estimation of the tax levies and insurance premiums (following paragraph) were taken from Subsection A.4 and are summarized in Table A-5.1.

The tax levy would, in this illustrative example, be applied both to the plant capital additions associated with spent fuel handling and packaging, and on capital additions to make provision for out-of-pool dry storage of fuel. The estimates of taxes are based on estimated storage requirements and costs given in Subsection A.4.5.

The dry storage methods assumed for at-reactor storage are 1) storage-only casks, consisting of a 50%-50% mixture of steel and concrete storage casks throughout the system, and 2) dual-purpose casks, steel casks which are initially used for at-reactor storage and later are incorporated into the Federal fleet of spent fuel transport casks. While the illustrative 40-mill levy is assumed to be applied to all such casks while in service at the reactor sites, there is considerable uncertainty as to how long these casks would be in use at a site. Once the repository has commenced acceptance, it is assumed that DOE would want to convert any dual-purpose casks in storage service to transportation service as soon as feasible. It is likely that use of these casks at a utility site would involve a DOE-utility agreement for their early conversion to transport service. On the other hand, a utility would resist delivering fuel that they had stored in a storage-only cask, preferring instead to ship spent fuel from the storage pool, to make room for more freshly discharged fuel. For purposes of this estimate, the storage-only casks were assumed to have an average at-reactor service life of 15 years; the dual-purpose casks were assumed to have an average at-reactor service life of 5 years. The plant capital additions used in fuel handling and packaging have an estimated service life of 26 years. The amounts of estimated tax payments on capital additions to storage, detailed in Table A-5.2, range from a maximum of about $384 million for the No-MRS reference case and Alternative 5, to $112 million for No-MRS Modification 3 and 4, in which all fuel was assumed to be consolidated and dry storage needs markedly reduced. The reference MRS case was estimated to incur storage taxes of $125 million, and for MRS Alternative 1 the estimate was $107 million.

The tax payments indicated in Table A-5.2 are included in the summary of indeterminate costs given in Table A-5.3.

A.5.5 Liability Coverage for Utilities

Utility representatives, in recent Congressional testimony and in other communications, have made it clear that their utilities would expect full indemnification for any liabilities they might be exposed to in performance of work required by the Federal government. This would include not only indemnification against liability from accidents arising from these operations, but defense against and reimbursement for NRC fines, PUC actions, etc., relating to the mandated work. Support for public relations activities and legal defense against intervenors and others could also logically be included.

It has been traditional in proximal cost estimates for nuclear facilities to allow 0.45% of the plant capital cost as an annual insurance premium cost. This amount is assumed to cover industrial property and liability insurance as well as nuclear liability insurance. The addition of responsibility for consolidation of fuel and canister preparation at reactors, while it introduces additional risks, is not likely to affect the balance between capital expenditure and insurance premium costs inferred by the 0.45% relationship. The added operational liability associated with possible NRC fines and other contingencies cannot be estimated at this time, and hence is marked "indeterminate".

A.5.6 Summation of Indeterminate Costs

As was noted in the preceding discussion, several of the categories of indeterminate costs cannot be estimated even as cost ranges at this time. Those which can be estimated, however, could add significantly to the definitive costs discussed in Subsection A.4. As shown in Table A-5.3, the range of added costs for Alternative 2 of the No-MRS system is only from $231 to $236 million. However, with increased responsibility for at-reactor functions (Modification 3 to 5), the additional costs can range from $1 billion to over $2 billion, and could go markedly higher. Cost ranges for the various modifications are given in the Table. Under appropriate conditions the cost categories marked as "indeterminate" in the table could of themselves provide significant additions to those costs estimated.

Table A-5.1 Estimates of Increased Capital Valuation

Costs in millions of dollars[a]

Cost Item		No-MRS Modification						MRS Mod.	
Pool Reracking		Ref	1	2	3	4	5	Ref	1
(Sect. A.4.1):									
Plant Capital Additions					170	170	170		
At-Reactor Dry Storage									
(Table 5.2)									
Capital Costs		640	490	340	200	200	640	210	180
Consolidation									
(Table A-4.2)									
Capital Equip	263								
Licensing	11								
40% Contingency	109								
Total	383			380	380	380	380		
Canister Closure									
(Table A-4.5)									
Capital Equip	309								
Licensing	32								
40% Contingency	136								
Total	477					480	480		
Decontamination Equip						200	200		
(Sec. A.4.4)									
Total Capital Valuation		640	490	720	750	1430	1870	210	180

(a) All values are rounded off to the tens-of-millions of dollars. Some columns may not sum exactly due to rounding.

Table A-5.2 Estimates of Tax Payments on At-Reactor Dry Storage Capital Costs

Costs in millions of dollars[a]

No-MRS Mod	Dry Storage (MTU)	Storage Capital Value	Tax Payments on Cask Type: Storage	Dual P.	Total
Ref.	9400	640	380		380
Mod. 1	7050	490	290		290
Mod. 2					
Stg. Casks	4300	320			
D. P. Casks	200	20			
Total	4500	340	190	7	200
Mod. 3 and 4 (Consolidated fuel)					
Stg. Casks	2950	180			
D. P. Casks	150	10			
Total	3100	190	110	4	110
Mod. 5 (Same Reqts as Ref. Case)	9400	640	380		380
MRS Mod:					
Ref.	2800	210	130		130
Mod.1	2200	180	117		110

(a) All values are rounded off to the tens-of-millions of dollars. Some columns may not sum exactly due to rounding.

TABLE A-5.3

Indeterminate Costs in No MRS System Activities

Costs in millions of dollars[a]

Cost Item	Estimated Costs for System Modification:								
	No MRS Cases						MRS Cases		
CASE:	Ref.	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Ref	Alt 1	Cost Components
Replacement Power Costs (a)				150-600	250-750	300-800			Replacement costs for power lost in extended outages
Use of Dual-Purpose Casks									
Assimilation into Transportation Fleet			10-20	10-20	10-20	10-20			Expedited licensing program; automated inspection
Facility Modification Costs				(Indeterminate)					Analysis and strengthening of pool structures
Tax Obligations (b)									
Added Plant Capital				790	1280	1280			40 mills (4%) annually on increased capital valuation
Storage Capital Costs	380	290	200	110	380	380	130	110	

TABLE A 5.3 (Con't)

Indeterminate Costs in No MRS System Activities

Costs in millions of dollars[(d)]

Cost Item	Estimated Costs for System Modification:								
	No MRS Cases						MRS Cases		
CASE:	Ref.	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Ref	Mod 1	Cost Components
Added Liability Insurance Premiums [(c)]									
Plant Additions				90	140	140			Increased liability premium (c)
Storage Casks	30	20	20	10	10	30	10	10	
Other liabilities		(Indeterminate)							NRC fines, adverse PUC actions, defense against intervenors, etc.
TOTALS	410	310	230-240	1160-1620	2090-2590	2150-2650	130	110	

(a) Cost ranges for estimated "average" loss of operating time. Upper-range outages could result in replacement costs of $2 billion or more.

(b) Taxes assumed to be levied annually at 40 mills (4%) per dollar of capital additions.

(c) Liability premiums based on added capital values to plant and to storage facilities as shown in Section 4. Annual premiums based on 0.45% of capital valuation.

(d) All values are rounded off to the tens of millions of dollars. Some columns may not sum exactly due to rounding.

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Appendix B

DESCRIPTION AND EVALUATION OF POTENTIAL MODIFICATIONS TO THE WASTE-MANAGEMENT SYSTEM

A number of questions have been raised concerning alternatives for the handling, packaging, storage and transportation of spent fuel which could be utilized in the reference no-MRS system, potentially improving the performance of that system.

The potential modifications can be grouped in four main categories:

- Expanded storage at reactor sites
- Transportation modifications
- Use of Federal Interim Storage (FIS)
- Expanded lag storage at the repository

The MRS proposal to the Congress includes a complete description and evaluation of most of the potential modifications available in the groups listed above. These descriptions and evaluations are contained in Appendix A and Appendix D to Volume II of the MRS proposal to the Congress. During the period since the preparation of the MRS proposal, additional information has become available from a number of the DOE and DOE-utility waste-management research and development programs.

This appendix reviews the potential modifications that have been described and evaluated in the MRS proposal and provides additional information that has become available on these potential options. This appendix also contains a description and evaluation of a few potential modifications that were not included in the MRS proposal.

B.1 REVIEW OF POTENTIAL MODIFICATIONS EVALUATED IN THE MRS PROPOSAL

As mentioned, Appendix A and Appendix D of Volume II of the MRS proposal evaluate many potential modifications to the waste-management system. The potential modifications that were evaluated fall into the following categories:

- Expanded lag storage at the repository to provide a buffer between waste acceptance and waste emplacement.
- Expanded storage at reactor sites, either by adding modular dry storage or in-pool consolidation of spent fuel, to provide contingency storage if repository operations were delayed.
- The use of larger shipping casks and multicask shipments, thereby increasing the tonnage per shipment and reducing the number of separate shipments.

The summary conclusions determined in the MRS proposal with respect to these potential modifications are provided below.

Expanded at-reactor storage to provide a system contingency in case of changes in the scheduled startup of the repository is a viable modification. There are two general ways that at-reactor storage can be expanded: by providing dry storage; or by consolidating the spent fuel to increase the capacity of the existing storage pool. The former is the more costly. The latter would necessitate the development and execution of contractual agreements between the DOE and each participating utility that would encompass such areas as responsibilities, liabilities, licensing, facilities, staffing, and costs. There is no assurance that any utilities will be interested or willing to participate in such arrangements.

Modifications to the transportation system (i.e., using larger casks and multicask shipments) could be implemented to reduce the number of cross-country shipments and lower overall transportation impacts because of the reduced number of shipment-miles. However, implementing some of these options would necessitate upgrading facilities and equipment at many reactors. The cost of these modifications cannot be assessed at this time because of the site-specific character of the at-reactor upgrading, and because some institutional interactions would be required for most of the modifications. Implementing multicask shipments from reactors would generally increase scheduling difficulties and transportation cost due to the increase in nontransport time for the casks.

Expansion of lag storage at the repository would provide the operational decoupling that the MRS facility provides, i.e., it would allow independent operation of acceptance and emplacement and would thus improve the reliability and efficiency of the system. It would not, however, separate the development of the waste acceptance, transportation, and packaging functions from the repository development process (site selection, characterization, licensing, and construction) since all of the repository facilities are subject to a common (10 CFR 60) license. Consequently, this option would not allow the early and increased spent-fuel receipt that the MRS facility provides. The cost of adding storage at the repository site is assumed to be identical to the cost of adding storage at the MRS site. This option would not, by itself, provide any benefits to the transportation function.

B.1.1 Expanded Storage at Reactor Sites

Expanding storage capacity at reactor sites could provide the contingency storage that would be needed if the repository is delayed. Three methods for expanding storage capacity at reactors are available: reracking for high-density storage, fuel consolidation, and dry storage. The first two involve expanding in-pool capacity, while the last requires storage outside of the pool. For this analysis, it is assumed that all reactors have been reracked to the maximum extent possible. Consequently, this option will not be discussed further.

B.1.1.1 Modular Dry Storage

Spent fuel that exceeds in-pool capacity could be stored in dry storage modules that are kept at the reactor site. Dry storage methods include metal casks, drywells, silos, and vaults. These methods are described in Appendix D of Volume II of the MRS proposal together with their relative costs. Typically, dry-storage methods at reactors are more costly on a per-kilogram of contained uranium (kgU) basis than in-pool consolidation.

B.1.1.2 Spent-Fuel Consolidation and Canistering

Spent-fuel consolidation is the process of separating the fuel-bearing components (spent-fuel rods) from the nonfuel-bearing components (assembly hardware) and placing the rods into a canister in a more compact array, thus reducing the space required to store spent-fuel rods by about one-half. Consolidation can also be used to provide a more compact waste form for dry storage (e.g., casks) as well. At-reactor consolidation is generally considered as a means to alleviate the spent-fuel storage problem at reactor sites; however, it has also been suggested as an alternative to consolidation in the federal portion of the waste-management system. There are three alternatives for at-reactor consolidation and canistering:

- At-reactor consolidation into a utility-selected canister.
- At-reactor consolidation into a repository-specific canister.
- At-reactor consolidation into a repository-compatible canister that is also compatible with reactor pool racks.

The utility-selected canister could, and likely would, be different in size from reactor to reactor, resulting in a variety of canisters that would not fit together well within the repository-specific disposal container. The repository-specific canister may not be identified until after a significant amount of spent fuel will have been consolidated to meet storage needs. This material might then have to be recanistered. Only the third alternative would actually permit canistering activities to proceed without the risk of the produced canisters being incompatible with the final repository-specific disposal container.

Each of the alternatives requires the utilities to perform the initial preparation and packaging of spent fuel, a responsibility assigned to the DOE by the Nuclear Waste Policy Act. The DOE could contract with utilities to perform this function, which could include some arrangement to appropriately reimburse the utilities. The reimbursement should be related to the costs avoided by the DOE when the utility provides canisters of consolidated spent fuel instead of intact fuel assemblies. The maximum avoided cost would occur when all utilities perform the consolidation function, thus eliminating the need for such a facility at the repository. However, there is no assurance that all utilities would be willing or able to perform this function. The feasibility of performing the consolidation function and storing consolidated fuel in a particular spent-fuel storage pool depends on structural, thermal, and seismic constraints for that pool. In addition, consolidating spent fuel in a reactor pool creates the potential for degrading the water quality for the reactor pool, and adding to the background radiation level of the pool. It is unlikely that consolidation would be a feasible or attractive option for all utilities.

Each of the alternatives for consolidating spent fuel at reactor sites would shift the location of this spent-fuel preparation step from the federal government site (either the MRS facility or the repository) to the utility sites. This shift creates several important tradeoffs that are common to each of the above alternatives.

Each of the alternatives for at-reactor consolidation and canistering are described in more detail below.

At-Reactor Consolidation into Utility-Selected Canisters

Utilities would most likely select a canister for consolidated fuel that would be compatible with their existing pool storage racks. Typically, each canister would hold the equivalent of two intact assemblies but would fit into the same rack space as a single intact assembly. The hardware from the disassembly process would most likely by compacted into a similarly-sized canister and also stored in the pool racks. Thus, a variety of reactor-specific canisters would be created which would not necessarily fit well together in the repository's disposal container. In addition, these canisters would probably not be sealed and inerted because systems capable of evacuating, backfilling with an inert gas, and seal-welding canisters underwater in the storage pools have not yet been demonstrated. These latter functions would probably have to be performed at the repository or the canister removed and discarded. Working over storage pools, consolidation workers would receive higher radiation doses than would be received at an MRS facility because of higher radiation levels over the pools.

At-Reactor Consolidation into a Repository-Specific Canister

In this alternative, the utilities would have to load the consolidated fuel roads into a repository-specific canister, which would be designed to fit efficiently into the repository's disposal container. The dimensions of the canister and the internal loading arrangements will be governed by the nature of the disposal medium and, therefore, may not be defined sufficiently early for the utility to provide an appropriate canister. An incorrect choice could result in the early-design canisters having to be repackaged. In addition, a repository-specific canister could be much larger in dimension and in total weight than would be a canister that fits within the pool storage racks. As a result, some new racks specifically designed for the canisters would have to be installed in the pool, and additional procedures and equipment would have to be put in place to ensure the safe handling and criticality safety of the large canisters.

At-Reactor Consolidation into a Repository-Compatible Canister That Is Also Compatible with Reactor Pool Racks

With this alternative, the utilities would consolidate fuel rods into canisters that are compatible with proposed repository disposal containers. The canister sizes also would allow the disposal package characteristics to be changed without requiring repackaging as knowledge of the disposal medium improves and requires such changes. One such canister concept considered for this alternative is the square/half-square configuration as proposed by NUS Corporation in its PRDA studies, where two assemblies are consolidated into a full-square canister and one assembly is consolidated into a half-square canister. One canister size would be used for pressurized water reactor (PWR) assemblies and a smaller canister size would be used for boiling water reactor (BWR) assemblies. Two half-square canisters would occupy approximately the same space as a single full-square canister, permitting a variety of geometric arrangements and improving the packing efficiency of the canisters within the repository disposal container.

B.1.2 Transportation Modifications in the No-MRS System

A series of changes to the transportation system were evaluated that would provide benefits similar to the MRS system by reducing the number of discrete shipments moving through the system. This reduction would be achieved by (1) using larger casks, and (2) combining casks into multicask shipments. The primary effect of these modifications would be to improve the degree of control that could be exercised over the transportation system, i.e., by reducing the number of cross-country shipments to the repository.

Implementing these modifications could reduce the total shipment-miles in the no-MRS system. These modifications will generally require use of new cask or handling technology, facilities such as marshalling yards, investments at utilities to improve existing reactor facilities, and some additional handling of spent fuel outside of contained areas. The total cost implications of these options have not been evaluated at this time, as most have not yet been designed in detail.

All of these modifications to the transportation system could be implemented in the MRS system and could lead to further reductions in transportation impacts for that system as well as the no-MRS system.

Each of the modifications is described below, along with preliminary information on the potential feasibility and reductions in transportation impacts (cask-miles and shipment-miles), costs, and radiation dose effects.

B.1.2.1 Increased Use of Rail Transport

Recent studies of cask-handling capability at existing reactors have shown that many reactors are limited in their ability to handle large rail casks. These limitations stem from such factors as inadequate crane lifting capacity, lack of a rail sur onto the site or into the reactor building, and structural limitations of the storage pool.

Two methods for increasing the use of rail transport for shipments originating from reactors are discussed in this section:

- Upgrade reactor facilities to provide direct rail access (e.g., by adding rail spurs and modifying crane capacity).

- Transfer spent fuel to large rail casks outside the pool using smaller transfer casks loaded in the storage pool and, if necessary, transport the large casks by truck ("heavy-haul") to the nearest rail access point.

Of these alternatives, the first can be accomplished without new technology development or application. Upgrading reactor-handling capabilities would require retrofitting or recertifying present equipment to handle heavier rail casks. Also, reactors that do not have rail service into the reactor site would need that service. The second alternative would require dry-cask transfer methods to be developed and certified. This technology is currently being investigated, especially for its use as a method to load storage units that could be used at reactor sites. The cost, risk, and feasibility of this alternative are uncertain at this time. "Heavy-haul" has been used many times to move heavy components such as reactor vessels onto sites without rail access, but has not yet been used for spent-fuel shipments. Each alternative is discussed in more detail below.

Upgrade Reactor Sites To Provide Direct Rail Access

A recent study has estimated that 41 of 127 reactors do not have active rail lines or do not have the capability to receive, handle, and load a rail cask. Of these 41 plants, 12 plants would require extensive structural modifications within the reactor or fuel-handling buildings to upgrade rail capability. The remaining 29 reactors are limited to truck shipping because they are not provided with rail access to the site. These plants would require rail spurs to be built between the reactor site and the nearest rail point, distances ranging from 1 to 50 miles. Seventeen of these reactors were judged to be the most likely candidates for upgrades because they would require less than 10 miles of new rail spur construction and have no known requirements for constructing bridges or tunnels. In many of these cases, additional studies would be required to assess the structural sufficiency of the pools, cranes and cask-handling areas before the first rail-cask handling sequence could commence.

Dry-Cask Transfer and Heavy-Haul Methods

This alternative involves the transfer of spent fuel between casks in a dry environment and/or transfers of loaded spent-fuel casks between transport vehicles. Spent fuel from reactors not having rail cask receiving and loading capability could be loaded into a transfer cask (about the size of a truck cask) in the reactor pool using conventional methods. This loaded transfer cask would be removed from the reactor building and the spent fuel could be transferred directly (in a dry environment) to a large rail cask. Several transfer cask loads would be required to fill the rail cask. If there is not rail access at the reactor site, this rail cask would be heavy-hauled by truck to a nearby rail access point where it would be transferred onto a rail car. Some reactors could load the rail casks in their existing pool, but may not have onsite rail access. For these reactors, the rail transport cask would be heavy-hauled by special truck to a nearby rail access point where it would be transferred into a rail car.

The overall result of this alternative would be a shift from truck to rail transport. This shift would decrease the number of shipments and cask-miles, but require additional spent-fuel handling and transfer activities at or near the reactor facility.

B.1.2.2 Use of Extra-Large Rail Casks

The use of extra-large rail casks (125 to 150 tons loaded) in the no-MRS system would significantly reduce the total cask-miles traveled as well as the total number of shipments required. The actual percentage reduction that may be obtained in cask-miles and in the number of shipments is directly proportional to the relative cask capacities. The majority of reactors that are currently listed as having rail-cask-handling capabilities can handle rail casks having a loaded weight between 100 and 125 tons. As a result, the use of these casks would be limited, or their widespread use would require modifications to rail-cask-handling capabilities or the implementation of dry-cask transfers at most of the reactors currently in operation in the United States.

B.1.2.3 Multicask Shipments

The total number of shipments and shipment-miles in the waste-management system can be reduced by combining single-cask shipments into larger multicask shipments.

Several alternatives for combining shipments were considered and are briefly described below.

Truck Convoys

This method of combining shipments would require individual truck shipments of spent fuel to be marshalled at either individual reactors or a centralized yard. The combined shipments would then travel as a convoy to the repository. This marshalling of truck shipments would, in effect, reduce the number of separate shipments of spent fuel on the highways.

Combining Rail Shipments at Marshalling Yards

Individual rail shipments from reactors could be combined into fewer, larger shipments to the repository by coordinating shipments from reactors near centralized marshalling yards. This would allow an opportunity for combining individual shipments into a single train and would minimize the total waiting time of casks at the marshalling yard.

Scheduling Multicask Shipments from Reactors

By scheduling to receive more than one cask of spent fuel at a time from each reactor and by combining the multiple casks in a single shipment, the number of separate shipments could be reduced.

Inherent in each of these options is the added amount of nontransport time that occurs for individual casks. This increased nontransport time is incurred either at the reactor, where loaded casks are idle while awaiting the loading of subsequent casks, or at the marshalling yards, where early arriving casks remain idle while awaiting the arrival of other casks to be added to the shipment. This increased nontransport time lengthens the average total time required for a trip for casks and requires that more casks be added to the cask fleet to ship the same amount of spent fuel in an equivalent time. These extra casks will add to the overall cost (capital and maintenance) of shipping the spent fuel.

All of these alternatives require differing degrees of planning, scheduling, and control of operational parameters. No new technology is required for the implementation of any of these options.

B.1.2.4 Use of Overweight Truck Shipments

The capacities of truck casks are generally limited by the gross vehicle weight limits rather than by physical volume constraints. Thus, the size of truck shipments could be increased, with corresponding reductions in the number of such shipments, by using overweight rather than legal-weight shipments.

One complication with this alternative is that the regulations and statutes governing overweight truck shipments are not consistent throughout the United States, but vary from State to State. This results in more complex scheduling and interactions to ensure that the overweight shipments are consistent with the regulations of the various States along the routes. Overweight shipments might also be constrained to operate only during certain times of the day or at reduced speeds, resulting in a net reduction in shipment speed. Some States also do not allow overweight truck shipments during the winter months because of possible damage to highways. The DOE is continuing to investigate and refine the scheduling and regulatory compliance issues associated with this option.

B.1.3 Expanded Lag Storage at the Repository

Lag storage capability could be added to the first respository to provide some of the same benefits that are provided by the MRS system. For example, the waste-acceptance process would be insulated from disruptions in repository emplacement. If the storage capability were licensed separately from the underground portion of the repository, spent fuel could also be received earlier and contingency storage could be provided in case of some types of delays in repository startup or diminished emplacement capability. Present designs of repository surface facilities include a 3-month operational buffer (750 MTU), which is sufficient to ensure smooth functioning during normal emplacement operations, to unload the transportation system during slowdowns or brief stoppages in emplacement activities, and to maintain emplacement operations during brief disruptions of the transportation system.

To accelerate the initial spent-fuel-acceptance rates in the no-MRS system, expanded lag (buffer) storage at the repository could be provided. The spent-fuel acceptance rate at the repository during the first 5 years of operation is controlled by the rate at which the underground emplacement excavations and operations progress after NRC licensing. (Completion of repository surface facilities also affects the lower acceptance rate but to a lesser degree.) The amount of storage that could be provided to accelerate the acceptance of spent fuel while not impeding repository construction cannot be predicted at this time. The licensability of such storage prior to repository operating approval could also be a major obstacle to its implementation, considering the constraints incorporated into the Nuclear Waste Policy Act. The Act prohibits the construction and operation of an MRS facility or FIS in a State in which a repository site is located. Also, to avoid characterization as a separate facility, the lag storage would have to be licensed in the same action as the repository. Thus, fuel acceptance in meaningful quantities could not begin much in advance of repository disposal activities; in other words, lag storage could not effectively separate the DOE's acceptance of spent fuel from the schedule of spent-fuel acceptance at the repository.

B.2 ADDITIONAL INFORMATION ON POTENTIAL MODIFICATIONS EVALUATED IN THE MRS PROPOSAL

During the period since the preparation of the MRS proposal, additional information on the potential modifications evaluated in the MRS proposal has become available from a number of DOE and DOE-utility programs on waste-management research and development. The additional information is in two general areas: at-reactor consolidation and transportation modifications. This section reviews the developments in these areas.

B.2.1 Additional Information on At-Reactor Consolidation

The consolidation of spent fuel in reactor pools has been proposed as a feasible and cost-effective means to increase pool storage capability. Recent small-scale demonstrations indicate that consolidation may be both feasible and economically attractive; however, the experience at present is too small to confidently estimate either the cost or the feasibility of large-scale applications of the process. Confident estimates will require data from larger-scale projects.

The experience to date with in-pool demonstrations has been variable. Five companies have designed in-pool consolidation equipment, and each has teamed up with one or more utilities to test and refine the systems. All of the development and experience has focused on PWR fuel consolidation--no efforts to consolidate BWR fuel have been made. The demonstration programs that have been performed to date can be summarized as follows:

- The Westinghouse Electric Corporation has designed an automatic system that pulls all rods from an assembly at once, and it has worked with the Duke Power Company on four PWR assemblies at the Oconee plant in November 1982. Westinghouse now has a contract with the Northern States Power Company to consolidate about 40 PWR assemblies at the Prairie Island plant. This "hot" demonstration program is reported to have been initiated in October 1987.

- Combustion Engineering (C-E) has an automated system that pulls one rod at a time or one row at a time. A cold demonstration of the equipment was completed in December 1986. C-E completed a "hot" demonstration program at the spent-fuel pool of the Millstone 2 plant (Northeast Utilities). Six PWR assemblies were consolidated, with a 2:1 compaction ratio achieved for each assembly. Northeast Utilities has a goal of eventually consolidating the entire pool inventory if approval from the NRC is obtained. C-E also has a contract with the Virginia Power Company to consolidate about 48 PWR assemblies at the Surry plant.

- The Nuclear Assurance Corporation (NAC) uses an elevator in the fuel pool to raise and lower assemblies and canisters, and rods are pulled one at a time. NAC worked with the Rochester Gas and Electric Corporation (RG&E) on six PWR assemblies from the Ginna plant at West Valley in December 1985 and February 1986. NAC and the Tennessee Valley Authority had planned a rod-consolidation demonstration of about 12 BWR assemblies at Browns Ferry, but this has been deferred indefinitely.

- The U.S. Tool & Die Company (UST&D) has designed a system using a funnel to guide and control the path of each fuel rod as it is drawn from the assembly into the storage canister. UST&D worked with RG&E to complete consolidation of the PWR assemblies from Ginna at Battelle Columbus Laboratories in October 1985.

- The Proto-Power Corporation uses a computer-controlled indexing system and a single rod transfer system and has worked with the Maine Yankee Atomic Power Company to refine the equipment. A "cold" test of the equipment has been done, but Maine Yankee has no plans for a "hot" demonstration in the near term.

In 1986, General Electric also indicated it might be considering rod consolidation at its Morris spent-fuel storage facility. GE has done fuel reconstitution and has talked to the NRC staff about consolidation at Morris. The future of GE's plans is uncertain, however, because of the company's decision in October 1986 to pull out of the waste-services business.

In each of these cases, the vendor's equipment has been designed for an optimum 2:1 compaction, but most efforts have so far had mixed success. Where 2:1 consolidation has been achieved, the tradeoffs have been low production rates, substantial man-hours, or high costs. Vendors agree that there is still a good bit or work needed to optimize the systems. The more recent demonstration by C-E was encouraging: a 2:1 consolidation ratio was achieved with reasonable production rates. The experience to date on achieving the desired compaction ratio is summarized below.

- At Oconee in 1982, two assemblies containing 208 rods each were consolidated into one canister. The other two assemblies (which were the first two worked on), however, were not successfully loaded into one canister: there were 33 stray rods because of a malfunction with one of the machines.

- NAC only succeeded in consolidating six Ginna assemblies into five canisters at West Valley. Only 109 of the 179 rods in the first assembly were loaded into the first canister. The next three canisters were loaded with 251, 251, and 276 rods, however, for a consolidation of about 1.4:1. The fifth canister was loaded with 187 rods but was not completely loaded. According to NAC, the loading of the fourth canister--with 276 rods--was equivalent to a consolidation of 1.8:1 because of the space taken up by thermocouplers and other instrumenting devices.

- UST&D succeeded in consolidating five Ginna assemblies into two-and-a-half canisters at Battelle Columbus Laboratories' West Jefferson facilities.

- C-E succeeded in consolidating six PWR assemblies into three canisters at Northeast Utilities' Millstone 2 plant.

Several utilities are considering fuel consolidation, and a recent limited study by NAC of utility preferences showed that utilities are willing to consider consolidation to meet their own storage requirements prior to the inception of Federal acceptance of spent fuel. Although the limited NAC study indicated a willingness among utilities to consolidate to relieve their own storage problems, it also indicated strong objections to voluntary consolidation to achieve benefits elsewhere in the waste system, even if substantial incentives were provided.

The interest of the nuclear utility industry in in-pool consolidation is isolated to specific operating units as follows:

- The Duke Power Company is primarily considering dry storage to meet short-term needs for Oconee in mid-1989 but is also investigating consolidation technologies.
- The Consumers Power Company plans to rerack the spent-fuel pool at the Palisades plant and has indicated plans to seek a license amendment to store consolidated fuel. Consumers will need additional storage space at Palisades in 1989.

Other utilities potentially interested in at rod-consolidation projects are the Wisconsin Electric Power Company, Baltimore Gas & Electric Company, Florida Power & Light Company, New York Power Authority, and Philadelphia Electric Company.

The utility licensing situation with the NRC is an evolving one. No generic or vendor-specific topical report has been submitted to the NRC for in-pool consolidation equipment. The position taken by the utilities--and so far not disputed by the NRC--is that consolidation itself does not need to be licensed by the NRC because the operations involved would be within utilities' technical specifications in most cases. Unless a change in technical specifications is required, it appears that consolidation is allowed under 10 CFR 50.59.

However, a license amendment is required if a utility will be increasing its in-pool storage capacity through consolidation. Since this is the primary reason for undertaking at-reactor consolidation, a utility's decision to consolidate will have to include an assessment of the factors associated with an operating license amendment. The experiences of Maine Yankee Atomic Power Company in attempting to attain a license amendment for this purpose are not encouraging. A summary of their efforts is provided below.

- In 1979, Maine Yankee submitted to the NRC a detailed safety analysis and application for approval. A local antinuclear group petitioned for leave to intervene and was admitted.
- In 1980, the necessary supplements were filed. At that point, the State of Maine also petitioned for leave to intervene and was admitted.
- By mid-1983, Maine Yankee could see no end to the licensing process--a trial date had not been set.

Maine Yankee currently has no plans to pursue consolidation, although it believes that consolidation and in-pool storage of consolidated fuel is technically and economically viable. Similarly, Northeast Utilities applied to the NRC for a license to consolidate (and store in the spent-fuel pool) the entire spent-fuel inventory at its Millstone 2 plant. The NRC, however, granted this utility the very limited authority to consolidate (and store) only up to 10 assemblies. The licensing problems encountered by Maine Yankee and Northeast Utilities are probably not unique.

B.2.2 Additional Information on Transportation Modifications

Since the preparation of the MRS proposal, a number of additional potential transportation modifications have been developed through various DOE programs. These potential modifications are described and evaluated below.

B.2.2.1 Larger-Capacity Standard Casks

Responses from commercial vendors to the recent request for proposals (RFP) for cask designs have confirmed that it is possible to design a new generation of truck and train casks that would have a much higher capacity than previous designs of the same weight and size. The train cask used in the MRS proposal was assumed to have a capacity of 14 PWR or 36 PWR spent-fuel assemblies, and the reference truck cask was assumed to have a capacity of 2 PWR or 5 PWR assemblies. The recent RFP responses, however, have suggested that new-generation cask capacities would be 21/48 for train and 3/7 for truck. These larger-capacity standard casks would significantly affect system development. A smaller cask fleet would be needed, and the design and operation of receiving facilities could potentially be based on handling fewer cask arrivals. It is important to recognize that the benefits of most other potential modifications to the transportation system would be reduced by the use of larger-capacity casks because the number of casks and cask shipments would be lower.

System operations would be simplified because fewer cask trips would be required. System costs would be reduced because fewer casks would be acquired, maintained, and decommissioned, and fewer casks would be transported, resulting in lower transportation costs.

System risks would be greatly reduced. Most radiation exposure is incurred in cask loading and maintenance operations. Far fewer handlings would be necessary with the larger-capacity standard casks. The risk of radiation exposure of the public would also be reduced by the smaller number of casks being shipped.

Preliminary analyses have shown these casks to be technically feasible, and no obstructions to institutional acceptance have been identified.

B.2.2.2 Dedicated Trains from Reactors

Rail shipments could be made in dedicated trains that would carry no other commodity. These trains would operate directly from a reactor to the repository. The dedicated-train alternative should not be confused with the multicask alternative. Multicask shipments are characterized by a number of casks moving as a set, which could move by either general freight or dedicated trains.

Dedicated trains would have a moderate effect on system development, with primary benefits coming from a greater control over the arrival and departure schedules, which would allow receiving facilities at the repository to be designed for a lower "surge" rate and for greater predictability and control of routing, which would allow institutional efforts to be focussed on fewer geographical areas. Dedicated trains would simplify system operations by allowing the scheduling and routing of trains to meet the DOE's needs rather than the railroads' convenience.

System costs might be slightly increased by dedicated trains, although the higher over-the-road cost of dedicated trains could be partially balanced by significantly higher over-the-road speeds and reduced stopped times. The greater control over the arrival and departure of trains would allow the receiving facilities to be designed for lower surge capacity.

System risks would be reduced by dedicated trains, for both occupational and nonoccupational radiological risks. Occupational and nonoccupational nonradiological risks may be slightly increased, reflecting the presence of additional trains (as compared to the presence of just additional cars if regular trains were used) on the rail network.

Dedicated trains are technically feasible and are in everyday use in the railroad industry for certain commodities and equipment types. A specialized form of dedicated train, called a "special train," has been used in various nuclear fuel shipments, notably for the Cooper and the Monticello plants. Dedicated trains are assumed to provide all transportation from the MRS facility to the repository.

B.2.2.3 Pick-Up Trains

Pick-up trains could pick up casks from two or more reactors before proceeding to a repository. This contrasts with the reference no-MRS system, where it is expected that shipments to a repository will be composed of casks from only one reactor site, except for those instances where railroads, by coincidence or for their own operational purposes, might combine the shipments on a single train.

A pick-up train is a form of "dedicated train". Pick-up trains could allow some of the benefits of dedicated trains by providing greater control over the shipments, and of multicask shipments by providing economies of scale and reducing shipment miles, without incurring waiting time at a single reactor site while several casks are loaded consecutively.

The effects of pick-up trains on system development would be mostly limited to the resolution of institutional considerations. Since pick-up trains require a gathering of casks from several or more reactors, most casks would not be moved by the shortest or the most-direct route to the repository and would incur some waiting time at another reactor while the next cask is added to the train. Public opposition to the increase in cask-miles could be expected, as could utility opposition to the requirement to "store" another utility's fuel during the time that the train is being made up. In fact, the NRC might require an amendment to each utility's license to allow it to temporarily "store" the spent fuel from other utilities that is in the casks. A recent survey of utility managers indicates strong opposition to the use of pick-up trains for these reasons.

System operations would be greatly complicated by the use of pick-up trains, as very precise scheduling and coordinating of shipments would be required so that shipment problems affecting one utility would not affect the others. Successful application would require precise scheduling many months ahead, the unfailing ability of utilities to ready shipments for pickup, and perfect coordination and cooperation between utilities, railroads, and the DOE.

Pick-up trains would probably have a higher system cost than regular or dedicated-train shipments from a single reactor because of operating inefficiencies such as numerous short rail hauls and time spent waiting for other casks. Some savings would be realized for reducing waiting time as compared to assembling an equal number of loaded casks at a single reactor site.

B.3 EVALUATION OF POTENTIAL MODIFICATIONS NOT INCLUDED IN THE MRS PROPOSAL

Two potential modifications to the waste-management system that were not evaluated in the MRS proposal are Federal interim storage (FIS) and the use of dual-purpose (transportable-storage) casks. This section describes and evaluates these alternatives.

B.3.1 Federal Interim Storage (FIS)

There are provisions in the Nuclear Waste Policy Act to assist the commercial nuclear power reactors that are unable to reasonably provide adequate storage capacity on site when needed to ensure the continued, orderly operation of such reactors. This Federal storage capability is limited to 1900 MTU.

The Act makes it clear, however, that the primary responsibility for providing interim storage for spent nuclear fuel rests with the individual utility owning reactors by maximizing, to the extent practical, the effective use of existing storage facilities at the site and by adding new on-site storage capacity in a timely manner where practical. For those commercial nuclear power reactors that have pursued all alternatives for additional spent-fuel storage without solving their storage difficulties, applications can be made to transfer spent nuclear fuel to Federal storage facilities. Such arrangements in the form of contracts with the DOE are required to be enacted not later than January 1, 1990. There is no evidence at this time that any utility plans to make an application for FIS. It should be noted that, before applying for transfer of fuel to FIS, the utility must request and receive from the NRC a determination that it has exhausted all other spent-fuel storage options.

The impacts of FIS on the total DOE spent-fuel storage requirements would be minimal in terms of system operations advantages. FIS must be fully supported by assessments against utilities using the services. Costs will depend heavily on factors such as the site and the storage technology. The use of Federal storage would introduce additional handling and transportation costs resulting from spent-fuel movement from reactors, to Federal storage facilities, and finally to the repository.

There are potentials for marginally increasing public risk due to the increase in transportation cask miles and also some increase in occupational worker radiation exposure due to additional handling of spent fuel in an uncanistered form.

There are no technical limitations in the transfer of spent fuel to licensed Federal storage facilities. There could be some institutional difficulties from State, Indian Tribes, and local groups because of additional transportation and storage activities. There is a restraint within the Act (Section 135(a)(2) that precludes Federal storage in any State in which there is a candidate site for a repository.

In summary, there does not appear to be any evidence that utilities owning civilian nuclear power reactors are considering Federal interim storage as a means of solving on-site spent-fuel storage shortfalls. It should be recognized that this storage concept is only a near-term stop-gap measure and was proposed pending the development and demonstration of new technologies; that is, it was never intended as a long-term safety valve.

B.3.2 Dual-Purpose Casks

The concept of the dual-purpose storage cask, which has been under study by the DOE for several years, is a variant of the metal storage cask alternative in which the same cask in which spent fuel is stored is later used to transport the fuel directly from the storage field to the MRS facility or the repository. In essence this arrangement amounts to storage in a metal storage cask, and, if needed, the cask could then be placed in service as part of the transportation fleet or serve as lag storage at the repository.

The system impacts of the dual-purpose cask are in many instances identical with those of the metal storage-only cask. The potential additional services of the dual-purpose cask, however, generate unique impacts.

The basic feasibility of the dual-purpose cask concept depends on its certification for transportation use after extended periods in storage. Current NRC interpretations of their regulations could preclude certification under those circumstances. There is currently no evidence as to whether such certification could be expected in the future with any degree of confidence.

Dual-purpose casks could either be furnished to utilities by the DOE or purchased by the utilities and later repurchased by the DOE. Several related concerns of equity, quality control, and records pertaining to certification would be involved in these proceedings.

The dual-purpose casks under consideration would weigh about 125 tons and have a capacity of 24 PWR or 60 BWR integral assemblies or 40 PWR or 96 BWR consolidated assemblies.

System development would be affected by the adoption of the dual-purpose cask as design and engineering of the casks would have to be accelerated to ensure that the casks are available to meet near-term storage needs while maintaining compatibility with the transportation and repository systems that are still being developed. Additionally, to gain full benefit from the use of these casks in the regular transportation fleet, their development would need to preempt the acquisition of most of the transportation-only cask fleet.

Dual-purpose casks would offer a minor reduction in the occupational and public risk of radiation exposure as a result of eliminating the rehandling of fuel at the reactors and the slight increase in cask capacity resulting in fewer shipments.

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September 24, 1984

P-0-7

Mr. L. C. Rouse
U. S. Nuclear Regulatory Commission
Wilste Building, Mail Stop FF-396
7915 Eastern Avenue
Silver Springs, MD 20910

Subject: Job No. 6440 - Monitored Retrievable Storage Facility
Submission of 70% Overall Project Review

Reference: Contract DE-AC06-85-RL10436

Gentlemen:

We are transmitting herewith one half size copy of the R & H Facility, Concrete Cast Storage, Drywell Storage, and Utilities drawings for the 70% overall project review. These drawings are listed in Attachment A.

We are transmitting this package directly to you per a request from DOE-RL Operation Office in order to expedite the review process in anticipation of the review meeting scheduled for October 22, 1984.

Very truly yours,

W. L. Santo for
W. D. Woods
MRS Project Manager

WDW:jf

cc: R. B. Goranson - DOE
G. S. Rokkan - DOE
D. S. Jackson - PNL
R. J. Hall - PNL

9405240282

ATTACHMENT A

DRAWING LIST

5.5.1 IMPROVEMENTS TO LAND

Architectural

H-3-54700	Site Arrangement Plan Storage Concept I - Sealed Concrete Cask

Civil Drawings

H-3-54702	Key Plan, Legend & Notes
H-3-54703	Site Plan - Sheet 1 Storage Concept 1 - Sealed Concrete Casks
H-3-54704	Site Plan - Sheet 2
H-3-54705	Grading & Drainage Plan - Sheet 1
H-3-54706	Grading & Drainage Plan - Sheet 2
H-3-54707	Standard Details
H-3-54708	Key Plan - Alternate Storage Concept

5.5.2 RECEIVING AND HANDLING FACILITY

Architectural Drawings

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H-3-54709	Overall First Mezzanine Plan
H-3-54710	Overall Second Level Plan
H-3-54711	Overall Second Mezzanine Plan
H-3-54712	Overall Third Level Plan
H-3-54713	Overall Roof Plan
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-54714	Partial General Arrangement - Sheet 2 Ground Level Plan - Area II
-54714	Partial General Arrangement - Sheet 3 Ground Level Plan - Area III
-54714	Partial General Arrangement - Sheet 4 Ground Level Plan - Area IV
-54714	Partial General Arrangement - Sheet 5 Ground Level Plan - Area V
H-3-54715	Partial General Arrangement - Sheet 1 First Mezzanine Plan - Area I
-54715	Partial General Arrangement - Sheet 2 First Mezzanine Plan - Area IV
H-3-54716	Partial General Arrangement - Sheet 1 Second Level Plan - Area I
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H-3-54716	Partial General Arrangement - Sheet 3 Second Level Plan - Area III & IV
H-3-54717	Partial General Arrangement - Sheet 1 Second Mezzanine Plan - Area I
-54717	Partial General Arrangement - Sheet 2 Second Mezzanine Plan - Area II
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H-3-54720	South and East Elevations
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H-3-54722	Building Sections E and F
H-3-54723	Building Sections G and H
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H-3-54742	First Mezzanine Floor Framing Plan
H-3-54743	Second Floor Framing Plan
H-3-54744	Second Mezzanine Floor Framing Plan
H-3-54745	Third Floor Framing Plan
H-3-54746	Roof Framing Plan
H-3-54748	Framing Elevations
H-3-54749	Framing Elevations

Heating, Ventilating and Air Conditioning Drawings

H-3-54756	HVAC Legend, Symbols and Abbreviations - Sheet 1
H-3-54756	HVAC Legend, Symbols and Abbreviations - Sheet 2

H-3-54757	Composite Air Flow Diagram - Sheet 1
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H-3-54758	Flow and Control Diagram - Outside Air Supply System
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-54763	Ducting Layouts - Sheet 2 - Second Floor Plan
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H-3-54765	Final Filter and Exhaust Fan Room Layouts - Sheet 1
-54765	Final Filter and Exhaust Fan Room Layouts - Sheet 2
H-3-54766	Remote Handling Filtration Room Layouts - Sheet 1
-54766	Remote Handling Filtration Room Layouts - Sheet 2
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Mechanical Process Drawings

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-54769	Liquid Radwaste System Process Flow Diagram - Sheet 2
H-3-54770	Solid/Offgas Radwaste System Process Flow Diagram
H-3-54771	Decon Solution Preparation and Distribution Utility Flow Diagram
H-3-54772	Washdown Water Utility Flow Diagram
H-3-54768	Plant and Instrument Air Piping and Instrument Diagram
H-3-54774	Steam Generation Utility Flow Diagram
H-3-54775	Deionizer System Utility Flow Diagram
H-3-54776	Water Softener System Utility Flow Diagram
H-3-54777	Inert Gas Systems Utility Flow Diagram
H-3-54778	Breathing Air System Piping and Instrument Diagram
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H-3-54781	BFW Storage Tank/Condensing Drum/F.O. Tank Piping and Instrument Diagram - Sheet 1
-54781	Chemical Treatment Tank Piping and Instrument Diagram - Sheet 2
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H-3-54782	Decon Solution Preparation Piping and Instrument Diagram - Sheet 1
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H-3-54783	Water Softener System Piping and Instrument Diagram
H-3-54784	Deionizer System Piping and Instrument Diagram - Sheet 1
-54784	Deionizer System Piping and Instrument Diagram - Sheet 2
H-3-54785	Liquid Radwaste Collection Vessel Piping and Instrument Diagram
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H-3-54787	Liquid Radwaste Oil Separators Piping and Instrument Diagram
H-3-54788	Liquid Radwaste Evaporator Feed Tank Piping and Instrument Diagram
H-3-54789	Liquid Radwaste Evaporators Piping and Instrument Diagram
H-3-54790	Liquid Radwaste Evaporator Condensate Hold Tank Piping and Instrument Diagram
H-3-54791	Liquid Radwaste Ion Exchangers Piping and Instrument Diagram
H-3-54792	Treated Liquid Radwaste Storage Vessels Piping and Instrument Diagram
H-3-54793	Cask Vent-off-Gas Monitoring/Sampling System Piping and Instrument Diagram
H-3-54794	Freon Supply System - Sheet 1 Piping and Instrument Diagram

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H-3-54818	Plant, Instrument and Breathing Air - Sheet 1 Ground Level Plan
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-54818	Plant, Instrument and Breathing Air - Sheet 4 Second Mezzanine Plan
-54818	Plant, Instrument and Breathing Air - Sheet 5 Third Level
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-54820	Steam and Condensate - Sheet 3 Second Level Plan
H-3-54820	Steam and Condensate - Sheet 4 Second Mezzanine Plan
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-54822	Radwaste Drain - Sheet 3 Second Level Plan
-54822	Radwaste Drain - Sheet 4 Second Mezzanine Plan
-54822	Radwaste Drain - Sheet 5 Third Level Plan
H-3-54823	Process Sewer Ground Level Plan
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H-3-54825	Drawing Location Plan - Sheet 1 Ground Level Plan
-54825	Drawing Location Plan - Sheet 2 Second Level Plan
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-54826	Compressor Room - Sheet 2 Elevation
H-3-54827	Aqueous Make-up and Wash Water - Sheet 1 Ground Level Plan
-54827	Aqueous Make-up and Wash Water - Sheet 2 Elevations
H-3-54828	Boiler Room - Sheet 1 Ground Level Plan
-54828	Boiler Room - Sheet 2 Sections
H-3-54829	Liquid Radwaste - Sheet 1 Ground Level Plan
-54829	Liquid Radwaste - Sheet 2 Elevations
-54829	Liquid Radwaste - Sheet 3 Sections
H-3-54838	Cooling Tower - Sheet 1 Ground Level Plan and Elevation
-54838	Cooling Tower - Sheet 2 Sections

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H-3-54869	Single Line Diagram
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Mechanical Specialities

H-3-54872	Washdown Area Plan and Elevation
H-3-54873	Washdown Area Elevation, Section and Details
H-3-54893	First-Stage HEPA Filter Handling System
SK-MS-19	Solid Radwaste Decon Equipment Assembly
SK-MS-20	Solid Radwaste HEPA Filter System System Arrangement
SK-MS-21	HEPA Filter Handling Arrangement Section and Elevation
SK-MS-22	Solid Radwaste Equipment Arrangement Elevation
SK-MS-23	Solid Radwaste Equipment Arrangement Elevation
SK-MS-24	Solid Radwaste Equipment Arrangement Grout Mixer Elevation

Material Handling

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-54899	R&H Building Material Equipment Flow Diagram - Sheet 3
-54899	R&H Building Material Equipment Flow Diagram - Sheet 4
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-54900	R&H Building Equipment L/O and Arrangement - Sheet 2
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H-3-54901	Spent Fuel Cask Cart - Sheet 1
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H-3-54903	Spent Fuel Canister

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H-3-54906	Canister Upending and Cutting Station
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H-3-54909	BWR Secondary Waste Removal System
H-3-54910	Swipe Station Upender and Swipe Dispenser
H-3-54911	Fuel Consolidation System Downender
H-3-54912	Fuel Consolidation System Clamping Module - Sheet 1
-54912	Fuel Consolidation System Clamping Module - Sheet 2
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-54912	Fuel Consolidation System Clamping Module - Sheet 5
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H-3-54913	Fuel Consolidation System Rod Extraction and Reordering -Sheet 1
-54913	Fuel Consolidation System Rod Extraction and Reordering -Sheet 2
-54913	Fuel Consolidation System Rod Extraction and Reordering -Sheet 3
-54913	Fuel Consolidation System Rod Extraction and Reordering -Sheet 4
-54913	Fuel Consolidation System Rod Extraction and Reordering -Sheet 5
-54913	Fuel Consolidation System Rod Extraction and Reordering -Sheet 6
H-3-54914	Fuel Consolidation System Equipment General Assembly
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-54915	Fuel Consolidation System Laser Disassembly Equipment - Sheet 2
-54915	Fuel Consolidation System Laser Disassembly Equipment - Sheet 3
-54915	Fuel Consolidation System Laser Disassembly Equipment - Sheet 4
H-3-54917	Fuel Consolidation System Intact Fuel and Recovery Upender - Sheet 1
-54917	Fuel Consolidation System Intact Fuel and Recovery Upender - Sheet 2
H-3-54918	Fuel Consolidation System Disassembly and Module Lifting Rig
H-3-54919	Hot Cell Overhead Crane Outline
H-3-54920	Homo Polar Generator Welding System
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-54924	Carousel Canister Supply Rack - Sheet 2
H-3-54929	Secondary Shredded Waste Transfer Equipment - Sheet 1
-54929	Secondary Shredded Waste Transfer Equipment - Sheet 2
H-3-54930	Secondary Shredded Waste Drum Transfer and Lifting Equipment
H-3-54931	Spent Fuel Cask Outline - Sheet 1
-54931	Spent Fuel Cask Outline - Sheet 2
H-3-54932	Hot Cell Access Ports - Unloading Port Plug - Sheet 1
-54932	Hot Cell Access Ports - Unloading Port Plug - Sheet 2
-54932	Hot Cell Access Ports - Unloading Port Plug - Sheet 3
H-3-54933	Hot Cell Maintenance Hatches
H-3-54935	Pneumatic Transfer Tube System
H-3-54936	Maintenance Hatch Jacking Mechanism - Sheet 1
-54936	Maintenance Hatch Jacking Mechanism - Sheet 2
H-3-54937	In Process Lag Storage - Sheet 1
-54937	In Process Lag Storage - Sheet 2
-54937	In Process Lag Storage - Sheet 3
-54937	In Process Lag Storage - Sheet 4
-54937	In Process Lag Storage - Sheet 5

H-3-54938	Lifting Yoke for REA-2023 Cask - Sheet 1
-54938	Lifting Yoke for REA-2023 Cask - Sheet 2
H-3-54939	Unloading Port Plug Jack - Sheet 1
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H-3-54940	Drum Lifting Cage-Non Fuel Bearing
H-3-54941	Drum Cage Support Apparatus
H-3-54942	Homo Polar Generator Welding Station - Sheet 1
-54942	Homo Polar Generator Welding Station - Sheet 2
H-3-54943	Contamination Control Adapters - Sheet 1
-54943	Contamination Control Adapters - Sheet 2
-54943	Contamination Control Adapters - Sheet 3
H-3-54944	Upender Module Storage Rack
H-3-54945	Grapple Layout
H-3-54946	Fuel Handling Grapple
H-3-54947	Contamination Control Hot Cell Access Ports
H-3-54948	Cask Contamination Barrier Assembly

5.5.3 CONCRETE CASK STORAGE

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H-3-54980	Grading and Drainage Plan
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H-3-54985	Material Handling Transporter Concrete Cask
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H-3-54987	Concrete Casks Handling/Lifting Fixture - Sheet 1
-54987	Concrete Casks Handling/Lifting Fixture - Sheet 2
H-3-54988	Transportable Cask Storage Arrangement
H-3-54989	Transportable Cask Storage Cradles

Electrical Drawings

H-3-55024	Symbol List and Abbreviations
H-3-55026	Single Line Diagram
H-3-55027	Single Line Diagram

5.5.4 DRYWELL STORAGE

Civil Drawings

H-3-55029	General Plot and Utility Plan
H-3-55030	Typical Grading Plan
H-3-55031	General Grading and Drainage Plan
H-3-55032	Typical Grading Plan
H-3-55033	Sections and Details

Material Handling Drawings

H-3-55034	Drywell Material Flow Diagram — Missing?
H-3-55035	Drywell Layout - Sheet 1
-55035	Drywell Layout - Sheet 2
H-3-55036	Transfer/Transport Vehicle
H-3-55037	Drywell Canister Transfer Shield
H-3-55038	16.00 Drywell Liner
H-3-55039	30.00 Drywell Liner
H-3-55040	16.00 Drywell Assembly
H-3-55041	30.00 Drywell Assembly
H-3-55042	16.00 Drywell Shield Plug Assembly
H-3-55043	30.00 Drywell Shield Plug Assembly
H-3-55044	Drywell Cover Plate Assemblies
H-3-55045	16.00 Drywell Installation
H-3-55046	30.00 Drywell Installation
H-3-55047	Temporary Drywell Cover
H-3-55048	Drywell Storage Arrangement (Arid Site)
H-3-55049	Drywell Storage Arrangement (Warm Wet and Cold Site)

5.5.8 UTILITIES

Civil Drawings

H-3-55144	Water System - Utility Flow Diagram
H-3-55145	Sanitary Sewer System - Utility Flow Diagram
H-3-55146	Process Sewerage Treatment - Utility Flow Diagram
H-3-55147	Underground Utility Plan - Sheet 1
H-3-55148	Underground Utility Plan - Sheet 2

Mechanical Processw Drawings

H-3-55165	Plant and Instrument Air Piping and Instrument Diagram
H-3-55167	Plant and Instrument Air Piping and Instrument Diagram
H-3-55169	Site Utilities Distribution Flow Diagram
H-3-55167	Plant and Instrument Air Piping and Instrument Diagram
H-3-55170	Fuel Systems Utility Flow Diagram
H-3-55171	Compressed Air Systems - Sheet 1 Utility Flow Diagram
H-3-55171	Compressed Air Systems - Sheet 2 Utility Flow Diagram
H-3-55172	Hot Water Boilers Utility Flow Diagram
H-3-55173	Retention Drain System Utility Flow Diagram
H-3-55174	Process Sewer System Utility Flow Diagram

H-3-55175 Radwaste Drain System - Utility Flow Diagram
H-3-55176 Oily Sewer System - Utility Flow Diagram
H-3-55177 Legend - Sheet 1
-55177 Legend - Sheet 2
H-3-55178 Fuel O.1 Distribution
Piping and Instrument Diagram
H-3-55179 Retention Drain System
Piping and Instrument Diagram
H-3-55180 Process Sewer - Sheet 1
Piping and Instrument Diagram
-55180 Process Sewer - Sheet 2
Piping and Instrument Diagram
H-3-55183 Retention Drain System
Piping and Instrument Diagram
H-3-55181 Radwaste Drain System
Piping and Instrument Diagram
H-3-55182 Cooling Tower
Piping and Instrument Diagram
H-3-55184 Water System - Sheet 1
Piping and Instrument Diagram
-55184 Water System - Sheet 2
Piping and Instrument Diagram
H-3-55185 Site Utilities Interconnecting Distribution - Sheet 1
Piping and Instrument Diagram
-55185 Site Utilities Interconnecting Distribution - Sheet 2
Piping and Instrument Diagram
-55185 Site Utilities Interconnecting Distribution - Sheet 3
Piping and Instrument Diagram
-55185 Site Utilities Interconnecting Distribution - Sheet 4
Piping and Instrument Diagram

Electrical Drawings

H-3-55194 Symbol List and Abbreviations
H-3-55195 Distribution Plan, Underground Power
H-3-55197 Generator and 5 kV SWGR
Single Line Diagram Sheet 1
-55197 Generator and 5 kV SWGR
Single Line Diagram Sheet 2
H-3-55199 Main Substation and Equipment Location Plan

Appendix A - Summary Table for the Selection of Potentially Ada

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 1 (Power Reactors)
1.1	Net Positive Suction Head for Emergency Core Cooling and Containment Hea System Pumps (12/70)
1.2	Thermal Shock to Reactor Pressure Vessels (12/70)
1.3	Assumptions Used for Evaluating the Potential Radiological Consequences of Coolant Accident for Boiling Water Reactors (Revision 2, 6/74)
1.4	Assumptions Used for Evaluating the Potential Radiological Consequences of Coolant Accident for Pressurized Water Reactors (Revision 2, 6/74)
1.5	Assumptions Used for Evaluating the Potential Radiological Consequences Line Break Accident for Boiling Water Reactors (Safety Guide 5, 3/71)
1.6	Independence Between Redundant Standby (Onsite) Power Sources and Betwee Distribution Systems (Safety Guide 6, 3/71)
1.7	Control of Combustible Gas Concentrations in Containment Following a Los Coolant Accident (Revision 2, 11/78)
1.8	Personnel Selection and Training (Revision I-R, 5/77)
1.9	Selection, Design, and Qualification of Diesel-Generator Units Used as S (Onsite) Electric Power Systems at Nuclear Power Plants (Revision 2, 12/
1.10	Withdrawn-See 46 FR 37579, 7/21/81
1.11	Instrument Lines Penetrating Primary Reactor Containment (2/72)
1.12	Instrumentation for Earthquakes (Revision 1, 4/74)
1.13	Spent Fuel Storage Facility Design Basis (Revision 1, 12/75)
1.14	Reactor Coolant Pump Flywheel Integrity (Revision 1, 8/75)
1.15	Withdrawn-See 46 FR 37579, 7/21/81
1.16	Reporting of Operating Information - Appendix A Technical Specifications (Revision 4, 8/75)
1.17	Protection of Nuclear Power Plants Against Industrial Sabotage (Revision

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ptable Regulatory Guides (Listed in Numerical Order)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
Regulatory Guides			
t Removal	Not Applicable	-	Reactor Design Specific
	Not Applicable	-	Reactor Design Specific
of a Loss	Not Applicable	-	Reactor Design Specific
of a Loss	Not Applicable	-	Reactor Design Specific
of a Steam	Not Applicable	-	Reactor Design Specific
n Their	3.2.2.1	Electrical and Power Supply Systems	-
s of	Not Applicable	-	Reactor Design Specific
	3.2.22.1	Personnel Training	-
tandby 79)	3.2.2.2	Electrical and Power Supply Systems	-
	Not Applicable	-	Reactor Design Specific/Withdrawal
	Not Applicable	-	Reactor Design Specific
	3.2.17.1	Seismic Design	-
	3.2.5.1	Storage and Handling	-
	Not Applicable	-	Reactor Design Specific
	Not Applicable	-	Withdrawn
	3.2.10.1	Accidents	-
1, 6/73)	3.2.19.1	Safeguard and Security	-

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Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 1 (Power Reactors)
1.18	Withdrawn-See 46 FR 37579, 7/21/81
1.19	Withdrawn-See 46 FR 37579, 7/21/81
1.20	Comprehensive Vibration Assessment Program for Reactor Internals During Preoperational and Initial Startup Testing (Revision 2, 5/76)
1.21	Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and R of Radioactive Materials in Liquid and Gaseous Effluents from Light-Wate Nuclear Power Plants (Revision 1, 6/74)
1.22	Periodic Testing of Protection System Actuation Functions (Safety Guide
1.23	Onsite Meteorological Programs (2/72)
1.24	Assumptions Used for Evaluating the Potential Radiological Consequences Pressurized Water Reactor Radioactive Gas Storage Tank Failure (Safety Guide 24, 3/72)
1.25	Assumptions Used for Evaluating the Potential Radiological Consequences Handling Accident in the Fuel Handling and Storage Facility for Boiling Pressurized Water Reactors (Safety Guide 25, 3/72)
1.26	Quality Group Classifications and Standards for Water-,Steam-, and Radio Waste-Containing Components of Nuclear Power Plants (Revision 3, 2/76)
1.27	Ultimate Heat Sink for Nuclear Power Plants (Revision 2, 1/76)
1.28	Quality Assurance Program Requirements (Design and Construction) (Revisi
1.29	Seismic Design Classification (Revision 3, 9/78)
1.30	Quality Assurance Requirements for the Installation, Inspection, and Tes Instrumentation and Electric Equipment (Safety Guide 30, 8/72)
1.31	Control of Ferrite Content in Stainless Steel Weld Metal (Revision 3, 4/
1.32	Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants (Revision 2, 2/77)
1.33	Quality Assurance Program Requirements (Operation) (Revision 2, 2/78)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
Regulatory Guides			
	Not Applicable	-	Withdrawn
	Not Applicable	-	Withdrawn
	Not Applicable	-	Reactor Design Specific
eleases r-Cooled	3.2.11.1	Radiological Assessment	-
22, 2/72)	3.2.3.1	Instrumentation and Control	-
	3.2.14.1	Meteorology	-
of a	Not Applicable	-	Reactor Design Specific
of a Fuel and	3.2.11.2	Radiological Assessment	-
active	3.2.4.1	Mechanical Systems/ Components	-
	Not Applicable	-	Reactor Design Specific
on 2, 2/79)	3.2.23.1	Quality Assurance	-
	3.2.17.2	Seismic Design	-
ting of	3.2.23.2	Quality Assurance	-
78)	3.2.9.1	Materials	-
	3.2.2.3	Electrical and Power Supply Systems	-
	3.2.23.3	Quality Assurance	-

Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 1 (Power Reactors)
1.34	Control of Electroslag Weld Properties (12/72)
1.35	Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containment Structures (Revision 2, 1/76)
1.36	Nonmetallic Thermal Insulation for Austenitic Stainless Steel (2/73)
1.37	Quality Assurance Requirements for Cleaning of Fluid Systems and Associa Components of Water-Cooled Nuclear Power Plants (3/73)
1.38	Quality Assurance Requirements for Packaging, Shipping, Receiving, Stora Handling of Items for Water-Cooled Nuclear Power Plants (Revision 2, 5/7
1.39	Housekeeping Requirements for Water-Cooled Nuclear Power Plants (Revisio
1.40	Qualification Tests of Continuous-Duty Motors Installed Inside the Conta of Water-Cooled Nuclear Power Plants (3/73)
1.41	Preoperational Testing of Redundant On-Site Electric Power Systems to Ve Proper Load Group Assignments (3/73)
1.42	Withdrawn-See 41 FR 11891, 3/22/76
1.43	Control of Stainless Steel Weld Cladding of Low-Alloy Steel Components (
1.44	Control of the Use of Sensitized Stainless Steel (5/73)
1.45	Reactor Coolant Pressure Boundary Leakage Detection Systems (5/73)
1.46	Protection Against Pipe Whip Inside Containment (5/73) (Withdrawn, 3/85)
1.47	Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety (5/73)
1.48	Design Limits and Loading Combinations for Seismic Category I Fluid Syst Components (5/73) (Withdrawn, 3/85)
1.49	Power Levels of Nuclear Power Plants (Revision 1, 12/73)
1.50	Control of Preheat Temperature for Welding of Low-Alloy Steel (5/73)
1.51	Withdrawn-See 40 FR 30510, 7/21/75

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
Regulatory Guides			
	3.2.9.2	Materials	-
	Not Applicable		Reactor Design Specific
	Not Applicable		Reactor Design Specific
ted	Not Applicable		Reactor Design Specific
ge and 7)	3.2.23.4	Quality Assurance	-
n 2, 9/77)	3.2.10.2	Accidents	-
inment	Not Applicable	-	Reactor Design Specific
rify	3.2.2.4	Electrical and Power Supply Systems	-
	Not Applicable	-	Withdrawn
5/73)	3.2.9.3	Materials	-
	3.2.9.4	Materials	-
	Not Applicable	-	Reactor Design Specific
	Not Applicable	-	Reactor Design Specific/Withdrawn
Systems	3.2.3.2	Instrumentation and Control	-
em	Not Applicable	-	Withdrawn
	Not Applicable	-	Reactor Design Specific
	3.2.9.5	Materials	
	Not Applicable	-	Withdrawn

Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 1 (Power Reactors)
1.52	Design, Testing, and Maintenance Criteria for Post Accident Engineered-S Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-W Nuclear Power Plants (Revision 2, 3/78)
1.53	Application of the Single-Failure Criterion to Nuclear Power Plant Prote Systems (6/73)
1.54	Quality Assurance Requirements for Protective Coatings Applied to Water- Nuclear Power Plants (6/73)
1.55	Withdrawn-See 46 FR 37579, 7/21/81
1.56	Maintenance of Water Purity in Boiling Water Reactors (Revision 1, 7/78)
1.57	Design Limits and Loading Combinations for Metal Primary Reactor Contain System Components (6/73)
1.58	Qualification of Nuclear Power Plant Inspection, Examination, and Testin (Revision 1, 9/80)
1.59	Design Basis Floods for Nuclear Power Plants (Revision 2, 8/77)
1.60	Design Response Spectra for Seismic Design of Nuclear Power Plants (Revision 1, 12/73)
1.61	Damping Values for Seismic Design of Nuclear Power Plants (10/73)
1.62	Manual Initiation of Protective Actions (10/73)
1.63	Electric Penetration Assemblies in Containment Structures for Light-Wate Nuclear Power Plants (Revision 2, 7/78)
1.64	Quality Assurance Requirements for the Design of Nuclear Power Plants (Revision 2, 6/76)
1.65	Materials and Inspections for Reactor Vessel Closure Studs (10/73)
1.66	Withdrawn-See 42 FR 54478, 10/6/77
1.67	Withdrawn, 4/83

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
Regulatory Guides			
afety-Feature ater-Cooled	3.2.6.1	Ventilation	-
tion	3.2.3.3	Instrumentation and Control	-
Cooled	3.2.23.5	Quality Assurance	-
	Not Applicable	-	Withdrawn
	Not Applicable	-	Reactor Design Specific
ment	Not Applicable	-	Reactor Design Specific
g Personnel	3.2.22.2	Personnel Training	-
	3.2.15.1	Flood Protection	-
	3.2.17.4	Seismic Design	-
	3.2.17.5	Seismic Design	-
	3.2.3.4	Instrumentation and Control	-
r-Cooled	Not Applicable	-	Reactor Design Specific
	3.2.23.6	Quality Assurance	-
	Not Applicable	-	Reactor Design Specific
	Not Applicable	-	Withdrawn
	Not Applicable	-	Withdrawn

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Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 1 (Power Reactors)
1.68	Initial Test Programs for Water-Cooled Reactor Power Plants (Revision 2,
1.68.1	Preoperational and Initial Startup Testing of Feedwater and Condensate S for Boiling Water Reactor Power Plants (Revision 1, 1/77)
1.68.2	Initial Startup Test Program to Demonstrate Remote Shutdown Capability f Water-Cooled Nuclear Power Plants (Revision 1, 7/78)
1.68.3	Preoperational Testing of Instrument and Control Air Systems (4/82)
1.69	Concrete Radiation Shields for Nuclear Power Plants (12/73)
1.70	Standard Format and Content of Safety Analysis Reports for Nuclear Power (Revision 3, 11/78)
1.71	Welder Qualification for Areas of Limited Accessibility (12/73)
1.72	Spray Pond Piping Made from Fiberglass-Reinforced Thermosetting Resin (Revision 2, 11/78)
1.73	Qualification Tests of Electric Valve Operators Installed Inside the Con of Nuclear Power Plants (1/74)
1.74	Quality Assurance Terms and Definitions (2/74)
1.75	Physical Independence of Electric Systems (Revision 2, 9/78)
1.76	Design Basis Tornado for Nuclear Power Plants (4/74)
1.77	Asumptions Used for Evaluating a Control Rod Ejection Accident For Press Reactors (5/74)
1.78	Assumptions for Evaluating the Habitability of a Nuclear Power Plant Con Room During a Postulated Hazardous Chemical Release (6/74)
1.79	Preoperational Testing of Emergency Core Cooling Systems for Pressurized Reactors (Revision 1, 9/75)
1.80	(Withdrawn-See 47 FR 192.8 5/4/82) Reissued as Regulatory Guide 1.68.3, renumbered revision to this guide with an expanded scope that addresses air systems (4/82)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
Regulatory Guides			
8/78)	Not Applicable	-	Reactor Design Specific
ystems	Not Applicable		Reactor Design Specific
or	Not Applicable		Reactor Design Specific
	Not Applicable	-	Reactor Design Specific
	3.2.13.1	Shielding	-
Plants	Not Applicable	-	Reactor Design Specific
	3.2.9.6	Materials	-
	Not Applicable	-	Reactor Design Specific
tainment	Not Applicable	-	Reactor Design Specific
	3.2.23.7	Quality Assurance	-
	3.2.2.6	Electrical and Power Supply Systems	-
	3.2.16.1	Tornado	-
urized Water	Not Applicable	-	Reactor Design Specific
trol	3.2.10.3	Accidents	-
Water	Not Applicable	-	Reactor Design Specific
a control	Not Applicable	-	Withdrawn

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Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 1 (Power Reactors)
1.81	Shared Emergency and Shutdown Electric Systems for Multi-unit Power Plan (Revision 1, 1/75)
1.82	Sumps for Emergency Core Cooling and Containment Spray Systems (6/74)
1.83	Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes (Revision 1, 7/75)
1.84	Design and Fabrication Code Case Acceptability-ASME Section III, Divisio (Revision 22, 7/84)
1.85	Materials Code Case Acceptability - ASME Section III, Division 1. (Revision 22, 7/84)
1.86	Termination of Operating Licenses for Nuclear Reactors (6/74)
1.87	Guidance for Construction of Class 1 Components in Elevated-Temperature (Supplement to ASME Section III Code Cases 1592, 1593, 1594, 1595, and 1 (Revision 1, 6/75)
1.88	Collection, Storage, and Maintenance of Nuclear Power Plant Quality Assu (Revision 2, 10/76)
1.89	Environmental Qualification of Certain Electric Equipment Important to S Power Plants (Revision 1, 6/84)
1.90	Inservice Inspection of Prestressed Concrete Containment Structures with Tendons (Revision 1, 8/77)
1.91	Evaluations of Explosions Postulated to Occur on Transportation Routes N Power Plant Sites (Revision 1, 2/78)
1.92	Combining Modal Responses and Spatial Components in Seismic Response Ana (Revision 1, 2/76)
1.93	Availability of Electric Power Sources (12/74)
1.94	Quality Assurance Requirements for Installation, Inspection, and Testing Structural Concrete and Structural Steel During the Construction Phase o Nuclear Power Plants (Revision 1, 4/76)
1.95	Protection of Nuclear Power Plant Control Room Operators Against an Acci Chlorine Release (Revision 1, 1/77)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability Technical Review Section	Categorized Subject	Remarks
Regulatory Guides			
ts	Not Applicable	-	Reactor Design Specific
	Not Applicable	-	Reactor Design Specific
	Not Applicable	-	Reactor Design Specific
n 1.	Not Applicable		Reactor Design Specific
	Not Applicable		Reactor Design Specific
	Not Applicable		Reactor Design Specific
Reactors 596)	Not Applicable	-	Reactor Design Specific
rance Records	3.2.23.8	Quality Assurance	-
afety for Nuclear	3.2.2.7	Electrical and Power Supply Systems	-
Grouted	Not Applicable	-	Reactor Design Specific
ear Nuclear	3.2.10.4	Accidents	-
lysis	3.2.17.6	Seismic Design	-
	3.2.2.8	Electrical and Power Supply Systems	-
of f	3.2.23.9	Quality Assurance	-
dental	3.2.10.5	Accidents	-

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Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 1 (Power Reactors)
1.96	Design of Main Steam Isolation Valve Leakage Control systems for Boiling Reactor Nuclear Power Plants (Revision 1, 6/76)
1.97	Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Pl Environs Conditions During and Following an Accident (Revision 3, 5/83)
1.98	Assumptions Used for Evaluating the Potential Radiological Consequences Radioactive Offgas System Failure in a Boiling Water Reactor (3/76)
1.99	Effects of Residual Elements on Predicted Radiation Damage to Reactor Ve Materials (Revision 1, 4/77)
1.100	Seismic Qualifications of Electric Equipment for Nuclear Power Plants (Revision 1, 8/77)
1.101	Emergency Planning and Preparedness for Nuclear Power Reactors (Revision
1.102	Flood Protection for Nuclear Power Plants (Revision 1, 9/76)
1.103	Withdrawn-See 46 FR 37579, 7/21/81
1.104	(Withdrawn-See 44 FR 49321, 8/22/79) See NUREG-0554, "Single-Failure-Pro for Nuclear Power Plants."
1.105	Instrument Setpoints (Revision 1, 11/76)
1.106	Thermal Overload Protection for Electric Motors on Motor-Operated Valves (Revision 1, 3/77)
1.107	Qualifications for Cement Grouting for Prestressing Tendons in Containme Structures (Revision 1, 2/77)
1.108	Periodic Testing of Diesel Generators Units Used as Onsite Electric Powe at Nuclear Power Plants (Revision 1, 8/77)
1.109	Calculation of Annual Doses to Man from Routine Releases of Reactor Effl the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I (Revision 1, 10/77)
1.110	Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclea Reactors (3/76)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
Regulatory Guides			
Water	Not Applicable	-	Reactor Design Specific
ant and	3.2.3.5	Instrumentation and Control	-
of a	3.2.11.3	Radiological Assessment	-
ssel	Not Applicable	-	Reactor Design Specific
	3.2.17.7	Seismic Design	-
2, 10/81)	3.2.21.1	Emergency planning	-
	3.2.15.3	Flood Protection	-
	Not Applicable	-	Withdrawn
of Cranes	Not Applicable	-	Withdrawn
	3.2.3.6	Instrumentation and Control	-
	3.2.2.9	Electrical and Power Supply Systems	-
nt	Not Applicable		Reactor Design Specific
r Systems	3.2.2.10	Electrical and Power Supply Systems	-
uents for	3.2.11.4	Radiological Assessment	-
r Power	3.2.11.5	Radiological Assessment	-

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Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 1 (Power Reactors)
1.111	Methods for Estimating Atmospheric Transport and Dispersion of Gaseous E in Routine Releases from Light-Water-Cooled Reactors (Revision 1, 7/77)
1.112	Calculation of Releases of Radioactive Materials in Gaseous and Liquid E from Light-Water-Cooled Power Reactors (Revision 0-R, 5/77)
1.113	Estimating Aquatic Dispersion of Effluents from Accidental and Routine R Releases for the Purpose of Implementing Appendix I (Revision 1, 4/77)
1.114	Guidance on Being Operator at the Controls of a Nuclear Power Plant (Revision 1, 11/76)
1.115	Protection Against Low-Trajectory Turbine Missiles (Revision 1, 7/77)
1.116	Quality Assurance Requirements for Installation, Inspection, and Testing Mechanical Equipment and Systems (Revision 0-R, 5/77)
1.117	Tornado Design Classification (Revision 1, 4/78)
1.118	Periodic Testing of Electric Power and Protection systems (Revision 2, 6
1.119	Withdrawn-See 42 FR 33387, 6/30/77
1.120	Fire Protection Guidelines for Nuclear Power Plants (Revision 1, 11/77)
1.121	Bases for Plugging Degraded PWR Steam Generator Tubes (8/76)
1.122	Development of Floor Design Response Spectra for Seismic Design of Floor Equipment or Components (Revision 1, 2/78)
1.123	Quality Assurance Requirements for Control of Procurement of Items and S for Nuclear Power Plants (Revision 1, 7/77)
1.124	Service Limits and Loading Combinations for Class 1 Linear-Type Componen Supports (Revision 1, 1/78)
1.125	Physical Models for Design and Operation of Hydraulic Structures and Sys Nuclear Power Plants (Revision 1, 10/78)
1.126	An Acceptable Model and Related Statistical Methods for the Analysis of Densification (Revision 1, 3/78)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
Regulatory Guides			
ffluents	3.2.18.1	Transport and Dispersion	-
ffluents	3.2.18.2	Transport and Dispersion	-
eactor	3.2.18.3	Transport and Dispersion	-
	Not Applicable	-	Reactor Design Specific
	Not Applicable	-	Power Plant Specific
of	3.2.23.10	Quality Assurance	-
	3.2.16.2	Tornado	-
/78)	3.2.2.11	Electrical and Power Supply Systems	-
	Not Applicable	-	Withdrawn
	3.2.7.1	Fire Protection	-
	Not Applicable	-	Reactor Design Specific
-Supported	3.2.17.8	Seismic Design	-
ervices	3.2.23.11	Quality Assurance	-
t	Not Applicable	-	Pressure Boundary Components
tems for	3.2.1.4	Civil, Structural and Site	-
Fuel	Not Applicable	-	Reactor Design Specific

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Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 1 (Power Reactors)
1.127	Inspection of Water-Control Structures Associated with Nuclear Power Pla (Revision 1, 3/78)
1.128	Installation Design and Installation of Large Lead Storage Batteries for Power Plants (Revision 1, 10/78)
1.129	Maintenance, Testing, and Replacement of Large Lead Storage Batteries fo Power Plants (Revision 1, 2/78)
1.130	Service Limits and Loading Combinations for Class 1 Plate-and Shell-Type Supports (Revision 1, 10/78)
1.131	Qualification Tests of Electric Cables, Field Splices, and Connections f Water-Cooled Nuclear Power Plants (8/77)
1.132	Site Investigations for Foundations of Nuclear Power Plants (Revision 1
1.133	Loose-Part Detection Program for the Primary System of Light-Water-Coole (Revision 1, 5/81)
1.134	Medical Evaluation of Nuclear Power Plant Personnel Requiring Operator L (Revision 1, 3/79)
1.135	Normal Water Level and Discharge at Nuclear Power Plants (9/77)
1.136	Materials, Construction, and Testing of Concrete Containments (Revision
1.137	Fuel-Oil Systems for Standby Diesel Generators (Revision 1, 10/79)
1.138	Laboratory Investigations of Soils for Engineering Analysis and Design o Power Plants (4/78)
1.139	Guidance for Residual Heat Removal (5/78)
1.140	Design, Testing, and Maintenance Criteria for Normal Ventilation Exhaus Air Filtration and Adsorption Units of Light-Water-Colled Nuclear Power (Revision 1, 10/79)
1.141	Containment Isolation Provisions for Fluid Systems (4/78)
1.142	Safety-Related Concrete Structures for Nuclear Power Plants (Revision 1

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
Regulatory Guides			
nts	Not Applicable	-	Power Plant Specific
Nuclear	3.2.2.12	Electrical and Power Supply Systems	-
r Nuclear	3.2.2.13	Electrical and Power Supply Systems	-
Component	Not Applicable	-	Pressure Boundary Components
or Light-	3.2.2.14	Electrical and Power Supply Systems	-
3/79)	3.2.1.5	Civil, Structural and Site	-
d Reactors	Not Applicable	-	Reactor Design Specific
icenses	3.2.22.3	Personnel Training	-
	Not Applicable	-	Power Plant Specific
2, 6/81)	3.2.1.6	Civil, Structural and Site	
	3.2.4.4	Mechanical Systems/ Components	
f Nuclear	3.2.1.7	Civil Structural and Site	
	Not Applicable	-	Reactor Design Specific
System Plants	3.2.6.2	Ventilation	-
	Not Applicable	-	Reactor Design Specific
10/81)	3.2.1.8	Civil, Structural and Site	-

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Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 1 (Power Reactors)
1.143	Design Guidance for Radioactive Waste Management Systems, Structures, an Components Installed in Light-Water-Cooled Nuclear Power Plants (Revisio
1.144	Auditing of Quality Assurance Programs for Nuclear Power Plants (Revisio
1.145	Atmospheric Dispersion Models for Potential Accident Consequence Assessm Nuclear Power Plants (Reissued February 1983)
1.146	Qualification of Quality Assurance Program Audit Personnel for Nuclear P (8/80)
1.147	Inservice Inspection Code Case Acceptability-ASME Section XI Division 1 (Revision 3, 7/84)
1.148	Functional Specification for Active Valve Assemblies in Systems Importan in Nuclear Power Plants (3/81)
1.149	Nuclear Power Plant Simulators for Use in Operating Training (4/81)
1.150	Ultrasonic Testing of Reactor Vessel Welds During Preservice and Inservi Examinations (Revision 1, 2/83)
1.151	Instrument Sensing Lines (7/83)
	Division 2 (Research and Test Rea
2.1	Shield Test Program for Evaluation of Installed Biological Shielding in and Training Reactors (5/73)
2.2	Development of Technical Specifications for Experiments in Research Reac (11/73)
2.3	Quality Verification for Plate-Type Uranium-Aluminum Fuel Elements for U Research Reactors (Revision 1, 7/76)
2.4	Review of Experiments for Research Reactors (Revision 0-R, 10/77)
2.5	Quality Assurance Program Requirements for Research Reactors (Revision 0
2.6	Emergency Planning for Research Reactors (Revision 1, 3/83)
	Division 3 (Fuels and Materials Fac
3.1	Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutio Fissile Material (Revision 1, 1/82)

ble Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
Regulatory Guides			
d n 1, 10/79)	3.2.4.5	Mechanical Systems/ Components	-
n 1, 9/80)	3.2.23.12	Quality Assurance	-
ents at	3.2.18.4	Transport and Dispersion	-
ower Plants	3.2.23.13	Quality Assurance	-
	3.2.8.1	Inservice Inspection	-
t to Safety	3.2.4.6	Mechanical Systems/ Components	-
	Not Applicable	-	Power Plant Specific
ce	3.2.8.2	Inservice Inspection	-
	Not Applicable		Reactor Design Specific
ctors) Regulatory Guides			
Research	Not Applicable	-	Reactor Design Specific
tors	Not Applicable	-	Reactor Design Specific
se in	Not Applicable	-	Reactor Design Specific
	Not Applicable	-	Reactor Design Specific
-R, 10/77)	Not Applicable	-	Reactor Design Specific
	Not Applicable	-	Reactor Design Specific
ilities) Regulatory Guides			
ns of	Not Applicable	-	Process Solutions Specific

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Appendix A - Summary Table for the Selection of Adaptable Reg

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 3 (Fuels and Materials Fac
3.2	Efficiency Testing of Air-Cleaning Systems Containing Devices for Remova Particles (1/73)
3.3	Quality Assurance Program Requirements for Fuel Reprocessing Plants and Plutonium Processing and Fuel Fabrication Plants (Revision 1, 3/74)
3.4	Nuclear Criticality Safety in Operations with Fissionable Materials Outs Reactors (Revision I-R, 2/78)
3.5	Standard Format and Content of License Applications for Uranium Mills (Revision 1, 11/77)
3.6	Content of Technical Specifications for Fuel Reprocessing Plants (4/73)
3.7	Monitoring of Combustible Gases and Vapors in Plutonium Processing and F Fabrication Plants (3/73)
3.8	Preparation of Environmental Reports for Uranium Mills (Revision 2, 10/8
3.9	Concrete Radiation Shields (6/73)
3.10	Liquid Waste Treatment System Design Guide for Plutonium Processing and Fabrication Plants (6/73)
3.11	Design, Construction, and Inspection of Embankment Retention Systems for Mills (Revision 2, 12/77)
3.11.1	Operational Inspection and Surveillance of Embankment Retention Systems Uranium Mill Tailings (Revision 1, 11/80)
3.12	General Design Guide for Ventilation Systems of Plutonium Processing and Fabrication Plants (8/73)
3.13	Guide for Acceptable Waste Storage Methods at UF_6 Production Plants (10/
3.14	Seismic Design Classification for Plutonium Processing and Fuel Fabricat Plants (10/73)
3.15	Standard Format and Content of License Applications for Storage Only of Unirradiated Reactor Fuel and Associated Radioactive Material (Revision
3.16	General Fire Protection Guide for Plutonium Processing and Fuel Fabricat (1/74)

ulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
ilities) Regulatory Guides			
l of	3.2.6.3	Ventilation	-
for	Not Applicable	-	Endorses Nuclear Plant Standard
ide	3.2.12.1	Criticality	-
	Not Applicable	-	Mill Tailings Specific
	3.2.25.1	General	
uel	Not Applicable	-	Process Plant Specific
2)	Not Applicable	-	Uranium Mill Specific
	3.2.13.2	Shielding	-
Fuel	Not Reveiwed		Processing Plant Specific
Uranium	Not Reveiwed		Mill Tailings Specific
for	Not Applicable		Mill Tailings Specific
Fuel	3.2.6.4	Ventilation	-
73)	Not Applicable	-	Production Plant Specific
ion	3.2.17.9	Seismic Design	-
1, 4/83)	Not Applicable	-	Unirradiated Fuel Specific
ion Plants	3.2.7.2	Fire Protection	-

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Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 3 (Fuels and Materials Fac
3.17	Earthquake Instrumentation for Fuel Reprocessing Plants (2/74)
3.18	Confinement Barriers and Systems for Fuel Reprocessing Plants (2/74)
3.19	Reporting of Operating Information for Fuel Reprocessing Plants (2/74)
3.20	Process Offgas Systems for Fuel Reprocessing Plants (2/74)
3.21	Quality Assurance Requirements for Protective Coatings Applied to Fuel R and to Plutonium Processing and Fuel Fabrication Plants (3/74)
3.22	Periodic Testing of Fuel Reprocessing Plant Protection System Actuation Functions (6/74)
3.23	Withdrawn-See 45 FR 71876, 10/30/80
3.24	Withdrawn-See 46 FR 14507, 2/27/81
3.25	Standard Format and Content of Safety Analysis Reports for Uranium Facil (12/74)
3.26	Standard Format and Content of Safety Analysis Reports for Fuel Reproces Plants (2/75)
3.27	Nondestructive Examination of Welds in the Liners of Concrete Barriers i Reprocessing Plants (Revision 1, 5/77)
3.28	Welder Qualification for Welding in Areas of Limited Accessibility in Fu Reprocessing Plants and in Plutonium Processing and Fuel Fabrication Pla
3.29	Preheat and Interpass Temperature Control for the Welding of Low-Alloy S Use in Fuel Reprocessing Plants and in Plutonium Processing and Fuel Fab Plants (5/75)
3.30	Selection, Application, and Inspection of Protective Coatings (Paints) f Reprocessing Plants (Revision 0-R, 5/77)
3.31	Emergency Water Supply Systems for Fuel Reprocessing Plants (Revision 0-

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
ilities) Regulatory Guides			
	3.2.17.10	Seismic Design	-
	3.2.6.5	Ventilation	-
	3.2.2.5.2	General	-
	3.2.4.7	Mechanical Systems/ Components	-
eprocessing	3.2.23.14	Quality Assurance	-
	3.2.3.7	Instrumentation and Control	-
	Not Applicable	-	Withdrawn
	Not Applicable	-	Withdrawn
ities	Not Applicable	-	Reprocessing Plant Specific
sing	Not Applicable	-	Reprocessing Plant Specific
n Fuel	3.2.9.8	Materials	-
el nts (5/75)	3.2.9.9	Materials	-
teel for rication	3.2.9.10	Materials	-
or Fuel	3.2.4.8	Mechanical Systems/ Components	-
R, 5/77)	3.2.4.9	Mechanical System/ Components	-

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Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 3 (Fuels and Materials Fac
3.32	General Design Guide for Ventilation Systems for Fuel Reprocessing Plant
3.33	Assumptions Used for Evaluating the Potential Radiological Consequences Accidental Nuclear Criticality in a Fuel Reprocessing Plant (4/77)
3.34	Assumptions Used for Evaluating the Potential Radiological Consequences Accidental Nuclear Criticality in a Uranium Fuel Fabrication Plant (Revision 1, 7/79)
3.35	Assumptions Used for Evaluating the Potential Radiological Consequences Accidental Nuclear Criticality in a Plutonium Processing and Fuel Fabrication Plant (Revision 1, 7/79)
3.36	Withdrawn - See 44FR 6535, 2/1/79
3.37	Guidance for Avoiding Intergranular Corrosion and Stress Corrosion in Au Stainless Steel Components of Fuel Reprocessing plants (9/75)
3.38	General Fire Protection Guide for Fuel Reprocessing Plants (6/76)
3.39	Standard Format and Content of License Applications for Plutonium Proces Fuel Fabrication Plants (1/76)
3.40	Design Basis Floods for Fuel Reprocessing Plants and for Plutonium Proce Fuel Reprocessing Plants (Revision 1, 12/77)
3.41	Validation of Calculational Methods for Nuclear Criticality Safety (Revi
3.42	Emergency Planning for Fuel Cycle Facilities and Plants Licensed Under 1 and 70 (Revision 1, 9/79)
3.43	Nuclear Criticality Safety in the Storage of Fissile Materials (Revision
3.44	Standards Format and Content for the Safety Analysis Report for an Indep Fuel Storage Installation (Water-Basin Type) (Revision 1, 11/80)
3.45	Nuclear Criticality Safety for Pipe Intersections Containing Aqueous So Enriched Uranyl Nitrate (11/80)
3.46	Standard Format and Content of License Applications, Including Environme Reports, for In Situ Uranium Solution Mining (6/82)
3.47	Nuclear Criticality Control and Safety of Homogeneous Plutonium-Uranium Mixtures Outside Reactors (7/81)
3.48	Standard Format and Content for the Safety Analysis Report for an Indepe Fuel Storage Installation (Dry Storage) (10/81)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
ilities) Regulatory Guides			
s (9/75)	3.2.6.6	Ventilation	-
of	3.2.12.2	Criticality	-
of	Not Applicable	-	Fabrication Plant Specific
of	Not Applicable	-	Plutonium Processing Plant Specific
	Not Applicable	-	Withdrawn
stenitic	3.2.9.11	Materials	-
	3.2.7.3	Fire Protection	-
sing and	Not Applicable	-	Processing Plant Specific
ssing and	3.2.15.2	Flood Protection	-
sion 1, 5/77)	3.2.12.3	Criticality	-
0 CFR 50	3.2.21.2	Emergency Planning	-
1, 4/79)	3.2.12.4	Criticality	-
endent Spent	Not Reviewed	-	Water - Basin Specific
utions f	Not Applicable	-	Processing Plant Specific
ntal	Not Applicable	-	Uranium Mining Specific
Fuel	Not Applicable	-	Material Not Expected
ndent Spent	Not Reviewed		ISFSI Related

Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 3 (Fuels and Materials Fac
3.49	Design of an Independent Spent Fuel Storage Installation (Water-Basin Ty
3.50	Guidance on Preparing a License Application to Store Spent Fuel in an In Spent Fuel Storage Installation (1/82)
3.51	Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Milling Operations (3/82)
3.52	Standard Format and Content for the Health and Safety Sections of Licens Renewal Applications for Uranium Fuel Fabrication Plants (7/82)
3.53	Applicability of Existing Regulatory Guides to the Design and Operation Independent Spent Fuel Storage Installation (7/82)
3.54	Spent Fuel Heat Generation in on Independent Spent Fuel Storage Installa (9/84)
3.55	Standard Format and Content for the Health and Safety Section of License Applications for Uranium Hexafluoride Production (4/85)
	Division 4 (Environmental and Si
4.1	Programs for Monitoring Radioactivity in the Environs of Nuclear Power P (Revision 1, 4/75)
4.2	Preparation of Environmental Reports for Nuclear Power Stations (Revisio
4.2.1	Additional Guidance - Environmental Data (4/74)
4.3	Measurements of Radionuclides in the Environment - Analysis of I-131 in (Withdrawn 12/76)
4.4	Reporting Procedure for Mathematical Models Selected to Predict Heated E Dispersion in Natural Water Bodies (5/74)
4.5	Measurements of Radionuclides in the Environment - Sampling and Analysis Plutonium in Soil (5/74)
4.6	Measurements of Radionuclides in the Environment - Strontium-89 and Stro Analyses (5/74)
4.7	General Site Suitability Criteria for Nuclear Power Stations (Revision 1
4.8	Environmental Technical Specifications for Nuclear Power Plants (12/75)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
ilities) Regulatory Guides			
pe) (12/81)	Not Reviewed	–	ISFSI Related
dependent	Not Reviewed	–	ISFSI Related
	Not Applicable	–	Milling Operations Specific
e	Not Applicable	–	Fuel Fabrication Specific
of an	Not Reviewed	–	ISFSI Related
tion	Not Reviewed	–	ISFSI Related
Renewal	Not Applicable		Fuel Production Related
ting) Regulatory Guides			
lants	3.2.11.6	Radiological Assessment	–
n 2, 7/76)	Not Applicable	–	Environmentally Related
	Not Applicable	–	Environmentally Related
Milk	Not Applicable	–	Withdrawn
ffluent	Not Applicable	–	Environmentally Related
of	3.2.11.7	Radiological Assessment	–
ntium-90	3.2.11.8	Radiological	–
, 11/75)	Not Applicable	–	Power Plant Specific
	Not Applicable	–	Environmentally Related

Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 4 (Environmental and Si
4.9	Preparation of Environmental Reports for Commercial Uranium Enrichment F (Revision 1, 10/75)
4.10	Irreversible and Irretrievable Commitments of Material Resources (Withdrawn 11/17/77)
4.11	Terrestrial Environmental Studies for Nuclear Power Stations (Revision 1
4.12	(Not Issued)
4.13	Performance, Testing and Procedural Specifications for Thermoluminescenc Dosimetry: Environmental Applications (Revision 1, 7/77)
4.14	Radiological Effluent and Environmental Monitoring at Uranium Mills (Revision 1, 4/80)
4.15	Quality Assurance for Radiological Monitoring Programs (Normal Operation Effluent Streams and the Environment (Revision 1, 2/79)
4.16	Measuring, Evaluating, and Reporting Radioactivity in Releases of Radioa Materials in Liquid and Airborne Effluents from Nuclear Fuel Processing Fabrication Plants (3/78)
4.17	Standard Format and Content of Site Characterization Reports for High-le Geologic Repositories (7/82)
4.18	Standard Format and Content of Environmental Reports for Near-Surface Disposal of Radioactive Waste (6/83)

le Regulatory Guides (Listec Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
ting) Regulatory Guides			
acilities	Not Applicable	-	Environmentally Related/Enrichment Facilities Specific
	Not Applicable	-	Withdrawn
, 8/77)	Not Applicable	- Related	Environmentally
e	3.2.11.9	Radiological Assessment	-
	Not Applicable	-	Uranium Mill Specific
s) -	3.2.23.15	Quality Assurance	-
ctive and	3.2.11.10	Radiological Assessment	-
vel-Waste	Not Applicable	-	Repository Specific
	Not Applicable	-	Low Level Waste Disposal Facility Specific

Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 5 (Materials and Plant Pro
5.1	Serial Numbering of Fuel Assemblies for Light-Water-Cooled Nuclear Power (12/72)
5.2	Withdrawn-See 44 FR 57542, 10/5/79
5.3	Statistical Terminology and Notation for Special Nuclear Materials Contr Accountability (2/73)
5.4	Standard Analytical Methods for the Measurement of Uranium Tetrafluoride and Uranium Hexafluoride (2/73)
5.5	Standard Methods for Chemical, Mass Spectrometric, and Spectrochemical A Nuclear-Grade Uranium Dioxide Powders and Pellets (2/73)
5.6	Standard Methods for Chemical, Mass Spectrometric, and Spectrochemical A Nuclear-Grade Plutonium Dioxide Powders and Pellets and Nuclear-Grade Mi (5/73)
5.7	Entry/Exit Control for Protected Areas, Vital Areas, and Material Access (Revision 1, 5/80)
5.8	Design Considerations for Minimizing Residual Holdup of Special Nuclear Drying and Fluidized Bed Operations (Revision 1, 5/74)
5.9	Specifications for Ge(Li) Spectroscopy Systems for Material Protection M (Revision 2, 1/84)
5.10	Selection and Use of Pressure-Sensitive Seals on Containers for Onsite S Special Nuclear Material (7/73)
5.11	Nondestructive Assay of Special Nuclear Material Contained in Scrap and (Revision 1, 4/84)
5.12	General Use of Locks in the Protection and Control of Facilities and Spe Nuclear Materials (11/73)
5.13	Conduct of Nuclear Material Physical Inventories (11/73)
5.14	Use of Observation (Visual Surveillance) Techniques in Material Access A (Revision 1, 5/80)
5.15	Security Seals for the Protection and Control of Special Nuclear Materia
5.16	Standard Methods for Chemical, Mass Spectrometric, Spectrochemical, Nucl Radiochemical Analysis of Nuclear-Grade Plutonium Nitrate Solution and P Metal (Revision 1, 5/75)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

tection) Regulatory Guides

	Applicability/ Technical Review Section	Categorized Subject	Remarks
Reactors	3.2.20.1	Material Accounting	-
	Not Applicable	-	Withdrawn
ol and	3.2.20.2	Material Accounting	-
(UF_4)	Not Applicable		UF Specific
nalysis of	Not Applicable		Operation Not Expected
nalysis of xed Oxides	Not Applicable		Operation Not Expected
Areas	3.2.19.2	Safeguard and Security	-
Material in	Not Applicable	-	Process Operations
easurements	Not Applicable	-	Utilization Not Expected
torage of	3.2.19.3	Safeguard and Security	-
Waste	Not Applicable	-	Operation Not Expected
cial	3.2.19.4	Safeguard and Security	-
	3.2.20.3	Material Accounting	-
reas	3.2.19.5	Safeguard and Security	-
l (1/74)	3.2.19.6	Safeguard and Security	-
ear, and lutonium	Not Applicable	-	Material Not Expected

Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 5 (Materials and Plant Pro
5.17	Truck Identification Markings (1/74)
5.18	Limit of Error Concepts and Principles of Calculation in Nuclear Materia (1/74)
5.19	Methods for the Accountability of Plutonium Nitrate Solutions (1/74)
5.20	Training, Equipping, and Qualifying of Guards and Watchmen (1/74)
5.21	Nondestructive Uranium-235 Enrichment Assay by Gamma-Ray Spectrometry (R
5.22	Assessment of the Assumption of Normality (Employing Individual Observed (4/74)
5.23	In Situ Assay of Plutonium Residual Holdup (Revision 1, 2/84)
5.24	Analysis and Use of Process Data for the Protection of Special Nuclear M (6/74)
5.25	Design Considerations for Minimizing Residual Holdup of Special Nuclear in Equipment for Wet Process Operations (6/74)
5.26	Selection of Material Balance Areas and Item Control Areas (Revision 1,
5.27	Special Nuclear Material Doorway Monitors (6/74)
5.28	Evaluation of Shipper-Receiver Differences in the Transfer of Special Nu Materials (6/74)
5.29	Nuclear Material Control Systems for Nuclear Power Plants (Revision 1, 6
5.30	Materials Protection Contingency Measures for Uranium and Plutonium Fuel Manufacturing Plants (6/74)
5.31	Specially Designed Vehicle with Armed Guards for Road Shipment of Specia Material (Revision 1, 4/75)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
tection) Regulatory Guides			
	3.2.19.7	Safeguard and Security	-
ls Control	3.2.20.4	Material Accounting	-
	Not Applicable	-	Material Not Expected
	3.2.19.8	Safeguard and Security	-
evision 1, 1/84)	Not Applicable	-	Utilization Not Expected
Values)	Not Applicable	-	Utilization Not Expected
	Not Applicable		Plutonium Inventory Specific
aterial	Not Applicable		utilization Not Expected
Material	Not Applicable	-	Wet Process Related
4/75)	3.2.20.5	Material Accounting	-
	3.2.20.6	Material Accounting	-
clear	3.2.20.7	Material Accounting	-
/75)	3.2.20.8	Material Accounting	-
	Not Applicable	-	Fabrication Plant Related
l Nuclear	Not Applicable	-	Transportation Related

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 5 (Materials and Plant Pro
5.32	Communication with Transport Vehicles (Revision 1, 5/75)
5.33	Statistical Evaluation of Material Unaccounted For (6/74)
5.34	Nondestructive Assay for Plutonium in Scrap Material by Spontaneous Fiss Detection (Revision 1, 5/84)
5.35	Withdrawn-See 42 FR 41677, 8/18/77
5.36	Recommended Practice for Dealing with Outlying Observations (6/74)
5.37	In Situ Assay of Enriched Uranium Residual Holdup (Revision 1, 10/83)
5.38	Nondestructive Assay of High Enrichment Uranium Fuel Plates by Gamma Ray Spectrometry (Revision 1, 10/83)
5.39	General Methods for the Analysis of Uranyl Nitrate Solutions for Assay, Distribution, and Impurity Determinations (12/74)
5.40	Methods for the Accountability of Plutonium Dioxide Powder (12/74)
5.41	(Not issued)
5.42	Design Consideratons for Minimizing Residual Holdup of Special Nuclear M in Equipment for Dry Process Operations (1/75)
5.43	Plant Security Force Duties (1/75)
5.44	Perimeter Intrusion Alarm Systems (Revision 2, 5/80)
5.45	Standard Format and Content for the Special Nuclear Material Control and Accounting Section of a Special Nuclear Material License Application (12
5.46	(Not Issued)
5.47	Control and Accountability of Plutonium in Waste Material (2/75)

e Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
ection) Regulatory Guides			
	3.2.19.9	Safeguard and Security	-
	Not Applicable	-	Utilization Not Expected
ion	Not Applicable	-	Material Not Expected
	Not Applicable	-	Withdrawn
	3.2.20.9	Material Accounting	-
	Not Applicable	-	Process Related
	Not Applicable	-	Material Not Expected
Isotopic	Not Applicable		Material Not Expected
	Not Applicable		Material Not Expected
	Not Applicable		Not Issued
aterial	Not Applicable	-	Process Operation Not Expected
	3.2.19.10	Safeguard and Security	-
	3.2.19.11	Safeguard and Security	-
/74)	Not Applicable	-	Not Pertinent
	Not Applicable	-	Not Issued
	Not Applicable	-	Material Not Expected

Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 5 (Materials and Plant Pro
5.48	Design Considerations-Systems for Measuring the Mass of Liquids (2/75)
5.49	Internal Transfers of Special Nuclear Material (3/75)
5.50	(Not issued)
5.51	Management Review of Nuclear Material Control and Accounting Systems (6/
5.52	Standard Format and Content of a Licensee Physical Protection Plan for S Special Nuclear Material at Fixed Sites (Revision 2, 7/80)
5.53	Qualification, Calibration, and Error Estimation Methods for Nondestruct (Revision 1, 2/84)
5.54	Standard Format and Content of Safeguards Contingency Plans for Nuclear Plants (3/78)
5.55	Standard Format and Content of Safeguards Contingency Plans for Fuel Cyc Facilities (3/78)
5.56	Standard Format and Content of Safeguards Contingency Plans for Transpor (3/78)
5.57	Shipping and Receiving Control of Strategic Special Nuclear Material (Revision 1, 6/80)
5.58	Considerations for Establishing Traceability of Special Nuclear Material Accounting Measurements (Revision 1, 2/80)
5.59	Standard Format and Content for a Licensee Physical Security Plan for th Protection of Special Nuclear Material of Moderate or Low Strategic Sign (Revision 1, 2/83)
5.60	Standard Format and Content of a Licensee Physical Protection Plan for S Special Nuclear Material in Transit (4/80)
5.61	Intent and Scope of the Physical Protection Upgrade Rule Requirements fo Sites (6/80)
5.62	Reporting of Physical Security Events (2/81)
5.63	Physical Protection for Transient Shipments (7/82)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
tection) Regulatory Guides			
	Not Applicable	-	Material Not Expected
	3.2.19.12	Safeguard and Security	-
	Not Applicable	-	Not Issued
75)	3.2.20.10	Material Accounting	-
trategic	Not Applicable	-	Not Pertient
ive Assay	Not Applicable	-	Utilization Not Expected
Power	Not Applicable	-	Nuclear Power Plant Related
le	3.2.19.13	Safeguard and Security	-
tation	Not Applicable	-	Transportation Related
	3.2.20.11	Material Accounting	-
	Not Applicable	-	Utilization Not Expected
e ificance	3.2.19.14	Safeguard and Security	-
trategic	Not Applicable	-	Transportation Related
r Fixed	3.2.19.15	Safeguard and Security	-
	3.2.19.16	Safeguard and Security	-
	Not Applicable	-	Transient Shipments Related

Appendix A - Summary Table for the Selection of Potentially Adaptab

Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 6 (Products) Re
6.1	Leak Testing Radioactive Brachytherapy Sources (Revision 1, 7/74)
6.2	Integrity and Test Specifications for Selected Brachytherapy Sources (Revision 1, 7/74)
6.3	Design, Construction, and Use of Radioisotopic Power Generators for Cert Land and Sea Applications (3/74)
6.4	Classification of Containment Properties of Sealed Radioactive Sources (Revision 2, 8/80)
6.5	General Safety Standard for Installations Using Nonmedical Sealed Gamma- Sources (6/74)
6.6	Acceptance Sampling Procedures for Exempted and Generally Licensed Items Containing Byproduct Material (6/74)
6.7	Preparation of an Environmental Report to Support a Rule Making Petition an Exemption for a Radionuclide-Containing Product (Revision 1, 6/76)
6.8	Identification Plaque for Irretrievable Well-Logging Sources (10/78)
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7.2	Packaging and Transportation of Radioactively Contaminated Biological Ma (6/74)
7.3	Procedures for Picking Up and Receiving Packages of Radioactive Material
7.4	Leakage Tests on Packages for Shipment of Radioactive Materials (6/75)
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7.6	Design Criteria for the Structural Analysis of Shipping Cask Containment (Revision 1, 3/78)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
gulatory Guides			
	Not Applicable	-	Medical Application Related
	Not Applicable	-	Medical Application Related
ain	Not Applicable	-	Radioisotopic Power Generators Related
	Not Applicable	-	Materials Not Expected
Ray	Not Applicable	-	Materials Not Expected
	Not Applicable	-	Byproduct Materials Related
Seeking	Not Applicable	-	Environmentally Related
	Not Applicable	-	Situation Not Expected
Regulatory Guides			
(6/74)	Not Applicable	-	Transportation Related
terials	Not Applicable	-	Transportation Related
s (5/75)	3.2.24.1	Transportation Interface	
	3.2.24.2	Transportation Interface	
nts over	Not Applicable	-	Transportation Related
Vessels	Not Applicable	-	Transportation Related

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Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 7 (Transportation)
7.7	Administrative Guide for Verifying Compliance with Packaging Requirement Shipments of Radioactive Materials (8/77)
7.8	Load Combinations for the Structural Analysis of Shipping Casks (5/77)
7.9	Standard Format and Content of Part 71 Applications for Approval of Pack Type B, Large Quantity, and Fissile Radioactive Material (Revision 1, 1/
7.10	Establishing Quality Assurance Programs for Packaging Used in the Transp Radioactive Material (1/83)
	Division 8 (Occupational Healt
8.1	Radiation Symbol (2/73)
8.2	Guide for Administrative Practices in Radiation Monitoring (2/73)
8.3	Film Badge Performance Criteria (2/73)
8.4	Direct-Reading and Indirect-Reading Pocket Dosimeters (2/73)
8.5	Criticality and Other Interior Evacuations Signals (Revision 1, 3/81)
8.6	Standard Test Procedure for Geiger-Miller Counters (5/73)
8.7	Occupational Radiation Exposure Records Systems (5/73)
8.8	Information Relevant to Ensuring that Occupational Radiation Exposures a Power Stations Will Be As Low As Is Reasonably Achievable (Revision 3, 6
8.9	Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay (
8.10	Operating Philosophy for Maintaining Occupational Radiation Exposures As Is Reasonably Achievable (Revision 1-R, 5/77)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
Regulatory Guides			
s for	3.2.24.3	Transportation Interface	-
	Not Applicable	-	Transportation Related
aging of 80)	Not Applicable	-	Transportation Related
ort of	Not Applicable	-	Transportation Related
h) Regulatory Guides			
	3.2.11.11	Radiological Assessment	-
	3.2.11.12	Radiological Assessment	-
	3.2.11.13	Radiological Assessment	-
	3.2.11.14	Radiological Assessment	-
	3.2.11.15	Radiological Assessment	-
	3.2.11.16	Radiological Assessment	-
	3.2.11.17	Radiological Assessment	-
t Nuclear /78)	3.2.11.18	Radiological Assessment	-
9/73)	3.2.11.19	Radiological Assessment	-
Low As	3.2.11.20	Radiological Assessment	-

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Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 8 (Occupational Healt
8.11	Applications of Bioassay for Uranium (6/74)
8.12	Criticality Accident Alarm Systems (Revision 1, 1/81)
8.13	Instruction Concerning Prenatal Radiation Exposure (Revision 1, 11/75)
8.14	Personnel Neutron Dosimeters (Revision 1, 8/77)
8.15	Acceptable Programs for Respiratory Protection (10/76)
8.16	(Not issued)
8.17	(Not issued)
8.18	Information Relevant to Ensuring that Occupational Radiation Exposures a Institutions Will Be As Low As Is Reasonably Achievable (Revision 1, 10/
8.19	Occupational Radiation Dose Assessment in Light-Water Reactor Power Plan Stage Man-Rem Estimates (Revision 1, 6/79)
8.20	Applications of Bioassay for I-125 and I-131 (Revision 1, 9/79)
8.21	Health Physics Surveys for Byproduct Material at NRC-licensed Processing Manufacturing Plants (Revision 1, 10/79)
8.22	Bioassay at Uranium Mills (7/78)
8.23	Radiation Safety Surveys at Medical Institutions (Revision 1, 1/81)
8.24	Health Physics Surveys During Enriched Uranium-235 Processing and Fuel F (Revision 1, 10/79)
8.25	Calibration and Error Limits of Air Sampling Instruments for Total Volum Sampled (8/80)
8.26	Applications of Bioassay for Fission and Activation Products (9/80)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
h) Regulatory Guides			
	3.2.11.21	Radiological Assessment	-
	3.2.11.22	Radiological Assessment	-
	3.2.11.23	Radiological Assessment	
	3.2.11.24	Radiological Assessment	
	3.2.11.25	Radiological Assessment	-
	Not Applicable	-	Not Issued
	Not Applicable	-	Not Issued
t Medical 82)	Not Applicable	-	Medical Application Related
ts Design	3.2.11.26	Radiological Assessment	-
	3.2.11.25	Radiological Assessment	
and	Not Applicable	-	Processing Plant Related
	Not Applicable	-	Uranium Mills Related
	Not Applicable	-	Medical Application Related
abrication	Not Applicable	-	Fuel Fabrication Related
e of Air	3.2.11.26	Radiological Assessment	-
	3.2.11.27	Radiological Assessment	-

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Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 8 (Occupational Heal
8.27	Radiation Protection Training for Personnel at Light-Water-Cooled Nucle Plants (3/81)
8.28	Audible-Alarm Dosimeters (8/81)
8.29	Instruction Concerning Risks from Occupational Radiation Exposure (7/81
8.30	Health Physics Surveys in Uranium Mills (6/83)
8.31	Information Relevant to Ensuring that Occupational Radiation Exposures Mills Will Be As Low As Is Reasonably Achievable (5/83)

ole Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
h) Regulatory Guides			
r Power	3.2.11.28	Radiological Assessment	-
	3.2.11.29	Radiological Assessment	-
)	3.2.11.30	Radiological Assessment	-
	Not Applicable	-	Uranium Mills Related
t Uranium	Not Applicable	-	Uranium Mills Related

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Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 9 (Antitrust Review
9.1	Regulatory Staff Position Statement on Anti-trust Matters (12/73)
9.2	Information needed by the NRC Staff in Connection with its Antitrust Rev Construction Permit Applications for Nuclear Power Plants (Revision 1, 6
9.3	Information needed by the AEC Regulatory Staff in Connection with its An Review of Operating License Applications for Nuclear Power Plants (10/74

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
) Regulatory Guides			
	Not Applicable	-	Not Pertinent
iew of /76)	Not Applicable	-	Not Pertinent
titrust)	Not Applicable	-	Not Pertinent

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Reg Guide No.	Regulatory Guide Title (Issuance/Revision Date)
	Division 10 (General) Re
10.1	Compilation of Reporting Requirements for Persons Subject to NRC Regulat (Revision 4 10/81)
10.2	Guidance to Academic Institutions Applying for Specific Byproduct Materi of Limited Scope (Revision 1, 12/76)
10.3	Guide for the Preparation of Applications for Special Nuclear Material L Less than Critical Mass Quantities (Revision 1, 4/77)
10.4	Guide for the Preparation of Applications for Licenses to Process Source (Revision 1, 3/77)
10.5	Applications for Type A Licenses of Broad Scope (Revision 1, 12/80)
10.6	Guide for the Preparation of Applications for Use of Sealed Sources and Devices for the Performance of Industrial Radiography (Revision 1, 12/81
10.7	Guide for the Preparation of Applications for Licenses for Laboratory Use of Small Quantities of Byproduct Material (Revision 1, 8/79)
10.8	Guide for the Preparation of Applications for Medical Programs (Revision
10.9	Guide for the Preparation of Applications for Licenses for the Use of Ga Irradiators (4/80)

le Regulatory Guides (Listed in Numerical Order) (Cont'd)

	Applicability/ Technical Review Section	Categorized Subject	Remarks
gulatory Guides			
ions	3.2.25.3	General	-
al Licenses	Not Applicable	-	Not Pertinent
icenses of	Not Applicable	-	Not Pertinent
Material	Not Applicable	-	Not Pertinent
	Not Applicable	-	Not Pertinent
)	Not Applicable	-	Not Pertinent
	Not Applicable	-	Not Pertinent
1, 10/80)	Not Applicable	-	Not Pertinent
mma	Not Applicable	-	Not Pertinent

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STAFF PAPER

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Office of Technology Assessment

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<u>Comments on the Department of Energy's Mission Plan</u>

<u>for the</u>

<u>Civilian Radioactive Waste Management Program</u>

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1. INTRODUCTION AND OVERVIEW

This paper focuses on two major aspects of the waste management strategy discussed in Chapter 2 of the Department of Energy's (DOE) Mission Plan: the role of the Monitored Retrievable Storage (MRS) facility, and the importance of explicit contingency planning for the repository siting program. OTA concludes that these two issues are closely related. Credible contingency plans that increase the confidence that a permanent repository will be available without extended delays can reduce a major source of concern about an MRS facility -- the fear that it may enable indefinite deferral of the difficult technical and political choices required in siting a permanent repository. At the same time, provision of an I-MRS could allow more flexibility in the siting program, which in turn could reduce the chances that major delays will be encountered.

Section 2 discusses the role of the integrated monitored retrievable storage facility proposed by DOE. (This paper uses the abbreviation "I-MRS" to refer to an integrated MRS facility designed to serve as the waste receiving and packaging facility for the repository, to distinguish it from an MRS facility designed only to provide interim storage.) It concludes that an I-MRS could add valuable flexibility to the waste management program, and discusses a more gradual, stepwise repository siting and development plan that could take full advantage of that flexibility. At the same time, it concludes that broad support for an I-MRS may be difficult to obtain unless assurance can be provided that it will not derail the repository program and that the I-MRS will not by default become a long-term waste repository. It also discusses measures that could help provide such assurance, including both linkages between operation of the MRS and progress on the repository, and measures to increase confidence in the repository siting program.

Section 3 discusses the way that confidence that a geologic repository will be available without extended delays can be increased by more explicit contingency planning for the repository siting program than is given in the Mission Plan. It discusses the implications for the siting program of the ambiguities concerning the interpretation of the Nuclear Waste Policy Act's provision concerning the timing of a preliminary determination of suitability for the sites chosen for characterization. It also describes a hypothetical siting plan that would be consistent with making the preliminary determination of suitability after the first exploratory shaft has been sunk during characterization.

Section 4 briefly discusses the value of making explicit contingency plans for the very unlikely possibility that major problems might be discovered that would lead to very long delays in availability of a geologic repository, or even rejection of the concept in favor of some other approach to final waste isolation. It points out that the I-MRS proposed by DOE is not optimally designed to provide the very long term storage that might be needed if that occurred, but that the I-MRS, if designed with sufficient flexibility, could serve as the packaging facility for either a long-term storage facility or an alternative disposal system.

2. THE ROLE OF THE MONITORED RETRIEVABLE STORAGE FACILITY

The DOE Mission Plan[1] presents two alternative waste management schemes. The first is the "authorized program", which uses only the facilities currently authorized by the Nuclear Waste Policy Act of 1982 (NWPA). OTA concluded in Managing the Nation's Commercial High-Level Radioactive Waste,[2] published in March 1985, that the facilities already authorized by NWPA are sufficient for safe storage and ultimate disposal of high-level radioactive waste, and thus that MRS facilities are not necessary for safe waste management. The DOE Mission Plan supports this conclusion, stating that "the Act authorizes a number of key activities that, taken together, can meet the objective of providing for the permanent disposal of spent fuel and high-level waste."[3] The Mission Plan also describes an "improved performance plan" that incorporates an integrated MRS (I-MRS) facility to serve as the waste receiving and packaging facility for the repository. This integrated operational role for an MRS is substantially different from the more traditional backup storage role that was proposed in DOE's draft Mission Plan.[4] In the backup storage role, the only function of an MRS is to provide a way for DOE to accept spent fuel if the repository is delayed. In the integrated role, the backup storage capability of the I-MRS is a secondary benefit.

OTA's March report examined only the backup role in its discussion of the benefits and costs of including an MRS facility in the waste management system, and thus focussed discussion on the issue of alternatives for providing the interim spent fuel storage that would be needed after 1998. It noted that the questions involved in providing a centralized Federal MRS for post-1998 interim storage are essentially similar to those involved in earlier proposals for a Federal Away-from-Reactor (AFR) storage facility that were considered at the time NWPA was being debated.[5] It also concluded that "if no further action were taken by Congress to authorize storage by the Federal Government, it appears now that the needed storage could and would be provided by the utilities themselves."[6] At the same time, OTA noted that even if the only function of an MRS were to provide backup storage, there may be overall system benefits to providing centralized facilities for the additional interim storage that would be required in the event of substantial delays in the repository program.[7] Referring to the newer integrated role just proposed by DOE, OTA noted in testimony on March 21, 1985, that the conclusion that MRS facilities were not necessary for safety was not meant to imply that an integrated MRS might not be beneficial to the waste management system, although a judgment about the particular merits of DOE's proposal would have to wait until some analysis of the concept was published.[8]

Based on the analyses that are now available,[9] OTA agrees with DOE's preliminary judgment that an integrated MRS facility can add substantial flexibility to the waste management system, and can increase the confidence that waste will be removed from reactors and ultimately emplaced into a repository on a reliable schedule -- provided that steps are taken to ensure that availability of the I-MRS would not appreciably delay siting of a permanent repository. Giving the I-MRS a central role in the operating waste management system changes the cost/benefit calculations by producing benefits that are not available if an MRS is only to provide a limited amount of backup storage until the repository is available. At the same time, the fact that the integrated MRS will be able to provide interim storage as needed makes it subject to the major concern discussed in OTA's report -- the concern that the availability of Federal storage capacity would lead to deferral of the politically and financially costly steps involved in siting a geologic repository. OTA noted that this is the principal programmatic risk in attempting to site and license a large Federal storage facility before a permanent repository site is selected and licensed.[10] Measures to enable the benefits of an I-MRS to be gained while reducing this programmatic risk are discussed below.

OTA believes that this integrated role for an MRS represents an excellent response by DOE to the requirement of section 141 of NWPA that the MRS proposal contain "a plan for integrating facilities constructed pursuant to this section with other storage and disposal facilities authorized in this Act." DOE has clearly devoted considerable effort towards waste management system integration in the last year. This effort is reflected in the proposed new role for an MRS. Whether or not an I-MRS is ultimately authorized, the effort to develop an integrated system including the I-MRS has already brought substantial benefits to the DOE program by focussing attention and effort on system integration.

This section discusses the advantages offered by an I-MRS, the costs and risks to the program, and possible measures that could reduce the risk that an I-MRS would adversely affect the repository program.

2.1 Advantages of an integrated MRS

The basic advantage of the I-MRS is that it provides a flexible coupling between the reactor unloading plan and the repository loading plan that allows each to be optimized independently. It serves a role like a transformer in an electrical system, or a transmission/differential in a car -- it provides a buffer between input and output systems that have unlike needs and characteristics and that would function less efficiently if directly connected. With no I-MRS, the reactor unloading plan is directly constrained by the feasible repository loading plan, and vice versa. There is no prima facie reason for concluding that there is any single spent fuel transfer plan that would optimize both ends of the high-level waste management system simultaneously; and, indeed, the history of the waste management policy debate suggests that the needs of the two ends may be in direct conflict. For example, with no I-MRS, pressures to stop the continued buildup of spent fuel in storage at reactors and to begin eliminating the backlogs that have already accumulated are translated directly into pressures to site and operate a repository at full scale as quickly as possible.

The buffer effects of the I-MRS can be considered in two categories: those associated with location of the repository's packaging facility away from the repository site and near the majority of the reactors in the East; and those associated with the ability of the I-MRS to decouple the spent fuel acceptance schedule from the repository loading schedule.

2.1.1 Advantages of an eastern packaging facility

The major difference between the current DOE proposal for an I-MRS and earlier proposals for Federal interim storage facilities (e.g. the backup MRS in the draft Mission Plan, and the Away-From-Reactor storage facility proposed by the Carter administration) is that the I-MRS would perform operational functions that had previously been planned to take place at the repository. Instead of receiving spent fuel only when the repository is unable to do so, the I-MRS would handle most spent fuel on its way to the repository. Thus the handling facilities at the I-MRS do not totally duplicate the facilities that would have to be provided at the repository in any event. (Some spent fuel, from Western reactors, and defense high level waste may be shipped directly to the repository, so that there may be a small packaging facility at the repository even with an I-MRS.) It is interesting to note that a recent German study of an integrated spent fuel disposal system also includes a spent fuel packaging ("conditioning") facility located separately from the permanent repository.[11] This concept has the following advantages:

2.1.1.1. An eastern packaging facility provides uniform quality assurance for those spent fuel treatment activities that are best performed as near as possible to the reactors where the fuel is used.

Preliminary systems analyses suggest that that the overall costs and impacts of waste management activities may be reduced if spent fuel is consolidated and placed into a final container before interim storage outside of the reactor's pool and transportation to the repository.[12] Consolidation reduces the cost of most subsequent operations (by allowing about twice the quantity of spent fuel to be placed into a given container); and placing the spent fuel into a final container as early in the process as possible minimizes the number of operations involving direct handling of spent fuel assemblies. (The container may be as simple as a stainless steel canister that will be placed inside other containers for later steps; or it might be a cask designed to be usable for storage, transportation, and final disposal.)

Available studies indicate that these activities could be performed at the reactors. However, with ultimately over 100 different reactors managed by more than 50 different utilities, performing these operations at reactors may present problems of assuring system compatibility and uniform level of quality control. An I-MRS would allow these operations to be performed relatively near the reactors, while at the same time providing standardization and uniform quality assurance that would be difficult if not impossible to obtain if the tasks were left to each utility. (Performing these operations at an I-MRS instead of at reactors may also reduce worker exposures, since at the I-MRS the operations would all be performed by robot equipment in heavily shielded hot cells; at reactor storage pools, workers are exposed to low but steady levels of radiation.)

In addition, it is not clear that all utilities would be willing to perform spent fuel treatment operations on site, even if the waste management program offered to compensate them for the expense. Increasing the amount of spent fuel handling and processing required at the reactor would divert utility management attention from the primary function of reactor operation. Some utilities seem to be quite reluctant even to undertake rod consolidation, although it might reduce their interim storage costs by increasing the amount of fuel that could be stored in pools before more expensive dry storage is required. Thus, while it may be technically possible to perform a range of spent fuel processing and packaging activities at reactors, it may not be institutionally easy to do so.

2.1.1.2. <u>An eastern packaging facility would allow separate optimization of multipurpose casks for interim storage and final disposal.</u>

Preliminary systems analyses have generally concluded that there could be substantial system benefits from use of spent fuel casks that could be used for more than one purpose -- e.g. for storage and transportation (S/T), or perhaps even storage, transportation, and disposal (S/T/D).[13] If designed with sufficient flexibility, the I-MRS could facilitate use of such casks by allowing DOE to proceed with design and procurement of one fleet of casks optimized for interim storage and transportation to the disposal packaging facility, while allowing time to develop and optimize the final disposal package system based on the characteristics of the repository site.

Studies suggest that the optimum capacity for a cask designed for transportation from reactors and for interim storage is significantly different from the optimum capacity for a multipurpose disposal cask. Storage/transportation casks are most efficient when designed for the maximum possible amount of spent fuel (approximately 20 tonnes of consolidated fuel.) However, this load may be too large for direct disposal because of limitations on the allowable heat output for individual disposal packages. Available studies suggest a maximum disposal cask load of about 9 tonnes of consolidated fuel, and lower loads (or extended cooling periods) may be necessary for some repository media.[14] An I-MRS could use optimized S/T casks for the reactor/I-MRS link, and optimized S/T/D casks for the I-MRS/repository link.[15] One preliminary study that examined a range of alternatives concluded that this approach could be the most cost-effective design for a system including an MRS facility.[16] If a significant amount of dry storage outside of reactor pools is ultimately required, then the potential cost savings from providing this storage in conjunction with the centralized packaging facility (the I-MRS) instead of at reactors could offset the additional costs of that facility, so that the overall system flexibility provided by an I-MRS might be obtained with no net cost to utility ratepayers.

The storage/transportation cask could be used as the link between the reactors and the I-MRS during normal operations, and to provide a buffer in the event of delays in MRS availability or interruptions of loading. Even if the proposal for an I-MRS develops sufficient consensus in Congress and the host state so that the political uncertainties about its construction are eliminated, there will still be the potential for some delays during construction that could cause slippage in the target I-MRS acceptance schedule. Some at-reactor buffer storage will be needed to insulate the reactors from such delays, or from problems at the I-MRS during operation. To provide this storage, DOE could furnish storage/transportation casks to utilities as needed until the I-MRS is operating at its target rate. These casks would then be used as part of the transportation cask fleet needed for the reactor/I-MRS link, and would also provide a buffer in the event of problems at the I-MRS during operation.

With this approach, the period of storage in the S/T casks should be considerably shorter than would be the case if no I-MRS were provided and the casks were used for storage at reactor sites until they could be shipped to a repository. This would reduce one of the uncertainties that has been raised about S/T casks -- whether such casks could be recertified as suitable for transportation after an extended period of storage.

For the I-MRS/repository link, casks suitable for final disposal as well as transportation to the repository might be used. Several preliminary studies in the U.S. have indicated that such casks could substantially reduce the costs and complexity of waste management operations.[17] On the same lines, the recent German study of a spent fuel disposal system includes a waste package that uses a cast iron shield that is intended to be able to qualify as a transportation cask for the packaging facility-repository trip. If such an approach were ultimately adopted, spent fuel would be stored at the I-MRS in an inner container of stainless steel placed into a concrete cask on the surface or into a borehole. When time for shipment for disposal arrived, the inner container would be sealed into a transportation/disposal cask for delivery to the repository. At the repository, the operations would be very simple, involving only transferring the cask from the railcar, lowering it down the repository shaft, and emplacing it on its side in a tunnel. The casks would provide buffer storage capacity at the repository if operational difficulties lowered the loading rate below the arrival rate.

2.1.1.3. <u>The integrated MRS allows planning and operation of the front-end of the waste management system -- interim storage, transportation to the packaging facility, and packaging -- to proceed independent of the uncertainties about timing, location, and design of the final repository</u>.

As noted earlier, the effort to develop the proposal for the I-MRS has already had a noticeable, beneficial impact on DOE's system integration activities. The I-MRS itself could provide a useful balance in the waste program that could offset the historical tendency of the Federal waste management effort to focus on finding a repository site, to the neglect of the equally important challenge of developing a waste management system that can function reliably at the required scale once a repository site is available.

Specifically, the I-MRS (if approved) could provide a clear focal point in space and time for system integration and planning. While most of the functions of the I-MRS could be performed at the repository, system planning would be more difficult until the location and characteristics of the repository are known for certain. Much of the uncertainty about the repository would be resolved when NRC issues a construction authorization for a repository, but the possibility would remain that the optimum waste package design might be changed, or perhaps the site rejected, on the basis of additional data obtained during construction before the final operating license. With the I-MRS, the site would be known as soon as the facility is authorized -- perhaps in the next year or so. Detailed planning for the complex task of shipping from many reactors to the packaging facility could proceed immediately. An optimized cask fleet could be designed and procurement initiated; routes could be determined; and firm schedules for accepting spent fuel from utilities could be specified by 1991, as provided in the DOE contract with the utilities.

DOE could proceed with planning and constructing a fleet of S/T casks for the front end of the waste management system, while deferring the final design of a multipurpose disposal cask until site-specific issues about the repository have been resolved. One candidate S/T cask is already being tested and demonstrated by DOE, and one design has been licensed for both purposes in Germany. Thus it appears likely that such casks might be available for use for interim storage before 1998. However, the information needed to develop a final optimized design for a multipurpose disposal cask will not be available until a repository site is approved, because the disposal package design depends upon the geologic medium and associated geochemistry of the final repository site. Thus it would be risky to commit to procurement of multipurpose disposal casks before the design has been finally approved by NRC in the repository licensing process -- which may occur only after casks would be needed for interim storage purposes. If the I-MRS is designed with sufficient flexibility, it would allow S/T casks, which are already well-advanced in development, to be used for early buffer storage needs while providing compatibility with a wide range of possible disposal packages.

It should be noted that although the I-MRS proposed by DOE is intended to be the front-end for a geologic repository, it could as easily feed a very-long term storage facility (e.g. a tunnel-rack system[18]) or even an alternative disposal system such as subseabed, if that became necessary. Any final isolation system will require that spent fuel or high-level waste be prepared for isolation. Thus a packaging facility will be needed whatever happens further on down the line. For this reason, the investment in an I-MRS would be used under almost any scenario, provided that the facility is designed with enough flexibility to handle a wide range of possible final isolation packages. (The ability of the I-MRS to serve as the coupling between reactors and a variety of possible long-term isolation options is discussed further in section 4.)

2.1.2. Advantages from decoupling the reactor unloading and repository loading schedules

The primary function of the I-MRS would be its operational role as the packaging facility for the repository. As discussed above, this allows the front and back ends of the waste management system to be designed separately. However, like earlier versions of an MRS, the I-MRS will also have the capacity to provide storage as needed. Thus the I-MRS would allow the schedules for removing spent fuel from reactors and for loading the repository to be optimized separately. Without an I-MRS, the two schedules are identical, since reactors could not be unloaded until the repository could be loaded, and vice versa.

The schedule that would be preferred for removing spent fuel from the reactor sites is not likely to be the preferred schedule for operating the repository. Without an I-MRS, pressures to remove spent fuel from reactor sites translate directly into pressures to hurry up the repository and to go to full scale operation as quickly as possible. Such pressures could increase the risk of premature decisions that could lead to delays in the repository program. The I-MRS would insulate the repository program from such pressures. (Of course, the converse of this is the concern that the I-MRS might provide so much insulation that the politically and technically tough decisions required to site a repository might be indefinitely deferred. Ensuring that the decoupling provided by the I-MRS is partial rather than total is the principal challenge to be faced in developing a consensus about the I-MRS. See section 2.4. for further discussion of this point.)

2.1.2.1. <u>The reactor unloading schedule</u>

NWPA requires disposal in a repository to begin by January 31, 1998, and requires DOE to begin taking title to waste for disposal when the repository is available. However, the Act provides little guidance about how quickly the transfer of spent fuel from utilities to DOE is to take place. In fact, the desired rate of reactor unloading has been given little systematic analysis and discussion to date. While the Mission Plan adopts a target rate sufficient to stop the buildup of spent fuel in storage at reactors by 1998, it has not evaluated systematically the relative costs and benefits of slower or faster unloading rates. Judgments about alternative unloading rates will be based on a number of factors including cost, impacts on reactor management and operations resulting from increased demands for spent fuel management and processing operations, and perceptions of equity.

It would be valuable for DOE to include in the MRS needs and feasibility study an analysis of the issues involved in relying upon at-reactor storage until a repository is available, taking into account a range of possible delays in full-scale repository loading. NRC has concluded that at-reactor storage would be safe for at least 30 years after reactor decommissioning.[19] However, some utilities would clearly prefer not to be responsible for spent fuel storage for extended periods. There may also be questions about the desirability or wisdom of giving an increasing role in waste management operations to over 50 different utilities with widely varying records of performance in constructing and operating reactors.

It would also be useful if the needs and feasibility study estimated the amounts of spent fuel that might ultimately be stored in individual reactor pools, taking into account the potential for higher-density reracking and rod consolidation (which some utilities appear likely to use). Because these storage options will probably be less expensive than out-of-pool dry storage technologies such as metal casks, they are likely to be used first. If full scale repository loading does not begin until 2008 or later (which is quite possible, particularly if the repository program were deliberately stretched out as discussed below), there could be many reactors with 20 or more annual spent fuel discharges in their pools. The longer spent fuel accumulates in the pools, the longer it will take to empty them. Thus the accumulation of large inventories of spent fuel in reactor pools may be relatively irreversible in the short run.

Because it may be difficult to quickly remove large accumulations of spent fuel from reactor pools, the consequences of such accumulations should be evaluated carefully. This evaluation should consider not only the implications of events that are more or less expected, but also the possibility of unlikely problems that could be exacerbated by the presence of large amounts of spent fuel in pools. For example, if a TMI-type meltdown occurred at a boiling water reactor with a storage pool inside the containment, the operators would probably prefer not to have 20-30 years' worth of spent fuel stored in a place that might be physically inaccessible for a period of years after the accident. To consider a more remote possibility, some analyses suggest that there may be civil defense benefits to preventing large buildups of spent fuel stored in reactor pools. In the unlikely event of a nuclear war in which reactors were hit with nuclear weapons, the presence of large quantities of spent fuel in the reactor pools would substantially extend the time for which land contaminated by fallout from the explosions would remain unusable.[20] While it is to be hoped that such an event is exceedingly unlikely, the consequences of having many reactors with 20-30 annual discharges in storage in their pools could be very serious in wartime.

Construction of an I-MRS could be the fastest possible way to stop the buildup of spent fuel in storage at reactor sites, and could allow the inventories that had already accumulated by the time an I-MRS could start operation to be drawn down at whatever rate is deemed desirable. In fact, if it is judged to be important to begin moving spent fuel from reactor sites at large scale by 1998, then the I-MRS is probably necessary. If sufficient political consensus can be reached about the I-MRS to prevent it from being to be deferred or cancelled after it was authorized, there is a high degree of probability that it could begin loading according to the schedule proposed by DOE. In that event, it would provide a clear and predictable basis for utility planning for at-reactor storage. Thus, construction of the I-MRS would transfer the burden of dealing with the uncertainty about interim storage after about 1998 from individual utilities to the Office of Civilian Radioactive Waste Management, funded by all nuclear utilities through the nuclear waste fee. An I-MRS would also provide insurance against the possibility that later developments might lead to a desire to remove spent fuel from reactor pools more rapidly than could be easily achieved if large inventories have been allowed to accumulate in the pools.

2.1.2.2. The repository loading schedule

The schedule for repository loading depends upon (1) the time it takes to site the repository, (2) the plan for scaling up to full-scale operations, and (3) the achievable loading rate. By allowing reactor unloading to proceed independently of repository loading, the I-MRS could broaden the base of support for a more gradual repository siting and operating schedule than now planned by DOE. Without the buffer provided by the I-MRS, any proposals to slow down repository siting and full-scale loading will be seen by utilities as increasing their burden of spent fuel management. This section will discuss some possible benefits of decoupling the repository loading schedule from the reactor unloading plan in terms of the implications for the repository siting program, the scaling-up process for operation at the repository, and the rate of loading during full-scale repository operations.

2.1.2.2.1. The repository siting program

The one repository now authorized by NWPA is the only facility DOE is now able to plan to use for accepting spent fuel from utilities. Thus, pressures from utilities and others for DOE to accept spent fuel at a large scale by the 1998 deadline for repository operation put great pressure on the repository siting schedule because of the time required to construct a packaging facility at the repository after the construction authorization is granted. If a full scale packaging facility must be operating at the repository by 1998, then the construction authorization would be needed by about 1992. Because of slippages that have already occurred, DOE has cut back from its original plan to have the full-scale loading facilities operating in 1998 to the current plan of having a pilot scale loading facility in operation by then -- a shift that has brought criticisms from some utilities who want a faster acceptance schedule.[21] At the same time, DOE is being criticized by potential repository states and others for hurrying the siting process.[22] With no I-MRS in the system, these simultaneous pressures to hurry up and to slow down will continue to push DOE in opposite directions. If provision of an I-MRS would gain support for a more gradual repository scaling-up plan (discussed below), it could increase the time available for site investigation and licensing, while still retaining the commitment to begin disposal in 1998. (Because NWPA required that that commitment be included in DOE contracts with utilities providing for waste disposal services in exchange for payment of nuclear waste fees, DOE is not at liberty to unilaterally abandon it without explicit direction from Congress. The history of NWPA suggests that it will probably be much easier to get agreement to a plan for relaxing the repository schedule that retains the 1998 commitment than to one that abandons it.[23])

Specifically, if the I-MRS would allow DOE to plan for minimum-scale repository operation in 1998, it might allow a more sequential process to be used in site characterization. Under the current Mission Plan strategy, the characterization phase is compressed because of the plan to meet the 1998 deadline with an operating packaging facility at the repository (albeit a small-scale facility). As a result, many characterization activities have to be done simultaneously. A more gradual approach would allow a phased screening process so that unsatisfactory sites can be identified and eliminated before the most expensive stage of testing is undertaken. Section 3 below discusses a phased site characterization process that may allow more information to be gathered and evaluated before the full underground test facilities are constructed at candidate sites, so that there is a better chance that potentially disqualifying information would be discovered before the costs and impacts of full in situ testing are incurred.

2.1.2.2.2. The repository scaling-up process

The DOE "Improved Performance Plan" that incorporates an I-MRS facility does not fully take advantage of the ability of the I-MRS to decouple reactor unloading and repository loading, since it uses the same repository loading schedule that is proposed under the "authorized plan" that has no I-MRS. OTA's report, published in March, suggested an alternative approach to repository development (referred to in this paper as the stepwise approach) that might be more compatible with an I-MRS facility, and thus might be a useful subject of analysis in the final MRS needs and feasibility study to be submitted next year.[24] The stepwise approach would retain the 1998 goal for initial disposal in the repository, while taking advantage of the availability of the I-MRS to allow the full-scale loading of the repository to be built up to in a more gradual, stepwise process in which the experience from each phase would be used to refine the designs for the next phase. This would defer full-scale repository loading somewhat compared to the reference schedule in the Mission Plan, but would increase the confidence that the revised schedule for repository loading would actually be achieved without any surprises. The stepwise approach would involve three distinct phases: a demonstration phase to begin by January 31, 1998; a pilot operating phase; and a full-scale operating phase.[25]

Demonstration Phase

Initial disposal in the repository (satisfying the legal requirement that disposal begin by Jan. 31, 1998) would be achieved using a small amount of high level waste and spent fuel packaged at the I-MRS for disposal. The total amount involved could range from 10 to 100 tonnes of spent fuel, depending on what method is used for initial emplacement. The Act currently allows up to 10 tonnes of spent fuel to be used during site characterization if it is needed. If this is done (e.g. to check worker radiation exposures during emplacement and to verify the retrievability required by NRC regulations), DOE could apply for permission to leave this material permanently at the same time it applies for the construction authorization. This method should minimize the time required for initial licensed disposal after the application to NRC. As an alternative method for initial emplacement, DOE might make use of the Test and Evaluation Facility provisions of the NWPA to emplace up to 100 tonnes of spent fuel and/or equivalent high-level waste. The time required to do this after the construction authorization is not clear. Whatever method is selected, however, the objective would be to minimize the time between the construction authorization and NRC approval for permanent emplacement of some quantity of spent fuel and/or high level waste. The stepwise approach should therefore maximize the chances of meeting the deadline in the Act, and provide the earliest possible demonstration of both the technical and institutional capacity to dispose of high level waste permanently. At the same time, by reducing the time between the construction authorization and initial disposal, it should allow more time before the construction authorization for the phased site characterization process mentioned above and discussed in more detail in section 3.

Combined with the early testing and demonstration of full-scale transportation and packaging of spent fuel that would be provided by operation of the I-MRS, this initial low-level licensed emplacement in a repository should definitively demonstrate all of the key steps and technologies involved in managing spent fuel from reactor discharge to final disposal. Without the I-MRS, the capability to handle highly radioactive material reliably at high annual rates would not be developed and demonstrated until at least 6 years after the construction authorization for the repository.

Pilot Scale Operational Phase

The second phase of disposal would involve construction of a small receiving, packaging and loading facility at the repository of sufficient size to handle both the defense high-level waste and the spent fuel from western reactors. (DOE's preliminary MRS needs and feasibility analysis recognizes that it may be best to ship western fuel directly to the repository and do the final rod consolidation and packaging there, rather than to ship it across the country to the I-MRS and then back to the repository.[26]) The stepwise approach thus involves a modification to the two-phase repository development process described in the Mission Plan, which involves a 400 tonne/year pilot facility to be operating by 1998, and a full-scale 3000 tonne per year facility to be operating about 3 years later. The purpose of the two-phase approach in the Mission Plan is to meet the 1998 deadline for repository operation. The small-scale facility can be built in about 4 years, while a full-scale facility would take nearly 6 years -- too long to be able to be in operation by 1998.

Under the stepwise approach proposed here, the 1998 target would be met in the demonstration phase, before any operational loading facilities are constructed at the repository site. The repository's loading facilities would be constructed and operated in two phases in order to achieve two goals: (1) to provide a facility that can be used to package western fuel and defense waste; and (2) to provide an interim stage of experience in receipt and emplacement before constructing and operating the full-scale facility for receiving packaged waste from the I-MRS. The two phase approach in the Mission Plan does not appear to serve either of these goals very well. In the first place, the scale of the phase-one facility may be too small for the western fuel plus the defense waste. (The discussion of the I-MRS in the Mission Plan does not relate the planned first phase repository packaging facility to the need for a facility at the repository to package western fuel if there is an eastern I-MRS.) In the second place, because the pilot-scale and full-scale facilities would be constructed in parallel according to the Mission Plan, there does not appear to be enough time between the two phases to allow the design for the full-scale facility to be modified if the experience of operating the first phase facility suggests that to be prudent.

Tentative designs for the I-MRS suggest that a single waste receipt, consolidation, and packaging line may be sufficient for the first phase repository facility. Since the I-MRS would already have been built and operated, the design for the first phase facility at the repository would benefit from that experience; it, in turn, would provide larger scale experience at emplacement of packages in the repository, to determine whether any modifications in the full-scale facility are needed. Thus the I-MRS would be the initial stage in a stepwise process for developing the loading facilities for the repository.

The pilot phase facility, which would be designed to accept unpackaged, unconsolidated spent fuel directly, could also provide a limited amount of backup in the event of stoppages or slowdowns at the I-MRS facility during operation. For example, if the facility were designed to achieve its target rate using a single shift, three shifts a day could be used to increase the throughputs into the repository to offset problems at the I-MRS.

Full-Scale Operational Phase

If the alternative approach suggested here were used, the full-scale loading facility at the repository would be constructed on a schedule that allows its design to be modified on the basis of experience with the phase one facility. This is likely to lead to full-scale loading several years later than provided in the reference loading schedule in the Mission Plan, which initiates construction of the full-scale phase two facility at the same time as the small-scale phase one facility. Because an I-MRS would allow unloading of reactors to occur at any desired rate even before the repository loads at full scale, such a planned deferral would not lead to a further buildup of spent fuel at reactors. While it would increase the amount stored at the I-MRS, the fact that this additional buildup would occur only after initial licensed disposal in the repository should provide the I-MRS host state and others with confidence that the spent fuel would in fact be removed for disposal within a reasonable period of time. It would not increase the total amount of spent fuel passing through the I-MRS, but rather would only mean that a larger amount was stored for an interim period before disposal.

Use of an I-MRS in combination with a more gradual process of repository development could increase the credibility of the repository evaluation process in two ways. First, deferring construction of the full scale loading facilities at the repository until results from pilot scale loading are available could reduce concerns that sunk costs at the repository site would create pressures to ignore problems discovered during construction. Second, the total investment at the repository site could be lower with an I-MRS, since a major portion of the full scale facilities needed for disposal would be located away from the repository site. Because the costs and operational consequences of a decision to abandon a repository site if problems are discovered during operation would thus be lower, a more objective assessment of such problems should be possible.

2.1.2.2.3 Matching reactor unloading and repository loading during normal operation

Once the full-scale loading facility has been built, the I-MRS would allow separate optimization of reactor unloading and repository loading rates. For example, it is possible that a judgment would be made that the desired unloading rate should be high enough not only to stop the buildup of spent fuel at reactor sites by 1998-2000, but also to reduce the inventories stored at reactor sites to some specified level within a given period of time. Yet the optimal loading rate for the repository may prove to be significantly lower than this desired rate. The I-MRS can act as a cushion by accepting waste from reactors as quickly as desired, and then feeding it to the repository at the optimal rate. If this were done, it would mean an additional amount would be stored at the I-MRS for some period. (For example, if the unloading rate is 3000 tonnes/year and the repository loading rate is 2000 tonnes/year, the amount stored at the I-MRS would increase by 1000 tonnes/year until the rate of deliveries from reactors fell below the repository loading rate.)

Alternatively, it may prove desirable later to provide some period of surface storage for all spent fuel or high level waste before emplacement in the repository in order to allow the heat output to decline. The I-MRS would allow this to be done without affecting the reactor unloading plan.

Surface storage for these reasons could also be provided at the repository, if there were no I-MRS. However, this has disadvantages. First, storage of a large inventory of spent fuel at the repository might be perceived as creating an incentive to overlook any problems with the repository site that are discovered during operation. If transitional storage (for loading rate equalization or for cooling) is done instead at a separately located I-MRS, it becomes easier to address problems at a repository site in an objective manner. Second, if buffer storage is to be provided at the repository, it could only be available after the repository has an operating license. Until then, interim storage would have to be provided at reactor sites. For some plausible repository delays, this could lead to very large inventories building up at reactors. To unload these significantly faster than the time it took them to accumulate in the first place would require a substantially higher acceptance rate at the repository than would be needed if unloading could begin years earlier using an I-MRS. This could increase both total system costs and peak annual transportation impacts.

The potential mismatch between reactor unloading rates and repository loading rate could work in the other direction if large inventories of spent fuel are stored in reactor pools instead of at an I-MRS before the repository is available. It is possible that the repository could ultimately be loaded at a rate that is considerably higher than spent fuel could readily be unloaded directly from reactor pools. In that case, the achievable loading rate could be constrained by the rate at which spent fuel could be unloaded from reactor pools.[27] This could lead to a cost penalty, since total disposal costs might be reduced if the time that the repository is kept open and loading can be reduced. If the backlog of spent fuel were stored at an I-MRS, its unloading rate could be increased to match the repository's capacity (using two or three shifts per day, if necessary).

2.2 COST OF AN INTEGRATED MRS

DOE's preliminary analysis indicates that inclusion of an I-MRS could increase the total cost for waste management facilities by $500 to $700 million -- about 2 percent of total costs for the Federal portion of the waste management system, to be paid for through the fee imposed by NWPA on nuclear-generated electricity.[28] However, whether there is in fact any significant net increase in total costs to users of nuclear-generated electricity will depend upon the extent to which the contingencies against which the I-MRS provides insurance come to pass. In particular, it will depend largely upon the amount of at-reactor dry storage that would eventually be required if no I-MRS is provided, which will in turn depend upon both the potential for increased in-pool storage and the delays in repository loading. For short delays on the order of a few years, at-reactor storage may be less expensive -- particularly if estimates of the potential for increased in-pool storage are correct. For long delays (which are possible even without the planned deferral of full-scale disposal suggested above), the at-reactor storage costs could become quite high if much out-of-pool dry storage is required, and the savings resulting from providing that storage at an I-MRS instead could offset the additional costs of that facility. (Because the packaging and handling facilities of the I-MRS will be used for waste disposal operations whether or not any significant amount of storage is provided at the I-MRS, their costs do not have to be included as part of the storage costs, as would be the case if an MRS were being used only for backup storage.[29] Thus the incremental cost of storage at the I-MRS is only the cost of the storage modules and associated handling operations -- estimated to be about $20 per kilogram of stored fuel.[30] This is well below the current estimates for out-of-pool storage at reactors, and comparable to estimates for additional in-pool storage.[31])

An important difference between the cases with and without an I-MRS in terms of interim storage costs is that the I-MRS option does not appear to add major new uncertainties to the estimates of waste management costs. A packaging facility will be required even if there is no I-MRS, so that locating that facility away from the repository should not substantially increase the uncertainties that are already present in estimating the cost of such a first of a kind facility. (Of course, it will increase total facility construction and operation costs, as noted above, because there will still have to be a simplified receiving and handling facility at the repository, which will lead to some cost duplication.) The cost of at-reactor storage, however, may be subject to greater uncertainty, since it depends heavily on the prospects for in-pool storage and the actual repository delays. For example, if rod consolidation at reactors does not turn out as well as some think it will, or if the repository experiences extended delays, the amount of out-of-pool dry storage required could increase sharply. As noted above, the cost of providing this dry storage at the I- MRS could be substantially lower. Thus the additional cost of providing a centralized packaging facility (the I-MRS) can be seen in part as an insurance policy against the possibility of higher storage costs that might result if there are substantial delays in repository loading and the requisite interim storage otherwise had to be provided at reactor sites.

These considerations suggest that the MRS needs and feasibility study should examine the relative costs of systems with and without an I-MRS under a wide range of contingencies, to evaluate the capacity of each approach to insure against large downside cost risks. This analysis should consider that under some possible scenarios, a decision would be made to construct an I-MRS later, even if it is not authorized now. For example, in the unlikely event that the siting program uncovers major problems with geologic disposal that would lead to extended delays or even rejection of the concept, it may be necessary to build a very long term storage facility to prevent reactors from becoming de facto repositories. As noted earlier, the I-MRS could also serve as the front end for such a facility.

OTA's analysis of the historical development of the waste management problem in the U.S. suggests that minimizing the initial costs of the waste management system will not necessarily minimize total costs in the long run; and that in any event cost minimization may not be as important as and confidence that spent fuel will be removed from reactors and ultimately be disposed of on a reliable schedule. If provisions can be made that ensure that the I-MRS does not itself adversely affect the repository program, it would provide a significant degree of flexibility and insurance against contingencies. This could enhance confidence in the program, and reduce the risk of substantially higher costs in the long run.

2.3 SYSTEM IMPACTS OF AN INTEGRATED MRS

The principal effect of an I-MRS on the total impacts of the high-level waste management system will result from the fact that it would funnel all the high-level waste transportation through one site (thus shifting the transportation routes from what they would be without the I-MRS), while reducing the amount of transportation into the repository itself by shipping only consolidated fuel in multi-cask dedicated trains. Without the I-MRS, the focus of the "funnel" would be the first repository itself, most likely somewhere in the West; the addition of the I-MRS would move the focus from there to a location in the East, nearer the reactors where the waste originates. As a result, the total impacts of waste disposal activities on the repository state would be reduced, while transportation impacts would be increased for some states nearer the I-MRS and along the corridor from the I-MRS to the repository. However, it is impossible to tell at this time what the net shifts in transportation effects would be. The routes that would be used in a system with no I-MRS cannot be specified until a repository site is finally approved, which is expected to occur sometime in the 1990's. In addition, the reduction in shipments that would actually result from consolidation at an eastern I-MRS cannot be assessed precisely until the final designs for shipping casks are known, the options for minimizing the impacts of transportation from reactors have been thoroughly assessed, and the amount of consolidation that would be done at reactors in any case is known. All that can be said with certainty at this time about the redistributional effects of the I-MRS is that some states will experience more transportation, and others less, with an I-MRS in the system. (The aggregate effects of the I-MRS are discussed below.)

(It may be noted that the I-MRS presents a somewhat different redistributional equity issue from the Away-From-Reactor (AFR) storage facilities proposed by the Carter administration. The only function of the AFR was to allow spent fuel to be removed from reactors before a repository was available. Thus the recipient communities perceived that they were being asked to bear a cost that the reactor host communities were unwilling to bear -- which raised strong equity objections. The I-MRS is intended to improve the performance of the waste management system whether or not it is used for large amounts of storage. Use for storage would not increase the amount of waste transported through the I-MRS host state; and the incremental impacts of storage at the facility would be small, and probably not proportional to the amount in storage. In other words, if a state is willing to accept the I-MRS in its integrated role, and is confident that a permanent repository will be available, then buffer storage at the I-MRS should not be a major additional concern. This may be particularly true if the storage is either for cooling before emplacement, or to match the reactor unloading rate to the repository loading rate, once a repository is available.)

Whatever the redistributional effects, it appears that the I-MRS could reduce the net aggregate impacts of transportation. While use of the I-MRS would increase the total number of miles each fuel assembly would be shipped on its way from the reactor to the repository (measured in "tonne-miles"), it should decrease the total number of miles traveled by individual shipping casks ("cask-miles") by reducing the total distance that fuel must be shipped in low capacity truck casks and by reducing the total distance that unconsolidated fuel is shipped.[32] Because the total radiation exposure to transportation workers and the public depends upon the cask-miles rather than the tonne-miles, a reduction of cask miles should reduce total exposures resulting from waste shipments. In addition, use of an I-MRS may be able to reduce the total number of miles traveled by separate shipments of waste ("shipment-miles") because shipments from the I-MRS to the repository would be done using a relatively small number of dedicated trains carrying many casks.[33] To the extent that transportation corridor states and communities are concerned more about the total number of separate waste shipments they must deal with, rather than the number of casks in each shipment, a reduction in "shipment-miles" could be beneficial.

As with the redistributional effects, the net reduction in aggregate measures of waste transportation cannot be predicted very precisely at this time. Nonetheless, it would be valuable for the final MRS needs and feasibility study to present best estimates of the effects of an I-MRS on the various measures of transportation discussed above, as well as estimates of the resulting worker and public radiation exposures and accident risks (taking into account the likely age of the spent fuel being shipped[34]). To be most useful, this analysis should include evaluation of the sensitivity of the results to the amount of consolidation done by utilities, the possible use of multipurpose casks, and the potential for batch shipments of casks from reactors to the I-MRS or the repository. Such analysis is needed to check the preliminary conclusion that the I-MRS will lead to some reduction in aggregate transportation impacts.

It should be noted, however, that OTA's analysis suggests that the transportation benefits of an I-MRS, while potentially significant, may not be as important a consideration as the other advantages of the I-MRS discussed in this paper.

2.4. MAJOR DISADVANTAGE: POTENTIAL IMPACTS OF THE I-MRS ON THE REPOSITORY PROGRAM

2.4.1. Sources of Concern

As noted earlier, a major concern about the I-MRS is that it could delay the repository program indefinitely. OTA's March report discussed two bases for this concern: 1) the possibility that the effort to site and construct such a facility would divert resources and energy from the repository program; and 2) the fact that, once a storage facility is available, it will be easier and less expensive to expand the storage capacity from year to year than to proceed rapidly to develop a geologic repository.[35] Each is discussed briefly below.

The effort to gain approval for an I-MRS and to construct it will clearly require some management effort on the part of DOE. However, this would probably not seriously affect the repository program if the same degree of consensus can be reached about the I-MRS as now exists about the need for a permanent repository. In that event, the I-MRS would not be a continuing drain on the management and political resources of DOE, but instead would serve as a valuable focus for the system integration efforts that are necessary. In fact, by shifting all of the problems of planning for the operational interface between the reactors and the repository to the I-MRS program, it could allow the repository development staff to better focus their attention on the task of finding and licensing a suitable site. From this perspective, the most serious impact of the I-MRS proposal on the DOE program would result if the issue cannot be resolved decisively one way or the other. If the I-MRS were approved, but only by a bare majority in the face of strong opposition, there would be the risk that DOE resources would have to be spent every year to ensure continued appropriations to prevent the project from being cancelled later. (In addition, continued uncertainty about the fate of the I-MRS would greatly reduce its value as firm basis for utilities' planning for their own storage needs.) On the other hand, if the I-MRS proposal were barely defeated in the face of strong support from some parties, it may be refought in later Congresses, thus continuing to demand DOE attention.

Earlier efforts to provide Federal storage facilities have raised the concern that the ready availability of Federal storage at low incremental cost would make it easy for the Federal government to continue to defer the difficult technical and political decisions required to site a permanent repository.[36] Judging from the history of these earlier efforts, it seems likely that unless this concern can be adequately addressed, it will be impossible to gain broad support for the I-MRS proposal. The history of the waste management program strongly suggests that the credibility of any interim storage measures will be suspect unless there is confidence that a permanent repository will be available within a reasonable period. In fact, a basic finding of OTA's study is that a credible program for siting and licensing a geologic repository is probably a necessary condition for agreement about interim measures. History does not provide a reason to be confident that any interim measures can be pursued successfully if there are serious concerns that the permanent repository might be deferred indefinitely.

The challenge with the I-MRS facility is how to use its ability to decouple reactor unloading from repository loading enough to allow some flexibility in the repository schedule, without decoupling the two so much that the repository is never developed.

There are two factors that should maintain pressure for progress on the repository even if an I-MRS is provided. First, acceptance of waste at an I-MRS will not satisfy the legal requirement in NWPA that disposal must begin by January 31, 1998, since disposal is defined as emplacement in a deep geologic facility. Since NWPA required this commitment to be included in DOE contracts with utilities in exchange for payment of fees to the waste program, failure to meet that provision of the contract could provide a basis for lawsuits. Second, an I-MRS by itself would not provide financial closure for the utilities, since expenditures for the repository program would continue, and since expenditures to maintain and replace storage facilities would continue until a permanent disposal system is provided.

The possibility that the I-MRS will adversely affect the repository program might be further reduced by measures that link operation of the I-MRS to progress on the repository, and by measures in the repository program designed to reduce the chance of major delays. Possible measures in each category are discussed below.

2.4.2. Measures to Prevent Repository Delays

2.4.2.1. Linkage between progress on the repository and development of the I-MRS

Various possibilities exist for making development and operation of the I-MRS contingent on the repository program in some way:

o Tie construction of the I-MRS to recommendation of a repository site. (This would be consistent with the current schedule in the Mission Plan, in which the repository site designation is planned to become effective by April 1991, while I-MRS construction is to start in the summer of 1991. However, it would not allow a longer site characterization process, as discussed in section 3.)

o Tie operation of the I-MRS to issuance of a construction authorization for the repository. (This would also be consistent with the Mission Plan schedule, since the construction authorization is anticipated in 1993, while I-MRS loading is not planned to begin until 1996.)

o Place a limit on the amount of spent fuel that can be stored at the I-MRS until the repository receives an initial operating license. According to the reference loading plan in the Mission Plan, if the I-MRS begins operation in 1996 as proposed, it would accept some 2,200 tonnes of spent fuel before the repository operating license is granted at the end of 1997. A ceiling of perhaps 10,000 tonnes until disposal begins would allow for some small slippages in the repository schedule, while still maintaining pressure to begin operation. A higher ceiling, say 15,000-20,000 tonnes, would provide additional flexibility, and may be needed if a more flexible repository siting and development plan were adopted, as discussed earlier. The ceiling might be absolute, requiring amendment of the authorizing legislation to waive; or it might be a trigger for a state veto over further loading, with provisions for a congressional override by joint resolution. (The latter procedure is provided in sec. 135(d)(6) of NWPA for expansion of a Federal interim storage facility beyond 300 tonnes.)

o Make progress on the I-MRS dependent upon continued NRC findings of confidence in the repository program instead of on achievement of specific milestones in the repository program. In its waste confidence decision in August, 1984, the NRC stated that it would "review its conclusions on waste confidence should significant and pertinent unexpected events occur, or at least every 5 years until a repository for high-level radioactive waste and spent fuel is available."[37] This suggests that NRC might review the decision in 1989, 1994, and 1999. Construction of the I-MRS could be tied to a positive finding in 1989; initial loading to a positive finding in 1994; and loading beyond an initial ceiling to a positive finding by 1999.

2.4.2.2. Measures to increase confidence that the repository program will not encounter major delays

Tying the I-MRS to the progress on siting a permanent repository would reduce the chances that the availability of the I-MRS itself would lead to delays in the repository. However, positive measures can be used to increase the confidence in the repository schedule. A number of possible measures are discussed in detail in Ch. 6 of OTA's March 1985 report.[38] These measures generally involve an expansion of DOE's reference siting program to ensure that backups can be made available with minimum delay if the primary candidate sites prove unacceptable. Such measures are discussed further in the following section.

3. CONTINGENCY PLANS FOR THE REPOSITORY SITING PROGRAM

3.1 Types of contingency measures

OTA's study concluded that the credibility of the Mission Plan would be enhanced if it contained explicit contingency plans for the repository siting program. Such plans should clearly identify the problems that could delay the development of a repository and include specific measures both to reduce the likelihood that such problems would occur and to mitigate the impacts of any problems that did occur. The Mission Plan has added a discussion of contingency plans, but at a higher level of generality than would be most useful in increasing confidence that major delays in the repository program would be avoided. That is, the Mission Plan shows what would happen in the event that major delays are encountered, rather than how to minimize or avoid such delays in the first place.

Contingency measures can be of two types: preventative, and mitigative. Preventative measures are those designed to reduce the chances that situations that could produce extended delays will arise in the first place. In this category perhaps the most important is redundancy -- the parallel development of more sites and technologies than are needed at each stage of the siting process, to allow the program to proceed even if some candidates are dropped from consideration. The ability of the space shuttle to achieve orbit and complete a successful mission several weeks ago despite failure of one engine during launch is an example of the effectiveness of this approach.

Mitigative measures are those designed to minimize the delays that could occur if the preventative measures are not adequate, and some phase of the siting process is completed without sufficient number of qualified sites to go to the next stage. (This problem might occur, for example, if only one good site is available at the end of characterization, and that site is successfully vetoed by the host state or is rejected by NRC at some point in the licensing process.) Mitigative measures may be preferred to parallel development of backups if the cost of parallel development is very high and/or the consequences of moderate delay are not serious. A major type of mitigative measure is a contingency plan for developing backup sites that lag the primary candidates by one stage, so that DOE does not have to go back to the very beginning of the siting process to develop backup sites if they are needed. For example, such a contingency plan could aim at having a suitable backup site fully characterized so that it could be submitted for licensing immediately if the first site is rejected by NRC.

3.2. Need for clear goals

To develop and evaluate alternative contingency plans, the requirements for the number of sites at each stage of the siting process must be well-defined. Some of the requirements of NWPA are in fact clear:

o Sec. 112 (b) requires that 3 sites be recommended for characterization.

o Sec. 114(a)(3) requires that the Secretary submit another site to Congress within 1 year of the date of disapproval of a recommended site by the host state or Indian tribe, if the disapproval is upheld by Congress. (This requirement can only be met if 2 fully qualified sites are available at the end of characterization; it is impossible to pick a new backup site and characterize it in one year.)

o Sec. 302(a)(5) requires that 1 site with an operating license be available by January 31, 1998.

However, other crucial requirements of NWPA are less clear. Specifically, section 114(f) requires that the EIS prepared at the time the first site is recommended for a repository must consider as alternate sites "3 candidate sites with respect to which (1) site characterization has been completed under section 113; and (2) the secretary has made a preliminary determination, that such sites are suitable for development as repositories consistent with the guidelines promulgated under section 112(a)." Both requirements appear to be subject to varying interpretations, with results that have major implications for the appropriate siting program. Each is discussed below.

3.2.1. The Preliminary Determination of Suitability

There is some disagreement about precisely when the preliminary determination of suitability required by sec. 114(f) is to be made. The Mission Plan states that the Secretary of DOE will make the preliminary determination at the time that DOE recommends 3 sites to the President for characterization.[39] Some Members of Congress support the DOE interpretation,[40] while others say that the determination is to be made at or near the end of the characterization process.[41]

The appropriate siting program would depend heavily upon which interpretation is correct. Depending upon the timing of the preliminary determination of suitability, characterizing only 3 sites initially could provide either a considerable degree of redundancy or none at all as far as DOE's ability to avoid major delays in recommending the first site for licensing is concerned.

If the preliminary determination of suitability is made before characterization, then characterizing 3 sites as DOE now plans to do should provide sufficient redundancy to give a reasonable degree of confidence that at least 1 would survive the characterization process and that DOE could recommend a site for licensing without major delay. In this case, contingency planning needs to focus on what would be done in the event that only one site appears usable for a repository after characterization. If that occurs, there will be some risk of major delays after the first site is recommended in the event that (a) the site is vetoed by the host state and Congress does not override the veto, or (b) the site is rejected by NRC at some point in the licensing process. In either case, a backup would need to be available as quickly as possible to minimize delays. (As noted above, the Act requires that DOE recommend a second site within 1 year if the first is vetoed and the veto is upheld.) The Mission Plan's analysis of possible delays in the various stages of the siting process does not address the possibility that only one site would survive characterization. The longest delay discussed for the licensing stage is 4 years, the time required for a second site to be prepared for licensing and reviewed by NRC; this short a delay would only be possible if a second suitable characterized site were already available.[42]

However, if the preliminary determination of suitability is made after characterization, then DOE could not recommend the first site for licensing until it had characterized 3 sites to the point that they could all be determined to be suitable for a repository. In this case, if DOE started with only 3 sites, the recommendation of the first site for licensing could be delayed by (a) delays in characterizing one or more of the sites, and/or (b) discovery of information during characterization that would disqualify one or more sites. The likelihood that no such problems would arise with any of 3 sites is low enough to warrant more extensive contingency plans. Thus, as DOE indicates, a finding that the preliminary determination of suitability would be made after characterization would either require characterization of more sites at the outset, or run a substantial risk of major delays before the first site could be recommended for licensing.[43]

In a recent letter on the subject, Representatives Dingell, Markey, Swift, and Wyden stated that the the preliminary determination should come "late in the site characterization process." [44] This appears to leave some ambiguity about the precise point in the characterization process at which the preliminary determination of suitability is expected to be made. An accompanying analysis of the legislative history of section 114(f) suggests that the preliminary determination of suitability would be made after "a detailed understanding of the site's geologic characteristics", but would still allow for the possibility that the site would subsequently be found unsuitable. It also indicates that testing at-depth would be required to produce that detailed understanding.[45]

The ambiguity lies in the fact that there is no precise technically-defined end point to characterization. Characterization will include both field tests from the surface designed to establish the large-scale properties of the site and surrounding environment, and in situ tests at the proposed depth of the repository. The more tests that can be done, and the longer they can be conducted, the more confidence in the suitability of the site can be obtained. There is no fixed point at which all conceivable relevant information would have been gathered. Instead, DOE will have to make a judgment as to when sufficient data are available to support a license application. At that point, DOE can recommend a site pursuant to sec. 114 of NWPA. If the preliminary determination of suitability had to be made after sufficient data were available to support a license application, it would imply that two exploratory shafts and an underground test facility would have to be completed and operated for some period for at least 3, and probably 4 or more, sites. It would also mean that DOE could not recommend one site for licensing until 3 had been determined to be ready for licensing.

However, the specification that the preliminary determination of suitability should come "late" in the characterization process suggests that it is not expected to come at the very end. Indeed, if it came at the very end, there would not seem to be any room for the site to be found inadequate at a later point in characterization, an event which the analysis cited above contemplates as possible. That view is also supported by sec. 114(a)(1)(E), which requires that the recommendation of a repository site to the President must be accompanied by a report containing preliminary comments by NRC concerning the extent to which the data from site characterization are sufficient for a license application. Presumably DOE would only recommend a site for which the NRC made a positive finding about the data and analysis, and NRC would only make such a finding if the data were sufficient to suggest that the site would in fact be licensable. Thus a preliminary determination of suitability made at this point would be tantamount to a preliminary finding by the NRC that the site appears suitable for licensing based on the available data. If the DOE preliminary determination of suitability is intended to be a less severe test than an NRC preliminary finding that the available data are sufficient for a license application, then the preliminary determination of suitability would need to be made at some earlier point in characterization.

Because site characterization is not clearly defined, there is no obvious stopping-place at which to make a preliminary determination of suitability, if it is decided that it must be made after characterization begins but before it ends. Since a major part of the cost and environmental impact of site characterization activities is associated with the underground test facility, one possible point before all of those costs and impacts have been incurred would be at the completion of the first exploratory shaft for the in situ facility. Some data on the suitability of the site will be obtained during the construction of the first shaft itself, particularly if the test program is designed to use the first shaft for that purpose. In addition, much relevant information to be obtained during characterization will be obtained from field activities on the surface, including additional boreholes. Some fraction of this data could also be available by the time the first shaft is completed. If the preliminary determination of suitability were to be made at this point, the test program could be designed to focus initially on determining whether any disqualifying conditions are present or qualifying conditions are absent.[46] A siting plan based on this approach is discussed below as an example of how resolution of the ambiguities about sec. 114(f) can determine the appropriate siting strategy.

3.2.2. Completion of Characterization at 3 Sites

As discussed above, sec. 114(f) also requires that characterization must have been completed under sec. 113 for the 3 sites described in the EIS. The ambiguity here involves just how far in the characterization process each site must be taken before characterization can be determined to have been completed for purposes of this section. This question is distinct from the question of when the preliminary determination of suitability is to be made, although the two questions are related. Obviously, if the preliminary determination of suitability must be made only after sufficient data are available to support a license application, then all 3 sites must be characterized to that point. However, if the preliminary determination of suitability can be made at an earlier point during characterization, or even before characterization, then it is not clear whether the 3 suitable sites must all be characterized beyond the point at which the preliminary determination of suitability is made. The resolution of this question could also have major implications. If DOE can terminate characterization of a site at any point following the preliminary determination of suitability and still satisfy the requirements of sec. 114(f), then a site can be recommended for a repository as soon as DOE has developed sufficient favorable data for one site to support a license application. That is, the program can proceed as quickly as the fastest site under consideration is ready for licensing. However, if each site that is not clearly disqualified following the preliminary determination of suitability must be carried all the way to the end of characterization, then the first site could not be recommended until the other remaining qualified sites had also been characterized to the same extent.

OTA cannot comment on the proper interpretation of the Act. However, it does conclude that it would be very valuable to the waste program to definitively resolve the ambiguities about sec. 114(f) as quickly as possible. DOE notes in the Mission Plan that a requirement that a preliminary determination of suitability be made for 3 sites at the end of characterization would in effect require that more than 3 sites be characterized initially, since it is likely that at least one site would drop out during characterization. This discussion suggests that the cost of deferring a definitive resolution of this question could be high. If DOE proceeds with 3 sites now on the assumption that the preliminary determination of suitability can be made before characterization, and if 1 or more of the sites proves to be unsuitable during characterization, then there is a good chance of a lawsuit at the time of the EIS. Such a lawsuit could itself hold up the process for a year or two. If the result of such a suit were a decision that the preliminary determination of suitability must be made at the end of characterization, 4 or more years could then be required for DOE to characterize additional sites.

OTA's March report described a conservative contingency siting plan that could provide considerable confidence that a repository could be operating full-scale no later than 2008 even if the preliminary determination of suitability had to be made after full characterization at-depth. The most expensive feature of this plan was full characterization of 4 sites in parallel, to increase confidence that 3 would be available after characterization, and to reduce the risk that recommendation of a site for licensing might be held up if one site experienced long delays during characterization.

To show how the resolution of the ambiguities about sec. 114(f) might affect the design of the siting plan, the following section describes one possible alternative contingency plan based on the assumption that the preliminary determination of suitability would be made at a point after characterization has begun but before it has been carried to the point that the site is ready for licensing. This discussion will also provide an example of what is meant by an explicit contingency siting plan.

3.3. Hypothetical Siting Plan

3.3.1. Assumptions

The plan described below assumes (1) that the preliminary determination of suitability could be made after construction of the first exploratory shaft but before construction of the second shaft and full underground test facility, and (2) that characterization of 3 sites to that point would fully satisfy the requirements of sec. 114(f) even if characterization were halted at some of the sites after the preliminary determination of suitability had been made. Thus it assumes that DOE can recommend the first site for licensing as soon as (1) a preliminary determination of suitability has been made for 3 sites for which an initial shaft has been sunk, and (2) full at-depth testing (following construction of a second shaft and underground facility) has been successfully completed for at least one of those sites. It is designed to give a high degree of confidence that at least 2 sites fully suitable for licensing would be available after full in situ characterization, so that if necessary DOE could meet the NWPA requirement that it submit a second site within 1 year of a successful state veto.

If this approach were allowed, it could significantly reduce the costs and environmental impacts of the characterization stage in two ways. First, a two-phase characterization process with a decision point after the first shaft is constructed could allow unsuitable sites to be identified and rejected as quickly as possible, so that the expense and environmental impacts of further characterization could be avoided. This could be attractive to the host states. Second, it could provide a basis for identifying the two most favorable sites so that the number carried into the second phase could be reduced to 2 with relatively little risk that the most promising site would be dropped inadvertently. (Completion of the full in situ test facilities would be undertaken for the third site only if it is needed later as a backup.) Reducing the number of sites for which full in-situ characterization must be performed and a detailed license application developed could decrease the costs and environmental impacts of the siting program or allow more sites to be considered in the earlier stages at no major increase in cost over current plans.

A two-phase process may extend the characterization stage to some extent. However, use of the I-MRS and the phased repository development plan discussed earlier could allow this to be done and still meet the 1998 deadline for initial disposal and also begin to move spent fuel from reactors in significant quantities by that time.

3.3.2. Elements of the siting plan

The following discussion will describe a reference plan for each stage of the siting process, as well as other options that could be considered.

3.3.2.1. Identification of sites suitable for characterization

3.3.2.1.1. Reference Plan

Sites for the first round of characterization: The initial sites for characterization would be selected from those that were under consideration at the time the NWPA was passed -- i.e. the 9 sites for which DOE has prepared draft Environmental Assessments. Since NRC's review of the draft Environmental Assessments for the 9 sites did not conclude that any of the sites were clearly disqualified on the basis of currently available data,[47] there does not appear to be a strong basis for concluding at this time that a suitable repository site cannot be selected from among the available candidates.

Identification of New Backup Sites. Site screening would be continued to identify new potential candidate sites for characterization to be used in the event that the first set of sites characterized were not adequate; this might be accomplished by continuing the Basin and Range screening program conducted by the U.S. Geological Survey.[48] Thus in the event that the initial round of sites are not sufficient, backups for characterization would be drawn from a new set of sites, rather than from the remainder of the original 9 sites for which draft Environmental Assessments were prepared. This may be needed to provide some geologic variety among the backup sites. All but 2 of the 9 sites are salt; and those 2 non-salt sites are currently ranked by DOE in the top 3 for characterization. If this ranking holds, the only remaining backups from the first 9 would be in salt. While salt may prove to be a good medium for a repository, it may be prudent to ensure that it is not the only medium available as a backup.

3.3.2.1.2. Options

o Defer selection of sites for characterization until additional data can be obtained about the 9 sites currently under investigation. This has been suggested as a way to increase the chances of success without incurring the costs of characterizing additional sites.[49] This approach would involve a certain delay of perhaps a year or two in exchange for some reduction in the risk that so many of the sites selected for characterization would be found later to be unsuitable that DOE would have to go back and characterize additional sites. It is not obvious, however, that this approach would be expected to lead to less total delay than the reference strategy, in which DOE would proceed with the full first phase of characterization for the most promising 3 sites, while acquiring additional data on a fourth site as a backup. Because no shaft would be sunk at the backup site until one of the first 3 had been found to be unsuitable, the extra cost of including a backup would only be the cost of surface tests. If desired, more of the first 9 sites could be evaluated further as possible backups, but is not clear that that would be superior to the proposed reference approach in which new sites would be identified as backups, rather than relying on the 5 of the first 9 that are not initially picked for characterization.

o Defer characterization until completion of a national site survey. This option has been suggested by some as a way of finding the best possible site for the first repository. It was not selected as the reference option for several reasons. First, it appears inconsistent with the requirements of NWPA. The Mission Plan's analysis of the repository schedule shows that it would be practically impossible to meet the Act's 1998 deadline for initial disposal if the siting process were halted while new potential candidate sites were identified and nominated. In this regard, a joint DOE-U.S. Geological Survey report suggested that a full national site survey could take about 8 years.[50] (In fact, the 1998 date was established after Congressional consideration and rejection of the alternative of a more extended schedule allowing time for a national site survey before selection of the first sites for characterization.[51]) Since the 1998 deadline is by law incorporated in the DOE contracts with utilities, DOE does not appear to be at liberty to unilaterally adopt a plan that would deliberately abandon that commitment.[52] Furthermore, abandonment of that commitment could exacerbate the very problem that some opponents of the I-MRS are concerned about -- the risk that repository siting would be deferred indefinitely.

Second, there may be no such thing as a "best" site that everyone would recognize as superior to all others. Because there is no generally accepted unique measure of the quality of a repository site, a judgment that one site is "better" than another must be based on a subjective balancing of many incommensurable factors.[53] It is unlikely that everyone would balance these factors in the same way. Even if such a unique "best" site did exist somewhere in the United States, it is not clear how one could ever be very confident that it had been found. For example, one could not be sure that some new site is superior to the current 9 candidates unless they had all been characterized, since there is no assurance that the ranking of potential sites based on pre-characterization data would be the same after characterization was completed. For the same reason, one could never be sure that the best of those sites that had been characterized (if agreement could be reached about which is best) was superior to all of the other potential sites that had not been characterized. Thus it appears that the most one could hope for is to find one site among all those that have been characterized that is generally regarded as preferable to all the others that have also been characterized; and it may be more likely that there would be no clear "winner" among those characterized sites that are determined to be able to meet the regulatory requirements. In other words, identification of one or more sites that are licensable by NRC may be the only reasonably achievable goal for the siting program.

As noted above, NRC's comments on the draft Environmental Assessments do not conclude that any of the 9 sites now under consideration can be clearly disqualified on the basis of available data. Thus it is not clear that deferring characterization of any sites until a range of new ones have been examined will produce much more confidence that a good site will be found than will the reference strategy of proceeding to the first phase of characterization on sites that are available now, while identifying new sites that could be characterized later if the current set are found to be unsuitable.

3.3.2.2. Site Characterization -- Phase 1

Completion of the first exploratory shaft (and perhaps a short exploratory drift at the bottom) provides one logical break-point for a two phase characterization process. Efforts in the first phase would consist of tests during construction of the shaft and an initial drift (or horizontal boreholes), as well as field tests (e.g. borehole pump tests to determine the bulk hydrologic characteristics of the site). The first phase would be focussed on rapidly reducing the uncertainty about the presence of disqualifying factors or the absence of qualifying factors -- i.e. on obtaining information that could lead to a determination that the site is not suitable.[54] (This may require more time during the sinking of the first shaft to allow for an appropriate test program.) At the end of this phase, DOE would complete the Advanced Conceptual

Design for the repository at each site -- the second step in the first of three design stages described in the Mission Plan[55]. According to the Mission Plan, this design should be completed by the time the first exploratory shaft is constructed.[56] Since the Advanced Conceptual Design will include a demonstration of project feasibility and an estimate of total life cycle cost for a repository at the proposed site,[57] it would provide a useful basis for determining whether further evaluation of the site is warranted.

(The likelihood that disqualifying features would be found early would be increased if the surface exploration activities of the characterization phase do not have to wait for issuance of a final site characterization plan (SCP), but rather could start as soon as the designation of the site is effective. This might be allowed under NWPA, which only specifies that the SCP must be issued before sinking an exploratory shaft at a candidate site.)

3.3.2.2.1 Reference plan

Recommend 4 sites for characterization. Prepare Site Characterization Plans for all four, and conduct the surface testing part of the first phase of characterization for all four; but sink initial shafts only at the most promising three. If one drops out, then sink a shaft at the fourth site. If more than 1 drop out, than sink a shaft at the fourth site and at 1 or 2 new sites selected from those identified in the backup screening process described above. Beginning work on a fourth site increases initial costs somewhat, but reduces the delay involved if one site drops out and a backup has to be brought along.

Note that this might be a useful site characterization strategy even if the preliminary determination of suitability were made before characterization begins, as DOE plans to do. Having 3 sites that survive the first phase of characterization could give a high degree of confidence that 2 would survive through the end of the second phase, so that DOE would be able to recommend a second for licensing within a year if the first is successfully vetoed by the host state.

Because of the potential sensitivity of individual states to the possibility that a site within their borders would be chosen for characterization, it is important to consider their possible reactions to the idea of recommending more than 3 sites for characterization. Those states already expecting to be included among the top 3 would likely support the inclusion of a fourth site, since that would make it easier for DOE to drop one of the top 3 sites on the basis of information discovered during characterization. However, a state believing that it is likely to host the fourth site would have to balance both advantages and disadvantages to being included from the beginning in the first set of sites to be characterized. On the one hand, if the top 3 sites prove to be suitable, then the fourth state would have unnecessarily experienced the impacts of at least the surface test part of characterization. In addition, being characterized for the first repository makes a site eligible for the second repository as well. Thus the host of the fourth site may prefer not to have that site named for characterization until it is certain that an additional site is needed. (This concern might be reduced if there were an explicit commitment to characterize 3 new eastern sites for the second repository, rather than to plan to carry over one or more from those characterized for the first repository.[58])

On the other hand, beginning characterization at the fourth site at the same time as the top 3 sites has some potential benefits for the host state because of the possibility that the fourth site would be pulled into characterization later in any event as a result of problems discovered with one or more of the first 3 sites. If the surface tests on the fourth site begin in parallel with full phase one characterization of the first 3 sites, it is possible that disqualifying features of the site could be discovered even before the first shaft was sunk. If characterization did not begin until one of the first 3 had dropped out, there might be more pressure to sink the exploratory shaft as quickly as possible and perform surface tests in parallel. In addition, once the site is designated and approved for characterization, the state becomes eligible under NWPA for funding to conduct its own technical analysis and oversight.[59] Thus if the fourth site ultimately has to be characterized, inclusion from the beginning would give the host state several extra years of support to enhance its own technical review capability.

3.3.2.2.2. Options

o Start with only 3 sites. If one or more drops out by the end of the first phase, recommend other sites for characterization (the number depending upon how many sites had dropped out). This has the minimum initial cost, but the maximum potential delay if any of the original 3 is dropped. However, the expected delay would be less than if the preliminary determination of suitability were made at the very end of characterization of 3 sites because (a) the decision that an additional site was needed would be made earlier, and (b) the determination that the new site is or is not suitable would be made earlier.

o Characterize 4 sites all the way to the end of the first phase. This option minimizes the expected delay resulting from failure of a site, but increases the costs and impacts if it turns out that the 4th site was not needed; i.e. if the three highest ranked sites all proved suitable at the end of the first phase. However, the extra cost of parallel characterization of a fourth site would be substantially lower than if the preliminary determination of suitability were made at the end of characterization, because the extra site would only have the first shaft sunk before its suitability was determined.

3.3.2.3. Site Characterization -- Phase 2

The second phase of characterization would include construction and operation of the second shaft and the in situ test facility, continuation of surface and lab tests as necessary, and preparation of the License-Application Design (the second design stage). DOE would be able to proceed with the second phase at any site which had been found suitable after the first phase, without waiting for a preliminary determination of suitability for 3 sites.

3.3.2.3.1. Reference Plan

Complete phase two characterization and license application designs only for the two most promising of the 3 suitable sites. By the assumption on which this analysis is based, the EIS requirements for 3 characterized sites would be met by having 3 sites that were determined to be suitable after having completed the first phase of characterization. If this assumption is valid, it would not be necessary to carry all 3 to the end of phase two. Focusing attention on two sites after the first phase of characterization would reduce costs and environmental impacts compared to the DOE Mission Plan, in which full underground facilities, and detailed designs suitable for a license application, are planned for all three sites. The risk of narrowing to two sites at this point is that the site with the best chance of being licensed might be dropped inadvertently; that is, the least preferred of the sites at the end of phase one might turn out to be the most preferred at the end of phase two if it were carried along with the highest ranked sites.

Two sites are carried all the way to the end of the second phase of characterization (instead of only one) to increase confidence that DOE would be able to meet NWPA's requirement that it recommend a second site for licensing within a year if the first is vetoed by the host state and that veto is not overturned by Congress.

3.3.2.3.2. Options

o Complete phase two characterization for all 3, but do license application designs only for most promising 2. This would increase the the cost and environmental impacts compared to the reference option, but would avoid any risk that the most promising site might be inadvertently dropped at the end of phase 1. Some savings would result from preparing only two license application designs.

o Complete phase two characterization and license application designs for all 3 suitable sites. This is identical to the Mission Plan. It maximizes the costs and environmental impacts of characterization, but minimizes the chance of significant delays during the recommendation and licensing process.

3.3.2.4 Recommendation by DOE and licensing

Under the assumptions discussed earlier, DOE would be able to recommend the first site for licensing as soon as (a) a preliminary determination of suitability had been made for at least 3 sites after completion of phase one of characterization, and (b) one site had completed phase two of characterization successfully.

3.3.2.4.1. Reference plan

Recommend only the top candidate for licensing, and prepare a Final Procurement and Construction Design only for that site. The backup would be recommended only if the first is rejected If the first is rejected and the backup must be used, or if the second site carried into the second phase of characterization were rejected in that phase, then a new backup would be prepared by bringing an additional site to the point of having completed phase 2 and having a full license application design. This would be particularly prudent if the first site were dropped for technical reasons after the initial recommendation had been made, since that would be evidence that the likelihood of rejection after characterization is higher than expected.

This approach involves the possibility of up to perhaps an 8-10 year delay if the first site were rejected very late in the licensing process -- e.g. at the operating license stage. This potential delay could be reduced if the backup were submitted for licensing as soon as data raising questions about the suitability of the first site were discovered.

3.3.2.4.2. Options

o Recommend a second site for licensing as soon as one has completed the second phase of characterization successfully.[60] This increases the initial costs somewhat, but reduces the delay involved if the backup must be used. It also allows repository construction to proceed as soon as the faster of the two sites is licensed.

4. BACKUP WASTE FACILITY PLAN

The contingency siting measures discussed in the preceding section should increase confidence that a geologic repository will be available without extended delay. This should decrease concerns about the adverse impacts of an I-MRS facility on the repository program, and the associated concern that the I-MRS facility would itself become a long-term waste repository by default. This latter concern could be further reduced by an explicit plan for providing long-term alternatives to geologic repositories in the unlikely event that unexpected major difficulties lead to extended delays in the availability of geologic disposal, or even rejection of the concept.[61] (The contingency analysis in the DOE Mission Plan does not address the possibility that geologic disposal might encounter insuperable obstacles.)

In general, there are two types of long-term alternatives to geologic repositories: 1) storage facilities, or 2) some other disposal technology such as subseabed emplacement. In the absence of any explicit contingency plan for providing long-term alternatives if needed, the I-MRS (if constructed) will itself be seen as the default option. Some supporters of a Federal MRS facility do see it as a suitable long-term alternative to geologic repositories, and NWPA requires that the design for the MRS facility that DOE is directed to submit to Congress must allow safe storage for "as long as may be necessary." However, it is not clear that the I-MRS being proposed by DOE is particularly well-suited for a long-term storage role.

In the first place, the storage technologies selected for use in the I-MRS (concrete casks and drywells) may be better suited for providing easily expandable storage capacity for a period of decades in the face of an uncertain level of demand (as would be the case for buffer storage to deal with small schedule slippages) than for providing large amounts of storage for an extended period (e.g. a century or more) in the event of major problems with geologic disposal. In the latter situation, a higher-density, higher fixed capacity technology (such as a tunnel rack system) might be preferable. In addition, storage facilities designed for a long and perhaps indefinite period of storage may raise licensing issues that are not faced by facilities intended for at most a limited period of interim storage.[62]

In the second place, the tentative candidate sites for the I-MRS were not selected with a very long-term storage role in mind. The siting plan for the I-MRS places very heavy weight on reducing the impacts of transportation between the reactors and the final repository, rather than upon the siting characteristics that might be desired for a very long-term storage facility.[63]

While the I-MRS thus might not be optimal as a long term alternative to geologic disposal, it could serve as the receiving and packaging facility for a long-term storage facility that is explicitly designed and sited with that role in mind. An explicit discussion of plans for developing such a facility if necessary could provide additional assurance that the I-MRS would only serve as a way-station on the road to a long-term isolation facility.

Such assurance should also be increased by providing sufficient flexibility in the I-MRS packaging facility design to ensure compatibility with alternative disposal technologies. Section 222 of NWPA requires accelerated development of such technologies. At present, subseabed emplacement appears to be the most promising alternative disposal technology, although it is subject to considerable institutional uncertainty.[64] The U.S. is currently participating in an international cooperative project to determine the technical feasibility of subseabed disposal, and the Mission Plan notes that DOE intends to continue this participation to keep this option open into the 1990's.[65]

[1]U.S. Department of Energy (DOE), Mission Plan for the Civilian Radioactive Waste Management Program, DOE/RW-0005, June 1985.

[2]Office of Technology Assessment, Managing the Nation's Commercial High-Level Radioactive Waste, OTA-O-171, March 1985.

[3]DOE, op. cit., p. 16.

[4] DOE, Mission Plan for the Civilian Radioactive Waste Management Program - Draft, DOE/RW-0005 DRAFT, April 1984, pp. 3-B-1 -- 3-B-3.

[5]OTA, op. cit., p. 126.

[6]Ibid., p. 125.

[7]Ibid., p. 127.

[8]Testimony of Thomas A. Cotton before the Subcommittee on Energy Conservation and Power, House Committee on Energy and Commerce, March 21, 1985.

[9] DOE, The Need for and Feasibility of Monitored Retrievable Storage -- a Preliminary Analysis, DOE/RW-0022, April 1985; and DOE, Screening and Identification of Sites for a Proposed Monitored Retrievable Storage Facility, DOE/RW-0023, April 1985.

[10]OTA, op. cit., pp. 127-128.

[11]Karlsruhe Nuclear Research Center Ltd., Systems Study Alternative Entsorgung: Executive Summary, KWA 2190/1, March 1985.

[12]See, for example, Westinghouse Electric Corporation, Waste Technology Services Division, "Preliminary Cost Analysis of a Universal Package Concept in the Spent Fuel Management System," WTSD-TME-032, September 1984; and also Boeing Engineering Company Southeast, Inc., "Spent Fuel Storage System Options: A Comparative Cost Analyses (sic)," final report (prepublication draft) of research project RP2511-2 for the Electric Power Research Institute, undated.

[13]Westinghouse, op. cit.; Boeing, op. cit. Karlsruhe, op. cit., also proposes to use a shielded disposal package for transportation from the spent fuel conditioning facility to the repository.

[14]Westinghouse, op. cit., pp. 4-19 -- 4-24.

[15]DOE is currently demonstrating a storage/transportation casks. See Pacific Northwest Laboratory, "Commercial Spent Fuel Management Program Monthly Progress Report," PNL-4947-20, May 1985, pp. 21-23. DOE is also supporting systems integration studies examining the feasibility of so called "universal casks" for storage, transportation, and disposal.

[16]Westinghouse, op. cit., Table 1-3 (case 5), p. 1-11. This study did not examine the DOE integrated MRS system, which involves a simpler, and thus less expensive, receiving and handling facility at the repository.

[17]Westinghouse, op. cit., and Boeing, op. cit.

[18]For a description and analysis of a tunnel-rack system, see DOE, The Monitored Retrievable Storage Concept: A Review of its Status and Analysis of its Impact on the Waste Management System, DOE/NE-0019, December 1981.

[19]U.S. Nuclear Regulatory Commission, "10 CFR Parts 50 and 51: Waste Confidence Decision," Federal Register, Vol. 49, No. 171, August 31, 1984, pp. 34659-34696.

[20]Ramberg, Bennett, Destruction of Nuclear Energy Facilities in War, (Lexington, Mass.: D.C. Heath and Company, 1980). For more detailed calculations of the effects of a nuclear war involving nuclear facilities, see Conrad V. Chester and Rowena O. Chester, "Civil Defense Implications of the U.S. Nuclear Power Industry During a Large Nuclear War in the Year 2000," Nuclear Technology 31 (December 1976), pp. 326-338.

[21]See summary of comments in DOE, Mission Plan, Vol. II, pp. 98-99.

[22]See statements by officials from potential repository states at the hearing on the repository site selection process before the Subcommittee on Energy Conservation and Power, House Committee on Energy and Commerce on August 1, 1985.

[23]For a discussion of the value of a commitment to an explicit date for repository operation, see OTA, op. cit., pp. 102-103 and pp. 253-256.

[24]OTA, op. cit., pp. 118-120 and pp. 148-150.

[25]See OTA, op.cit., ch.6 for a more extended discussion of a stepwise approach to repository operation.

[26]DOE, The Need for and Feasibility of Monitored Retrievable Storage, p. 3-4.

[27]See OTA, op. cit., appendix G, pp. 334-337 for a discussion of possible reactor unloading rates.

[28]DOE, The Need for and Feasibility of Monitored Retrievable Storage, p. 4-16.

[29]OTA, op. cit., pp. 60-61 notes that the least expensive way to provide modular dry storage is to locate the storage in conjunction with another facility where the existing staff and handling equipment for that facility can be used for packaging and handling the fuel for storage. This is precisely the situation if the primary function of the MRS is to perform consolidation and packaging operations required for disposal.

[30]DOE, The Need for and Feasibility of Monitored Retrievable Storage, p. 4-17.

[31]OTA, op. cit., Table 3-4, p. 60.

[32]McNair, G.W., "Analyses of Potential Effects of an MRS Facility on Spent Fuel Transportation Requirements," in Roy G. Post (editor), Waste Management 85: Waste Isolation in the U.S., Technical Programs and Public Participation, Proceedings of the Symposium on Waste Management at Tucson, Arizona, March 24-28, Vol. 1, pp.373-374.

[33]DOE, Screening and Identification of Sites, p. 6.

[34]Most available analyses of spent fuel transportation accidents assume that the spent fuel is only about 150 days old; yet spent fuel shipped to the I-MRS will be at least 5 years old, and most likely more than 10 years old. Because the heat output of this older fuel is so much lower than that of 150-day-old fuel, the consequences of transportation accidents would be lower. For a discussion of this point, see OTA, op. cit., pp. 65-67.

[35]OTA, op. cit., p. 128.

[36]OTA, op. cit., appendix A, pp. 207-208.

[37] U.S. Nuclear Regulatory Commission, op. cit., p. 34660.

[38]OTA, op. cit., pp. 132-141.

[39]DOE, Mission Plan, p. 64.

[40]Letter from Senators James A. McClure, Pete V. Domenici, J. Bennett Johnston, and Alan K. Simpson to The Honorable John Herrington, Secretary of Energy, June 25, 1985.

[41]Letter from Representative Morris K. Udall to Mr. Benard C. Rusche, Director, Office of Civilian Radioactive Waste Management, July 26, 1985; and letter from Representatives John D. Dingell, Edward J. Markey, Al Swift, and Ron Wyden to Ben Rusche, July 26, 1985.

[42]DOE, Mission Plan, Case 4-D, p. 66.

[43]Ibid., vol. II, p. 25.

[44]Representatives Dingell, Markey, Swift, and Wyden, op. cit.

[45]"Detailed Analysis of Section 114(f)." Attachment to cited letter.

[46]Qualifying and disqualifying conditions are described in the DOE site selection guidelines, 10 CFR Part 960. The guidelines provide that "a site shall be disqualified at any time during the siting process if the evidence supports a finding by the DOE that a disqualifying condition exists or the qualifying condition of any system or technical guideline cannot be met." (Part 960.3-1-5.) Thus identification of the presence of any disqualifying condition

or absence of any relevant qualifying condition would lead to rejection of the site.

[47]Letter from John G. Davis, Director, NRC Office of Nuclear Material Safety and Safeguards, to Ben C. Rusche, Director, Office of Civilian Radioactive Waste Management, March 20, 1985.

[48]This idea is discussed further in OTA, op. cit., pp. 138-139.

[49]For example, this has been recommended by the State of Utah. See "Utah Nuclear Waste Repository News," Issue 9, August 1985.

[50]U.S. Geological Survey, Plan for Identification and Characterization of Sites for Mined Radioactive Waste Repositories, Water-Resources Investigations Open-File Report 80-686, prepared by Subgroup 1 of the Earth Science Technical Plan Working Group, U.S. DOE and U.S. Geological Survey, (Reston, Va., May 1980), Fig. 3, p. 67.

[51]Congressional Record, April 29, 1982, pp. S 4293-S 4303.

[52]Sec. 302(a)(5)(B) of NWPA. The commitment to begin disposal by January 31, 1998 is contained in Article II of the standard contract adopted by DOE, specified in 10 CFR Part 961.

[53]On this point, the U.S. Department of the Interior's comments on the site ranking process used in the draft Environmental Assessments notes that "subjective judgment is required to reach any ranking, no matter what method is employed." See p. 3 of the general comments on the Environmental Assessments, sent to the Department of Energy by Bruce Blanchard, Director, Environmental Project Review, Office of the Secretary, U.S. Department of the Interior, on March 27, 1985.

[54]Ibid., pp. 1-2 also emphasizes the importance of a site characterization process designed "to ensure that sites with presently unknown flaws could be eliminated from further study during the characterization phase."

[55]DOE, Mission Plan, pp. 221-222.

[56]Ibid., Figure 3-5, p. 59.

[57]Ibid., p. 221.

[58]The idea of a commitment to separate western and eastern siting rounds for the two repositories required by NWPA is discussed further in OTA, op. cit., p. 135.

[59]Sec. 116(c)(1)(B) of NWPA.

[60]This approach is discussed in OTA, op. cit., p. 137.

[61]For a discussion of this concept, see OTA, op. cit., pp. 128-129.

[62] OTA, op. cit., p. 58.

[63] DOE, Screening and Identification of Sites, op. cit., p. 6.

[64] OTA, op. cit., pp. 50-51.

[65] DOE, Mission Plan, p. 55.

DOE/RW-0035
Volume 3 of 3 Volumes

Nuclear Waste Policy Act

Monitored Retrievable Storage Submission to Congress

Volume 3

Monitored Retrievable Storage
Program Plan

PREFACE

On January 7, 1983, President Reagan signed the Nuclear Waste Policy Act (NWPA) of 1982, which establishes the federal policy for disposal of commercial spent nuclear fuel and high-level radioactive waste. The NWPA instructs the Secretary of Energy to start accepting spent fuel and high-level waste for disposal in a deep geologic repository by January 1998. The NWPA also states that storage of high-level radioactive waste or spent fuel in a monitored retrievable storage (MRS) facility is an option for providing safe and reliable management of such waste or spent fuel.

Section 141 of the NWPA instructs the Secretary of Energy to prepare a proposal for construction of one or more MRS facilities. The NWPA states that the proposal to Congress shall include the establishment of a federal program for the siting, development, construction, and operation of such facilities; a plan for funding the construction and operation of such facilities; a plan for integrating the facilities with other storage and disposal facilities authorized in the NWPA; and site-specific designs and cost estimates. The proposal is to be accompanied by an environmental assessment.

In response to these requirements, the Office of Civilian Radioactive Waste Management in the Department of Energy (DOE) has prepared this submission to Congress. The submission consists of three volumes, described below. The required site-specific designs and cost estimates are incorporated by reference.

The first volume, The MRS Proposal, describes the DOE's proposal to construct and operate an MRS facility at the Clinch River Site in Roane County, Tennessee. The proposed MRS facility would be an integral part of the federal waste management system and would perform most of the waste-preparation functions before emplacement in a repository.

The second volume, The Environmental Assessment, is divided into two parts. Part 1 examines the need for and feasibility of constructing an MRS facility as an integral component of the waste management system. Part 2 includes descriptions of two facility design concepts at each of three candidate sites, and a detailed assessment and comparison of the environmental impacts associated with each of the six site-design combinations.

The third volume, The Program Plan, describes the activities, costs and schedules for establishing a federal program to site, develop, construct, and operate an MRS facility, if approved by Congress. It includes plans for funding the construction and operation of an MRS facility and for integrating the facility with other waste management facilities authorized in the NWPA.

CONTENTS

FIGURES

TABLE

1.0 INTRODUCTION

This Program Plan has been prepared in response to the requirements of Section 141 of the Nuclear Waste Policy Act (NWPA) of 1982. It describes the Department of Energy's (DOE) proposed program for developing, constructing, and operating a monitored retrievable storage (MRS) facility. The MRS facility, if approved by Congress, will be an integral part of the federal waste management system and will perform the necessary waste preparation functions for spent fuel prior to its emplacement in a repository.[a]

This document presents the current DOE program objectives and the strategy for implementing the proposed program for the integral MRS facility. If the MRS proposal is approved by Congress, DOE will periodically review the need to revise or update this Program Plan. Any needed revisions to the Program Plan will be made available to the Congress, the State of Tennessee, affected Indian tribes, local governments, other federal agencies, and the public.

The NWPA requires that the proposal for constructing an MRS facility include:

1. the establishment of a federal program for the siting, development, construction, and operation of MRS facilities [Section 141(b)(2)(A)]

2. a plan for funding the construction and operation of MRS facilities [Section 141(b)(2)(B)]

3. site-specific designs, specifications, and cost estimates for the first such facility [Section 141(b)(2)(C)]

4. a plan for integrating MRS facilities with other storage and disposal facilities authorized by the NWPA [Section 141(b)(2)(D)].

This plan includes the information required in Items 1, 2, and 4, and a summary of the cost estimates required in Item 3. Detailed site-specific designs, specifications, and cost estimates for an MRS facility are provided in the DOE's Conceptual Design Report (Ralph M. Parsons Company 1985).

Chapter 2.0 of this Program Plan provides an overview of the proposed MRS Program. It describes the functions of an MRS facility and includes a discussion of schedules, costs, and management approaches for implementing the Program. Chapter 3.0 identifies the elements which will comprise the MRS

(a) Present and future verb tenses are used for ease in describing this Program Plan and do not imply that an MRS facility will be approved or built.

program and provides further details on proposed program activities and schedules. Chapter 4.0 contains schedule information on the integration of the MRS Program with other DOE programs and with other waste management facilities authorized by the NWPA. Chapter 5.0 describes the funding plan proposed for MRS facility development, construction, operation, and decommissioning. The source of funding and funding needs are both discussed. Detailed information to support the Program Plan is provided in the appendices.

2.0 PROGRAM OVERVIEW

This chapter provides an overview of the MRS Program by presenting and discussing the proposed functions and site for the MRS facility, a proposed schedule for key program activities, the estimated costs of the program, and the proposed DOE management approach and responsibilities for implementing the program, if the MRS proposal is approved by Congress.

2.1 MRS FACILITY FUNCTIONS

The MRS facility will be an integral part of the federal waste management system. Its primary functions will be to receive spent fuel assemblies from commercial nuclear power plants, consolidate them (i.e., disassemble them to reduce their volume), package them in sealed canisters, and ship them to the repository for disposal. It will also provide temporary storage for up to 15,000 MTU (metric tons uranium) of the canistered spent fuel, if required. It will receive, consolidate, and package between 2500 and 3000 MTU of spent fuel annually. The facility will be licensed by the Nuclear Regulatory Commission (NRC). Figure 2.1 depicts the operation of the MRS facility.

2.2 PROPOSED MRS SITE

The proposal to Congress for the MRS facility recommends that the facility be constructed at the Clinch River site in Tennessee. The Clinch River site, located 25 miles west of Knoxville, is adjacent to the DOE's Oak Ridge reservation and lies within the Roane County portion of the city of Oak Ridge. The site covers only a portion of the site area for the canceled Clinch River Breeder Reactor project.

2.3 PROGRAM SCHEDULE

The deployment schedule,[a] shown in Figure 2.2, presents major events that must occur prior to operation of the MRS facility. The proposed MRS facility will be operational approximately 10 years after the date of congressional approval. Initial operation will be at a reduced capacity. Operation

(a) To correlate program activities with specific dates, it was necessary to assume a starting date for the program. The starting date will depend on the date of congressional approval of the MRS proposal but was assumed to be July 1986.

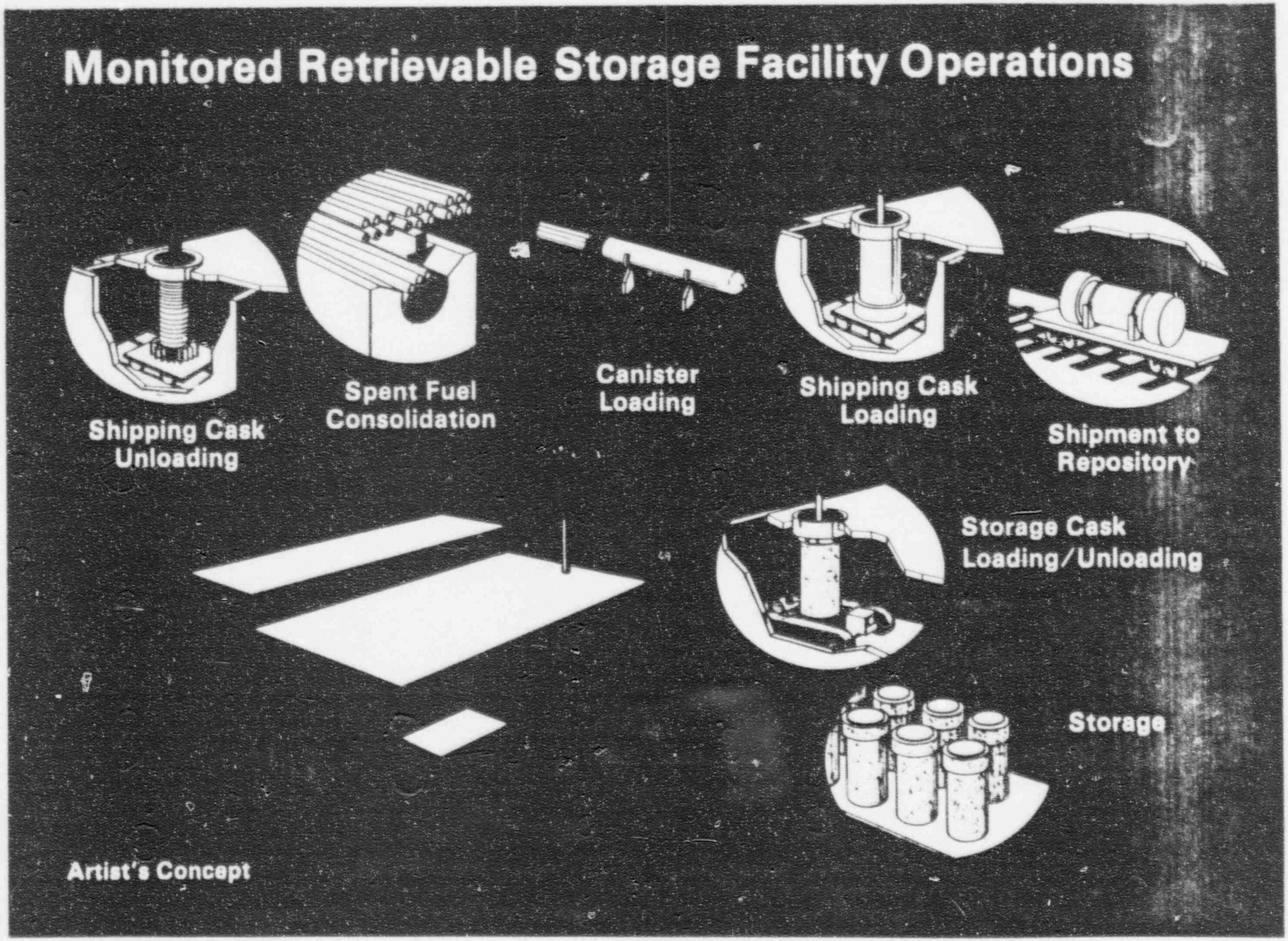

FIGURE 2.1. Monitored Retrievable Storage Facility Operations

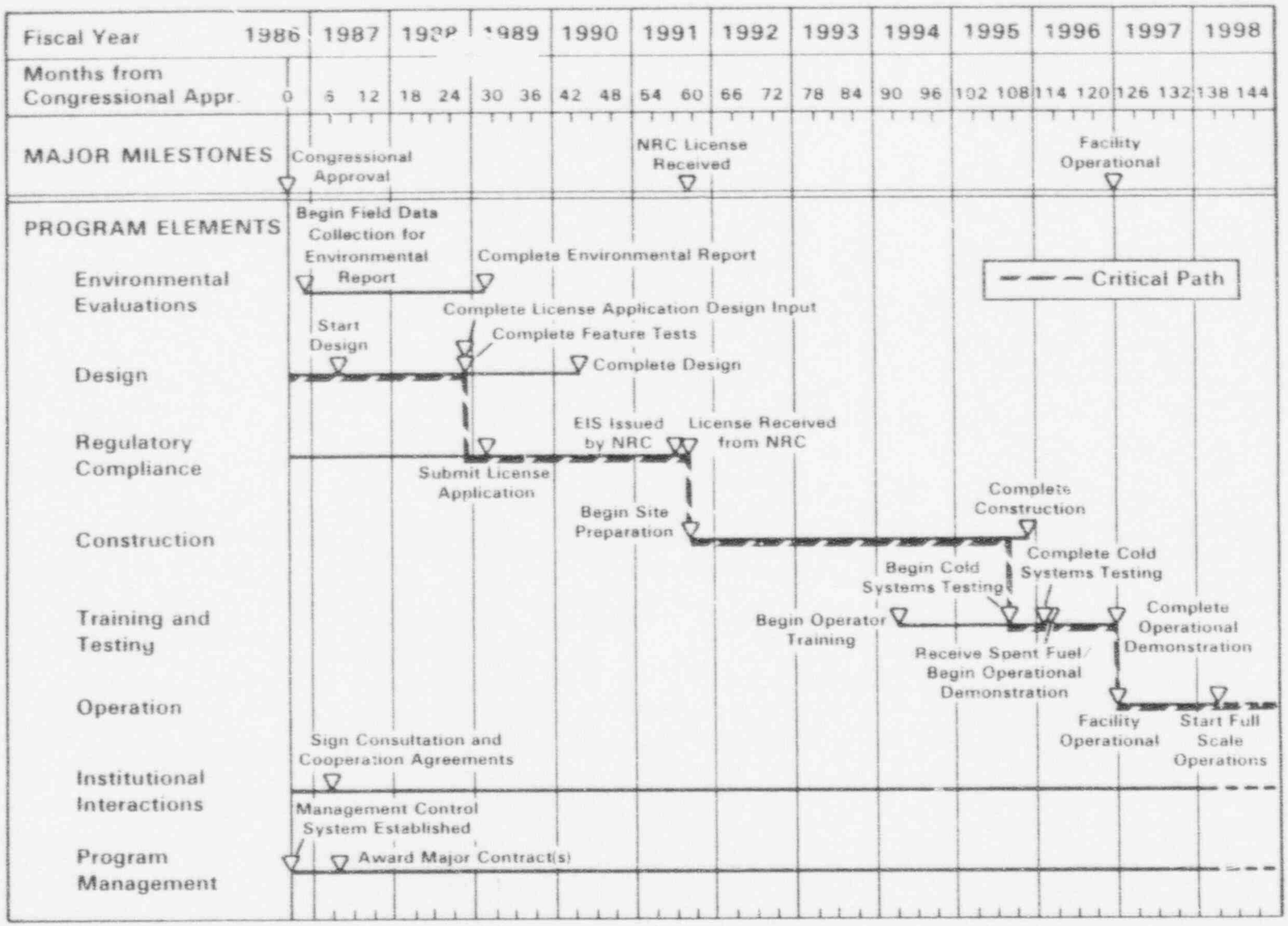

FIGURE 2.2. MRS Deployment Schedule

at full capacity will be achieved about 15 months after initial operation. The MRS facility will service the first repository and will operate for approximately 26 years. Decommissioning of the facility will be completed approximately 4 years after operations cease.

Figure 2.2, the MRS deployment schedule, identifies key milestones and the critical path to operation of the MRS facility. The following discussion describes the activities that correspond with the milestones on the deployment schedule.

Early activities in the Environmental Evaluations and Design elements support the preparation of a license application to the NRC for construction and operation of the MRS facility. In order to submit a license application, the DOE must have sufficient information on facility design and expected performance and on the potential environmental effects of the facility so that the NRC can make a judgment on whether to grant a license. The license application does not require a complete definitive design of the entire facility, only those portions that affect safety or environmental impact. Design of other portions of the facility (e.g., the administration buildings) will continue after the license application is submitted.

Two other elements that will be initiated immediately upon receipt of congressional approval of the MRS proposal are the Institutional Interactions element and the Program Management element. An initial activity in the Institutional Interactions element will be the establishment of binding Consultation and Cooperation Agreements with the State of Tennessee. These agreements will specify the processes and procedures for interactions between the State of Tennessee and the DOE relative to MRS facility development. The Program Management element will adapt state-of-the-art management control systems to support sound and efficient management of the program.

As shown on the Regulatory Compliance line of the deployment schedule, 30 months are allowed for the NRC review, issuance of the Environmental Impact Statement (EIS), and the granting of a license. Following receipt of the license from the NRC, the approximately 4-year construction effort for the facility will begin. After construction is completed there will be approximately 1 year of testing and demonstration before the facility becomes operational.

2.4 ESTIMATED COSTS

The costs for implementing the MRS Program were estimated using information developed as a part of the conceptual design effort (Ralph M. Parsons Company 1985) which also supports the MRS submission to Congress. Analysis of other program activities necessary to deploy and operate the MRS facility provided supplemental information that was used in the cost estimate.

The cost estimate is based on development of an MRS facility that uses the sealed storage cask design and is located at the Clinch River site in Tennessee. The facility functions and schedule used in the cost estimate were briefly described in Sections 2.1 and 2.2.

The cost of the program from the time of congressional approval until the facility becomes operational will be approximately $97[illegible] million. From this total, approximately $700 million of capital funds will be used for facility design and construction. The annual operating costs of the facility, which will employ about 600 workers, will be approximately $70 million. The costs are higher during the initial years of operation when the sealed storage casks must be procured and lower in the later years when the MRS facility stops receiving spent fuel and is only shipping spent fuel canisters to the repository. The cost of decommissioning the facility following completion of operations will be approximately $80 million.

All costs are in constant 1985 dollars. The estimates do not include costs for financial assistance to state and local governments.

It should be noted that inclusion of an integral MRS facility in the waste management system will reduce the costs of other components of the system (e.g., the repository). These cost reductions are discussed in Chapter 5 and Appendix E of this Program Plan and in Volume 2 of this submission to Congress, <u>Environmental Assessment for a Monitored Retrievable Storage Facility</u>.

2.5 MANAGEMENT APPROACH AND RESPONSIBILITIES

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

The OCRWM's operations are 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, the 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. This section describes the organizational structure of the OCRWM and the approach and responsibilities for implementating the MRS Program, if approved by Congress.

As shown in Figure 2.3, the OCRWM is organized by staff responsibility and functional responsibility. The Office of Policy and Outreach provides staff support. The three major functional components are 1) the Office of Resource Management, 2) the Office of Geologic Repositories, and 3) the Office of Storage and Transportation Systems.

The Director of the OCRWM interacts regularly with the Secretary of Energy in establishing overall policy and ensuring that the activities of OCRWM

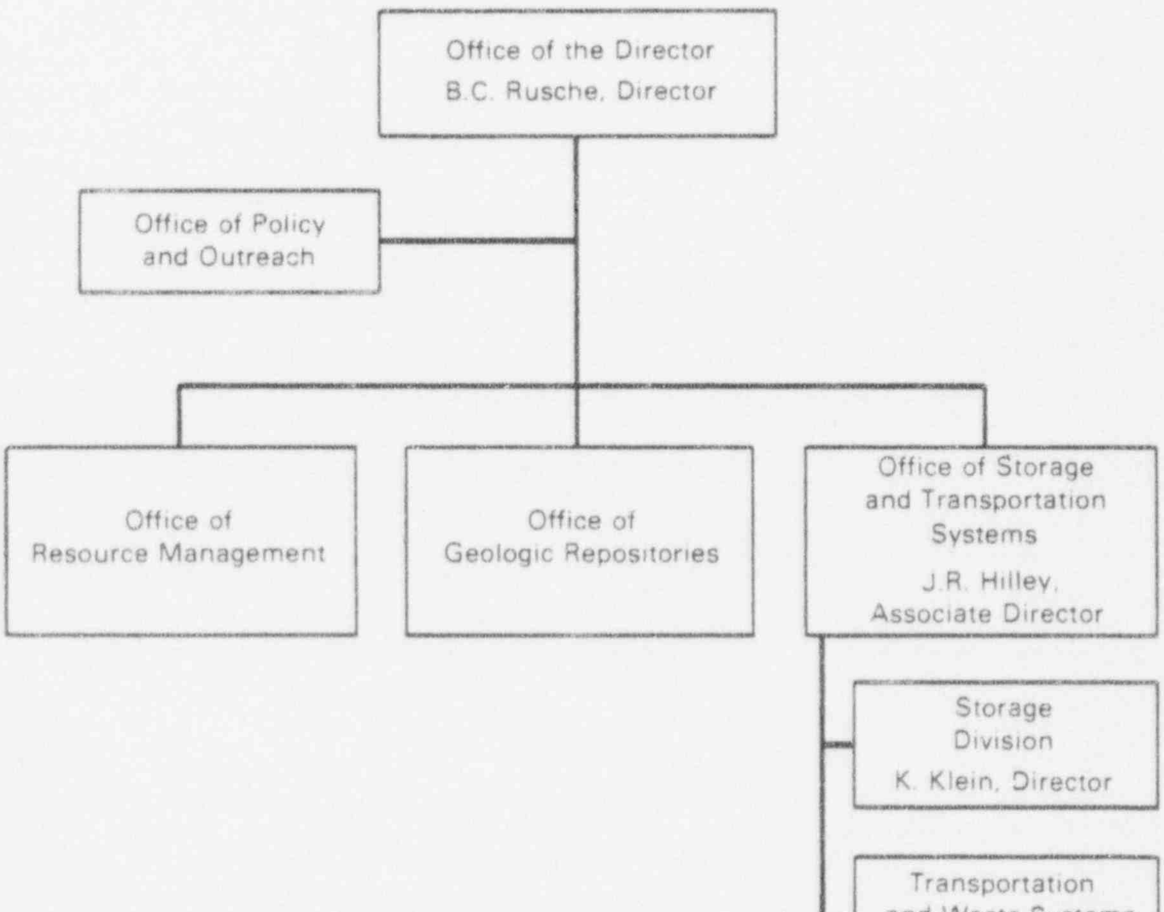

FIGURE 2.3. The Office of Civilian Radioactive Waste Management

components are properly focused, paced, and integrated. His associate directors and their staff guide the project offices in implementing major program decisions.

The Office of Policy 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 associate director for Resource Management and his staff administer the Nuclear Waste Fund and the Interim Storage Fund. This responsibility 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.

The associate director for Geologic Repositories and his staff have primary responsibility to site, design, construct, operate, close, and decommission geologic repositories for spent nuclear fuel and high-level waste.

The associate director for Storage and Transportation Systems and his staff implement all storage and transportation activities. The Office is responsible for developing: 1) a systems integration approach that coordinates all activities for the entire federal waste management system; 2) R&D to support increased at-reactor storage and 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; 3) an MRS facility, if approved by Congress; and 4) a transportation system that will meet the requirements of the waste management system.

The Storage Division of the Office of Storage and Transportation Systems has developed the Monitored Retrievable Storage submission to Congress and will be responsible for policy and direction of the MRS Program, if the MRS proposal is approved by Congress.

The responsibility for implementation of this Program Plan will be assigned to the Oak Ridge Operations Office. An MRS Project Office will be established within the Operations Office.

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IMAGE EVALUATION TEST TARGET (MT-3)

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IMAGE EVALUATION TEST TARGET (MT-3)

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IMAGE EVALUATION TEST TARGET (MT-3)

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IMAGE EVALUATION TEST TARGET (MT-3)

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3.0 DEPLOYMENT PLAN

This chapter describes the activities and schedule for implementing the MRS Program. The activities and schedules are discussed in terms of program elements. These elements were developed by analysis and grouping of the many and diverse activities that are required to develop, operate and decommission an MRS facility. The following elements make up the MRS Program:

- Environmental Evaluations
- Design
- Regulatory Compliance
- Construction
- Training and Testing
- Operation
- Decommissioning
- Institutional Interactions
- Program Management.

The chapter is organized by program element in the same order as listed above. For each element, the objective and scope are stated, and the status at the time of proposal submittal is provided as background information. Planned activities and schedules within each element and the interfaces with other activities and program elements are described. Anticipated interactions with other government organizations, regulatory agencies, state and local governments, and the public are included. A master schedule, which combines the individual program element schedules, is given in Section 3.10.

3.1 ENVIRONMENTAL EVALUATIONS

The objective of the Environmental Evaluations element is to evaluate the environmental effects of proposed MRS Program activities and to provide guidance to other program elements on monitoring for and control of these effects. Work in this element includes collection of any additional environmental data determined to be needed on the Clinch River site and surroundings, evaluation of impacts on the environment, monitoring and guidance of other program elements whose activities could potentially affect the environment, and preparation of all environmental documentation related to the development, operation, and decommissioning of an MRS facility.

3.1.1 Background

The NWPA directs the Secretary of Energy to prepare an Environmental Assessment (EA) on at least five alternative combinations of proposed sites and facility designs. The EA analyzes the relative advantages and disadvantages among the site-design combinations. It is based on a conceptual design for a facility that is an integral component of the federal waste management system, with a design capability to receive, prepare, and ship up to 3600 metric tons of uranium (MTU) per year.[a]

The EA is only one of several documents that consider the environmental impacts of constructing and operating an MRS facility. Documentation ranges from the consideration of environmental factors during the site screening process (DOE 1985a) to the future preparation of an Environmental Report. The NRC will prepare and issue an Environmental Impact Statement to support their licensing action for the MRS facility.

Other documents related to environmental evaluations for the MRS facility include the following:

- Environmental Assessment on 10 CFR 72 Proposed Revisions (NRC 1984)
- Reference-Site Environmental Document (Silviera 1985)
- Site Screening and Evaluation Report (Golder Associates 1985)
- Regulatory Assessment Document (Ralph M. Parsons Company, Vol. II 1985).

3.1.2 Planned Activities

Discussions will be held with the NRC to confirm the scope of environmental data needed to support the license application. In addition, discussions with state and local officials will assist DOE in scoping the issues that need more detailed evaluation. Based on these discussions, any additional field data needed to estimate the environmental impacts will be identified. These data will be collected by a contractor for use in the preparation of an Environmental Report that will accompany the license application to the NRC. Other activities will be to monitor and guide other program elements such as design, construction, and decommissioning, whose activities could potentially

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(a) Within this program plan, the MRS receipt, preparation and shipment of spent fuel is referred to as throughput. The design throughput for the MRS facility operating 4 shifts, 7 days a week, is 3600 MTU per year of spent fuel. The planned throughput of 2500 to 3000 MTU per year can be achieved with a 3-shift, 5 day-per-week operation. The larger throughput was analyzed in the EA to assure that the maximum potential impacts were considered.

affect the environment. The key document produced will be the Environmental Report which is discussed in more detail below.

Environmental Report

The schedule of activities to support the Environmental Report is shown in Figure 3.1. Upon congressional approval to proceed with deployment of an MRS facility, verification of environmental characteristics of the site and surroundings will begin by identifying specific characterization needs. Detailed environmental data was collected for the Clinch River site to support the Environmental Report for the Clinch River Breeder Reactor Plant (PMC 1975 and Amendments through 1982). Much of this data is applicable to the Environmental Report for an MRS facility at the Clinch River site. An early activity will be detailed evaluation of this existing data to determine the additional data needs. These needs may include the collection of baseline environmental data about meteorology, air quality, geologic and hydrologic characteristics and use; surface-water quality; and natural background radiation. Other types of site and regional data that may need to be updated include ecological conditions and socioeconomic characteristics.

The NRC requires that an Environmental Report be submitted with the license application for the MRS facility. In accordance with NRC requirements,

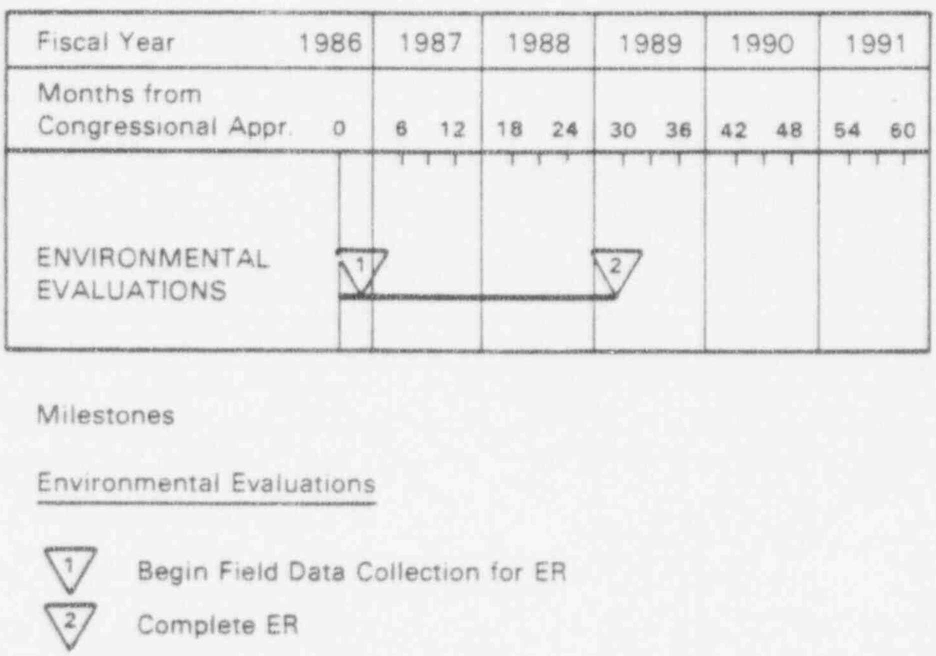


FIGURE 3.1. Schedule for Environmental Evaluations

the Environmental Report will discuss the potential environmental impacts (and mitigation of those impacts) resulting from construction and operation of an MRS facility at the Clinch River site. The Environmental Report will also discuss alternative designs, consistent with the requirements of the NWPA and with any additional requirements that Congress may impose as conditions for approving the MRS proposal.

Field data collection at the site will begin after obtaining any permits that may be required. This activity will result in an updated collection of environmental information obtained through both environmental monitoring and verification of available site data. This updated site data, together with design information related to construction, operation and decommissioning, will be used to prepare the Environmental Report.

3.2 DESIGN

With the MRS facility conceptual design (Ralph M. Parsons Company 1985) as a starting point, the objectives of the Design element are 1) to develop an MRS facility definitive (detailed) design that emphasizes safety, cost effectiveness, operability, and reliability; and 2) to verify performance of the design for key MRS systems. Work in this element includes collecting site engineering data; performing design optimization studies; identifying quality requirements for procurement and construction; developing technical specifications; identifying limiting operating conditions; and preparing design documents required for licensing, equipment procurement, installation, and acceptance, and for facility construction and acceptance. Tests and demonstrations will be performed to verify performance of key systems and the results will be factored into the final design.

3.2.1 Background

In order to select a storage concept for MRS, eight dry storage concepts[a] employing passive cooling of spent fuel were identified and design studies were performed for each using a common set of design requirements. These concepts were then evaluated and compared in terms of a set of criteria that included safety, environmental and socioeconomic impacts, siting, cost, technological maturity, and facility flexibility.

(a) The Monitored Retrievable Storage Proposal Research and Development Report (DOE 1983a), which was required by the NWPA and submitted to Congress in June 1983, concluded that all of these storage concepts were sufficiently mature to allow development of an MRS proposal without additional research and development.

Based on these evaluations, two storage concepts were selected (DOE 1984a). The sealed storage cask (SSC) concept was selected as the primary storage concept. Its design is simple, economical, and sufficiently flexible to accommodate all proposed waste forms and packages in any incremental quantity required, and it is relatively independent of site characteristics. In addition, the accumulated experience with cask storage provides assurance of safe, reliable operations and accurate cost estimates. The field drywell was selected as the alternative storage concept for similar reasons; however, the drywell is more dependent on site characteristics and requires more land area than the sealed storage cask for equivalent amounts of storage.

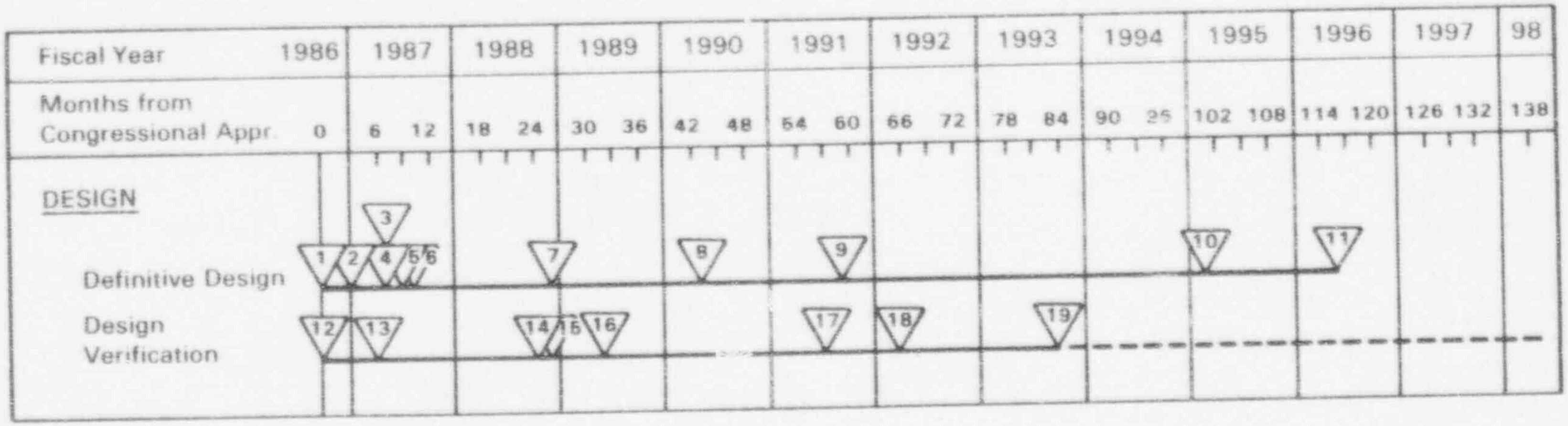
Conceptual designs were developed for both storage concepts located at three different sites. These conceptual designs are for facilities that receive, unload, disassemble and consolidate, canister, and temporarily store or directly ship spent fuel to a geologic repository.

The conceptual designs are documented in the MRS Facility Conceptual Design Report (Ralph M. Parsons Company 1985). The conceptual design was performed under stringent quality assurance requirements consistent with the ANSI/ASME Standard NQA-1 (ASME 1983). The Conceptual Design Report describes the design features and operations of the facility; documents how expected licensing requirements were incorporated in the design; and includes the conceptual drawings, design calculations, cost estimates, and design studies performed to date. Also identified in the Conceptual Design Report are areas that require further design study. These and additional studies that may be identified during review of the present conceptual design will be performed during the definitive design.

The conceptual design encompasses a number of technologies that must be interfaced to provide a facility that will safely, reliably and efficiently receive, handle, disassemble, package, temporarily store and ship commercial spent nuclear fuel. Although each of the principal subsystems or "features" of the MRS design is derived from a mature technology, they have not been demonstrated as combined systems under the operating conditions or at the production rates required for the MRS facility. Therefore, there is a need for limited design verification testing that includes tests of individual features of the MRS design as well as prototype MRS systems demonstrations.

3.2.2 Planned Activities

Activities for the Design element are discussed in terms of those required for preparation of the definitive design and those required for verification of the design. The schedule for these activities is shown in Figure 3.2. The scope and schedule of work has been developed to provide timely input to



Milestones

Definitive Design

1. Begin Site Data Confirmation
2. Canister Configuration Interface Baselined
3. Start Design
4. Transportation Cask Interface Baselined
5. Decision on Waste Reduction Concepts
6. Complete Site Data Collection
7. Complete License Application Design Input
8. Complete Design
9. Begin Field Inspection
10. Begin As-Built Drawings
11. Complete As-Built Drawings

Design Verification

12. Begin Test Plan Development
13. Begin Feature Tests
14. Start SSC Testing
15. Complete Feature Tests
16. Complete SSC Performance Testing
17. Begin Prototype Consolidation Equipment Tests
18. Complete Prototype Consolidation Equipment Tests
19. Complete 5 Year SSC Tests

FIGURE 3.2. Schedule for Design

support the license application to the NRC, and to provide the drawings and specifications necessary for construction of an MRS facility.

Definitive Design

Detailed identification and confirmation of site data required for the design will be initiated immediately following congressional approval. Collection of site data (such as soil and rock characteristics needed to design building foundations) will start after obtaining any required site investigation permits.

The initial design activity will be a review of the conceptual design to identify any outstanding needs. There were a few instances in the conceptual design activity where a particular process or design feature was selected because it was a demonstrably safe and feasible method of meeting the design requirements. In the definitive design, additional studies will be undertaken to determine if other approaches or design features also meet the safety and feasibility requirements, but are preferable because they offer lower cost or higher reliability. One area that has been identified for evaluation is the methodology for volume reduction of the spent fuel hardware that remains after the fuel rods are removed and consolidated. Additional studies and a decision on the volume reduction concept are planned early in the definitive design.

The MRS Program will coordinate with the other DOE waste management programs to establish design interfaces for system components common to these programs (e.g., the canister and the transportation cask). These interfaces will be put under baseline control, so that no changes will be made in features that affect another program without full review and analysis of impacts by all programs involved. As designs become further advanced the design baseline will become more complete and specific. The MRS facility design will have sufficient flexiblity to accommodate any uncertainties in the interfaces.

Other early design work will include optimization and tradeoff studies for the purpose of identifying and evaluating approaches which would lead to reduction of radiological exposure (including application of the ALARA principle to occupational and public exposure), reduction of costs, or improvements in operability and reliability. Quality standards for structures, systems, and components important to safety as defined by 10 CFR 72 will be designated to ensure that safety and reliability goals are met. To meet the requirements of applicable NRC regulations and DOE orders, technical specifications will be developed and limiting conditions for operations will be identified. Sufficient design information will be available to support submission of the license application to the NRC prior to completion of the definitive design.

Documents needed for construction of the MRS facility, including detailed drawings and procurement, construction, and installation specifications for the facilities and equipment, will continue to be developed after submittal of the license application. As part of the remaining design, a systems description document will be completed. The systems description document will describe in detail the specific process systems and equipment used in the MRS facility and their methods of operation and maintenance. The document will become the basis for the operations and maintenance manuals. Once the construction documents are completed, the detailed acceptance test plan for the facility will be prepared. The total time required for definitive design is 3 years.

The final activities performed in the design consist of field engineering inspection to verify that construction is in accordance with the design drawings and specifications, processing and approving design changes made during construction, and preparing as-built drawings.

Design Verification

Several types of tests are planned for design verification; these tests are described more fully in Appendix C and Section 3.5 of this Program Plan:

- Feature Tests - tests performed to verify conceptual design choices for individual components, equipment, processes, and materials.
- Systems Development Tests - tests to assist in the design of the disassembly and consolidation equipment.
- Prototype demonstrations - tests to verify operability of major systems.
- Preoperational Tests - tests performed on MRS systems installed in the facility before receipt of spent fuel (described in Section 3.5, Training and Testing).

Feature Tests. Feature tests are planned for components or subsystems of the disassembly, packaging and storage systems. Equipment components for which feature tests are currently planned include:

- Robotics - tests of equipment for automated remote operations, such as cask handling, sampling, and unbolting.
- Canisters - tests to verify the integrity of canisters during storage or after an accidental drop.

- Welding - tests of equipment selected to weld canisters and cask liners.

- Volume Reduction - tests of equipment to shred, melt, or incinerate contaminated materials.

Wherever possible the feature tests will be done "cold" (i.e., without use of radioactive materials). Verification of "hot" performance (i.e., with radioactive materials) will be achieved in subsequent system demonstrations. Preparation of test plans will be initiated upon congressional approval and feature tests will start shortly thereafter.

System Development Tests. The spent fuel disassembly and consolidation system is a mechanical system that must operate remotely. Although spent-fuel rods have been pulled from assemblies in large quantities and some few assemblies have been consolidated, this MRS system must operate on a production basis in a hot cell. Development tests already included in the DOE's Prototypical Consolidation Development Project will be performed concurrently with design of this system to assure its operability and reliability. The current schedule for these tests (see Chapter 4.0 and Appendix C) calls for completion of most tests in time to provide confirmation of designs to be submitted with the MRS license application.

Prototype Demonstrations. Prototype demonstrations are planned for the sealed storage cask and the spent fuel consolidation/packaging systems. The sealed storage cask demonstration will consist of two phases. The first phase will be a short-term verification of the cask thermal, shielding, and structural performance. The thermal and shielding tests will be done with a cask containing consolidated spent fuel. The structural performance tests will include drop and impact tests. The second phase involves long-term tests to monitor the thermal and shielding performance with periodic inspections to measure any material or performance degradation.

A spent fuel disassembly and consolidation demonstration is planned to demonstrate the capability of achieving the operability and reliability goals. All key subsystems will be tested, including fuel disassembly and packaging, radioactive scale collection, volume reduction of hardware, canister decontamination, and associated handling apparatufM The scope and extent of any hot tests that may be needed will be determined from the results of cold tests.

3.3 REGULATORY COMPLIANCE

The objective of the Regulatory Compliance element is to obtain 1) applicable permits from the State of Tennessee, local governing bodies, and the Environmental Protection Agency (EPA); and 2) a license from the NRC to receive, prepare, and store spent nuclear fuel. This element identifies permitting and licensing requirements, ensures that the applications and supporting information for the required permits and licenses are filed with the EPA, state and local agencies, and the NRC at the earliest feasible time and ensures that appropriate regulations and agency standards applicable to the MRS facility are met.

3.3.1 Background

The MRS Program must comply with the requirements of the National Environmental Policy Act (NEPA), the regulations of the EPA and the NRC, and many specific federal, state, and local statutes, regulations, and standards. In addition, the DOE has developed standards for DOE-owned nuclear facilities that are applicable to the MRS facility. The DOE and other federal requirements are enumerated in Volume 2, Appendix C of this submission to Congress, Environmental Assessment for a Monitored Retrievable Storage Facility. The DOE will also comply with the applicable statutes and requirements of the State of Tennessee and the local governmental entities.

The DOE is committed to provide a safe and environmentally acceptable facility. The independent reviews and inspections specified in the regulatory requirements will provide additional assurance that public health and safety, environmental values, and socioeconomic impacts are adequately addressed during design, construction, and operation of the MRS facility. The permitting and licensing processes described below provide for review and approval by the agencies involved and for involvement of the public and other interested parties at various points in the processes.

The NWPA requires that the MRS facility, if approved by Congress, be licensed by the NRC. The NRC has indicated that they intend to use 10 CFR 72 as the basis for licensing the MRS facility (NRC 1984). The purpose of the licensing requirements is to protect the health and safety of the public and the environment. The licensing process used by the NRC provides for information dissemination to the public through NRC public document rooms and for review and comment on the NRC draft Environmental Impact Statement by federal agencies, affected state and local governments, and other interested parties. In addition, the regulations provide for public hearings, as needed, before a license is issued.

Since the NRC requirements pertain to all activities from site characterization through design, construction, operation, and decommissioning, the DOE has consulted with the NRC, as directed by the NWPA, during preparation of the conceptual designs and the proposal. In addition, the NRC observed and provided comments on a DOE design review and a quality assurance audit of the design process.

As a part of the conceptual design, a Regulatory Assessment Document was prepared to document, to a degree commensurate with this stage of the design process, the design features provided to ensure compliance with each requirement in 10 CFR 72. The Regulatory Assessment Document, Volume II of the Conceptual Design Report (Ralph M. Parsons Company 1985), references a preliminary evaluation of off-normal events and the design features that will provide for safe operation in spite of malfunctions or operational errors. The radiological impacts of postulated accidents are documented in Volume 2 of this submission to Congress, Environmental Assessment of a Monitored Retrievable Storage Facility. The conclusions drawn from these studies are that the facility design will provide the requisite level of safety, and the radiological impacts on the public will be well below EPA and NRC regulatory limits.

The reasons for these conclusions are:

- The radioactivity content and heat release of the five- (or more) year-old spent fuel to be handled at the MRS facility are much lower than that of freshly discharged fuel handled at reactors.

- The release of significant quantities of radioactive material can result only from an energetic driving force such as high temperatures or pressures which will not be present in an MRS facility.

- The multiple barriers used to prevent release of radioactivity are metallic containers, reinforced concrete, and highly efficient ventilation filters which are carefully engineered and tested and which have been routinely used for this purpose for more than 40 years.

- The facility is designed to limit any dispersal from 1) very unlikely events such as major earthquakes and 2) events which must be anticipated, such as dropping a spent fuel assembly.

The activities planned for regulatory compliance are summarized below. A more detailed description of the plans for licensing the MRS facility with the NRC is contained in Appendix D.

3.3.2 Planned Activities

The schedule for the Regulatory Compliance element is shown in Figure 3.3. After approval of the MRS proposal by Congress, the DOE will arrange meetings with the EPA, the NRC, and the State of Tennessee and local governments to discuss the plans for the facility and to obtain guidance on the requirements to be met and the permits or licenses to be obtained. A regulatory compliance plan will be prepared that will identify the times at which applications for various permits and licenses are needed, the data that must be provided in the applications, and the agencies that will issue the permits and licenses. The schedule of activities to obtain the necessary data and to make applications will be included in the plan. This plan will be the primary mechanism for providing guidance on regulatory matters to other program elements and for monitoring progress toward compliance.

State and Local Governments

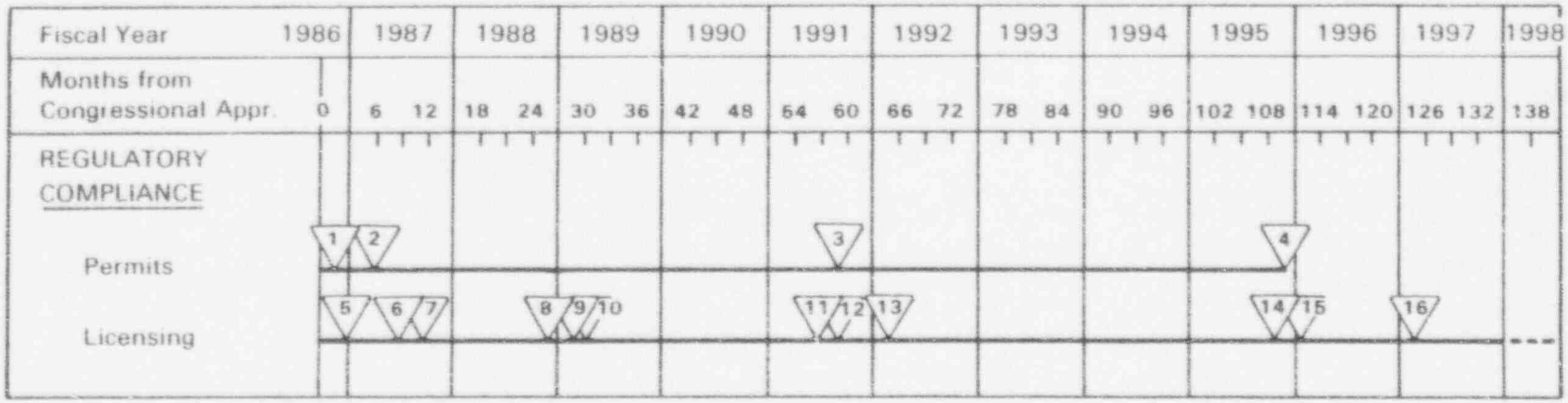
State and local governmental requirements to which the MRS facility must conform include land-use and zoning laws; air, water, noise, and solid waste pollution control laws; hazardous waste disposal laws; transportation laws and ordinances, including carrier statutes and vehicle permit laws; state and local occupational and public health and safety laws; state environmental review statutes; and specific statutes pertaining to preservation of environmental values.

Specific permits and requirements will be identified early so that they can be factored into plans for site and regional data collection, for facility design, and for supporting utilities and the local infrastructure. Meetings with state and local officials in the early stages of the program will establish lines of communications that will promote mutual understanding of needs and requirements.

The Environmental Protection Agency

The EPA is responsible for protection of the general environment and has issued regulations for control of offsite releases of radioactivity, emissions of pollutants to the air or water, and disposal of solid wastes.

The environmental standards for the uranium fuel cycle and management of spent nuclear fuel and high-level wastes are contained in 40 CFR 190 and 191. These EPA standards are implemented by the NRC through their regulations, specifically 10 CFR 72, and through issuance of a license for the MRS facility.



Milestones

Permits

1. Receive Site Investigation Permits
2. Complete Regulatory Compliance Plan
3. Receive Site Utilization Permits
4. Complete Permitting

Licensing

5. Establish Procedural Agreement with NRC
6. Begin Preparation of SAR
7. Submit First Topical Reports to NRC
8. Complete Safety Assessment and SAR
9. Submit License Application
10. LA Docketed
11. EIS Issued by NRC
12. License Received from NRC
13. Submit First Semiannual SAR Update
14. Submit Final Semiannual SAR Update and Final Technical Specifications
15. Submit Preoperational Test Criteria and Test Results to NRC
16. Submit First Annual SAR Update to NRC

FIGURE 3.3. Schedule for Regulatory Compliance

The EPA has responsibility for implementing the Clean Air Act, the Clean Water Act, and the Resource Conservation and Recovery Act. Since the EPA delegates its regulatory authority to their regional offices and in some cases to individual states, coordination with these offices will be required. A listing of the related federal statutes and regulations is given in Volume 2, Appendix C of this submission to Congress, Environmental Assessment for a Monitored Retrievable Storage Facility.

Interactions with the NRC

To ensure that the MRS facility is deployed on a planned schedule, it is necessary that the DOE and the NRC reach agreement on the activities related to licensing that will be required of each agency. As soon as possible after congressional approval, the DOE will seek to enter into a Procedural Agreement with the NRC on plans and actions that will foster cooperation on planning of licensing activities including NEPA, and establish an open information exchange between the DOE and the NRC. The existing Procedural Agreement between the DOE and the NRC for the conduct of the geologic repository program serves as a precedent for agreements on the MRS Program.

One objective of the Procedural Agreement is to provide for meetings, prior to submitting a license application, at which appropriate management and technical personnel of both agencies could discuss plans, review progress, and facilitate the resolution of problems. The meetings will be open to the public. Another objective is to obtain agreement that NRC staff will review and comment on Topical Reports submitted to the NRC. The purpose of these reports will be to receive an NRC staff evaluation before completion of design and submittal of the license application, that the technical plans and analytic techniques are adequate to meet the requirements foreseen by the NRC.

Based upon interactions with the NRC, the EPA, and the State of Tennessee, the Regulatory Compliance element will develop guidance for the site investigation studies and definitive design. This guidance will be included in the Regulatory Compliance Plan, and used as input to update the bases for definitive design and to prepare a systems studies plan that specifies the optimization and design trade-off studies to be performed during the design.

Preparation of the NRC License Application

It will take about two and one-half years to develop all of the information required for the NRC License Application. Part 72 of 10 CFR requires that the application contain a Safety Analysis Report (SAR), an Environmental Report, and a number of plans for operations. The design and safety studies will be carefully planned and scheduled so that the SAR contains a safety assessment of the final design of all structures, systems, and components important to safety. The Regulatory Compliance element will ensure that the information required is available for preparation of the SAR at about the midpoint in the design process. The license application will be submitted about 4 months later.

The MRS Program schedule assumes that the NRC review process will take 30 months from application to issuance of a license. Although a longer review period may be required in the event of serious contentions which require extensive hearings and appeals, a shorter period may be sufficient in the absence of unresolved issues. The DOE believes that the scheduled 30 months is reasonable in view of the proposed pre-licensing interactions with the NRC.

NRC Requirements During Construction and Testing

After receipt of a license, the DOE will proceed with site preparation and construction. During this period, the major NRC requirements that will need to be addressed involve inspection and the assurance that quality standards specified in the design are met for purchased materials and equipment, and for major construction and installation and that the conditions of the license are met. The NRC also requires that an updated SAR be submitted semiannually throughout the period.

The final semiannual SAR update must be delivered to the NRC no later than 3 months before spent fuel is to be received at the MRS facility. The final semiannual SAR update will be followed by a report to the NRC containing the acceptance criteria and test results of the preoperational tests. This report must be submitted at least 1 month before the intended date for receipt of spent fuel.

After receipt of spent fuel, the preoperational tests will be continued in one cell at a time to test each component and system required in normal operation. The throughput rate of the facility will be judiciously increased during the hot demonstration period as more experience is gained in the use of the operating procedures and in the operating characteristics of the processes and equipment. All operations with spent fuel will be in accordance with the Technical Specifications approved by the NRC. In addition, the SAR will be updated on an annual basis in accordance with NRC requirements throughout the operational phase.

3.4 CONSTRUCTION

The objective of this element is to construct a licensed MRS facility from the drawings and specifications prepared by the Design element. Work to be undertaken in the Construction element includes procurement of equipment; selection of contractors; improvements to the site; and construction of the Receiving and Handling (R&H) building, the storage facility, and the support buildings.

3.4.1 Background

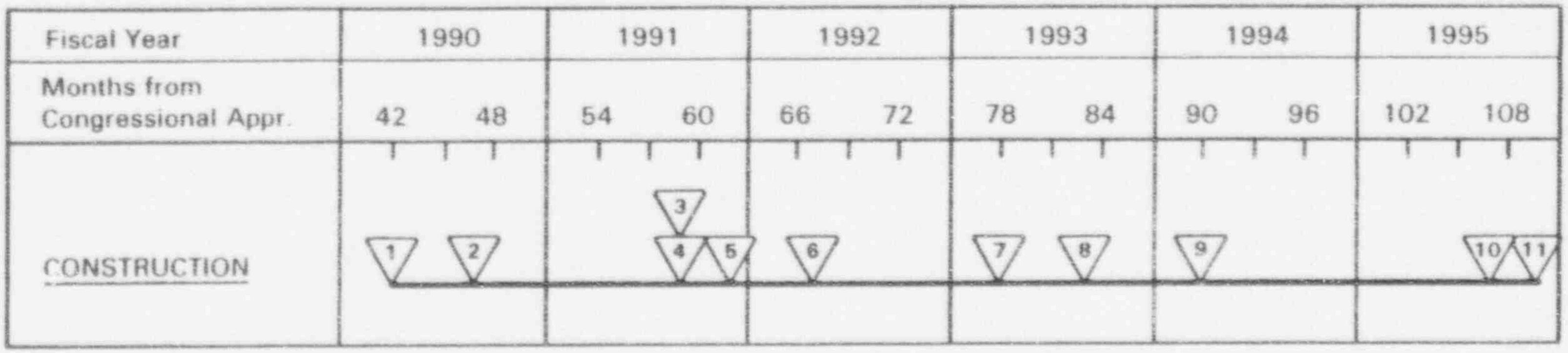
The conceptual design completed for the MRS proposal includes drawings, outline specifications for construction, cost estimates, and a construction schedule. Evaluation of the information developed in the conceptual design process leads to the conclusion that the facility can be successfully constructed at any of the candidate sites. The construction schedule and plans described below are based on the information developed in the conceptual design.

3.4.2 Planned Activities

The schedule for the Construction element is shown in Figure 3.4. Construction field work is not scheduled to start until the NRC issues a license for the MRS facility. Prior to receiving the license, procurement activities will be initiated for specialized equipment that require long lead times to obtain, particularly the R&H building equipment. This will ensure that material and equipment are available to support field work.

Construction will begin immediately upon receipt of the license from the NRC. The first step will be field work to improve the site so construction of the R&H building, the storage facility, and the support buildings can commence. Improvements to the site include clearing the land, constructing roads and railroads onsite and offsite, grading, installing drainage, installing fences, and landscaping. Fabrication of special equipment to be installed in the R&H building will also be initiated at this time.

Construction of the R&H building, the storage facility, and the support buildings will follow site improvement activities. Design work to date shows that the R&H building is on the critical path to completion of construction. Therefore, R&H building construction will begin as soon as the needed site improvements are completed. Actions to procure consolidation equipment will also be initiated at that time.



Milestones

1 Prepare Long Lead Item Bid Package

2 Solicit Bids for R&H Building Equipment

3 Begin Site Preparation

4 Begin R&H Building Equipment Fabrication

5 Begin Concrete Pours

6 Begin Consolidation Equipment Procurement

7 Complete Site Mockup Facility

8 Begin R&H Building Equipment Installation

9 Complete Consolidation Equipment Installation in Mockup Facility

10 Complete Equipment and Controls Installation

11 Complete Construction

FIGURE 3.4. Schedule for Construction

Construction of the storage facility and the support buildings will be coordinated with construction of the R&H building. Included with the storage facility construction are the concrete cask support pads to be used with the sealed storage casks. The site services building will be constructed early since it will contain a mockup area of the R&H building hot cell. Prototype equipment will be installed in the mockup area for equipment testing and staff training in a nonradioactive environment.

Construction is estimated to be completed in about 50 months. The R&H building is on the critical path. This schedule is based on 2 shifts per day and 40 hours per week for each shift involved in constructing the R&H building. The schedule assumes no major work interruptions caused by bad weather or labor disputes. Construction of the other support buildings and storage areas is scheduled to be completed within the time-frame required for the R&H building.

The equipment and structures of the MRS facility are designed to be constructed using standard materials and normal construction practices. There will be no specialty items used in construction of the facility. There are many construction contractors with the experience and capabilities required to build the MRS facility. The quality requirements identified during the design period will be implemented by the construction contractors. Inspections will be planned and performed to conform with the QA plan and procedures. Quality assurance requirements will meet or exceed ANSI/ASME Standard NQA-1.

3.5 TRAINING AND TESTING

The objective of the Training and Testing element is to provide a trained staff and a tested facility that can function together to meet the MRS operating goals. Work to be undertaken in this element includes reviewing the design for operability and maintainability, preparing operations and maintenance manuals and procedures, monitoring construction, performing construction acceptance tests, preparing training manuals, and conducting preoperational systems tests.

3.5.1 Background

The Mission Plan for the OCRWM Program proposed that an MRS facility receive 2200 MTU of spent nuclear fuel prior to 1998 (DOE 1985b). To accomplish this mission, it will be necessary to have a trained and experienced operating staff and an operating facility ready for routine spent-fuel receiving and handling operations by late 1996. All handling, processing, and storage equipment must also have been tested and operated successfully using actual spent fuel by that time.

3.5.2 Planned Activities

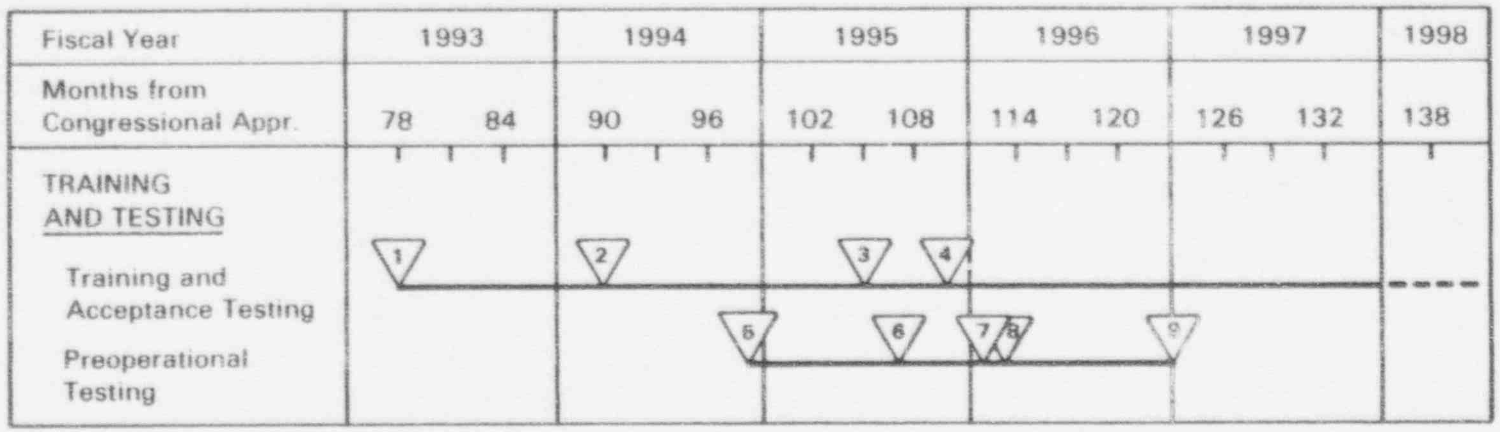
The schedule for the Training and Testing element is shown in Figure 3.5. Activities in this element are designed to ensure that the MRS facility and operations staff can safely perform their intended functions at the required throughput rates and in a manner that is consistent with product quality requirements. The training and testing plans will be part of the NRC license application and will be reviewed by the NRC.

Experienced operating and maintenance personnel will review the design for operability and maintainability. They will then prepare the training documents, operating and maintenance manuals, and operational test procedures. A number of these people, after becoming familiar with operation of the various systems and components, will be assigned to train additional operating and maintenance staff who will perform the preoperational tests. Others will be assigned to follow construction of the various MRS buildings and systems, to witness acceptance testing of these buildings and systems, and to become familiar with their functions, features, and installations.

To allow early testing of fuel-handling equipment and systems and training of the operators, the design of this equipment will be scheduled to permit early procurement. Construction of the mockup area in the site services building will be completed and the mockup fuel handling equipment installed early in the construction sequence to support the onsite training and testing program.

The first stage of training and testing related to the fuel handling operations will take place in the mockup area of the site services building. This area will be equipped with a full complement of cask and fuel handling equipment upon which operators and maintenance staff will be trained in remote handling and remote maintenance procedures. Using this mockup will allow remote handling operations to be tested at full scale in a nonradioactive environment. These prototypic tests will also permit modifications to be made to either the equipment or the operating procedures.

A team of operating personnel who have been trained in the mockup area will be qualified to perform the same tests and operations on a full complement of equipment installed in one of the hot cells. The first tests and demonstrations in the hot cells will not use spent fuel assemblies. If any problems with operating or maintaining the equipment are observed, the deficiencies will be corrected and the tests rerun until reliable operation is demonstrated. These cold tests and demonstrations will be performed in succession in each of the remaining cells until each functions reliably. In addition, the operation



Milestones

Training and Acceptance Testing

1. Begin Preparation of Training Documentation
2. Begin Operator Training
3. Begin Construction Acceptance Tests
4. Complete Construction Acceptance Tests

Preoperational Testing

5. Begin Preparation of Systems Test Plan
6. Begin Cold Systems Testing
7. Complete Cold Systems Testing
8. Receive Spent Fuel/Begin Operational Demonstration
9. Complete Operational Demonstration

FIGURE 3.5. Schedule for Training and Testing

of the radwaste and other systems and utilities will be tested. The test acceptance criteria and test results will be submitted to the NRC for review at least 30 days prior to planned receipt of irradiated fuel.

After operation of the equipment in a cell has been successfully demonstrated using dummy (nonradioactive) spent fuel, hot tests and demonstrations will be performed using spent fuel, again demonstrating successful operation in one cell at a time. All systems will be demonstrated to be operational. Operating procedures and manuals will be revised, as required, throughout testing and demonstration.

After the operating personnel are trained and qualified in the mockup area for hot operations in the R&H building, the throughput rate of the facility will be prudently increased. As the operating personnel become more familiar with operation and maintenance of the receiving and handling equipment and with load-out procedures to the storage facility, the processing times will be reduced and the throughput will be increased to rates that conform to full-scale routine operations.

3.6 OPERATION

The objective of the Operation element is to safely operate and maintain the MRS facility. The MRS facility operations consist of all activities associated with spent-fuel receipt, consolidation and canistering, temporary storage, and shipment to a repository.

3.6.1 Background

As part of the conceptual design activities, the operations and maintenance characteristics of the MRS facility were analyzed. The analyses included evaluations of operating and maintenance activities, equipment reliability and maintainability, operating staff size and skills, materials and equipment needed during operation (e.g., canisters, casks), and operating costs. These analyses, which were independently reviewed by persons with experience in the design, construction and operation of nuclear facilities, formed a large part of the basis for the planned activities identified for this element.

3.6.2 Planned Activities

The schedule for operation of the MRS facility is shown in Figure 3.6. The facility will become operational following completion of hot systems testing in October 1996. The facility receipt rate will be gradually increased over a 15-month period to reach the planned throughput rate of 2500 to 3000 MTU per year (full-scale operation) in January 1998.

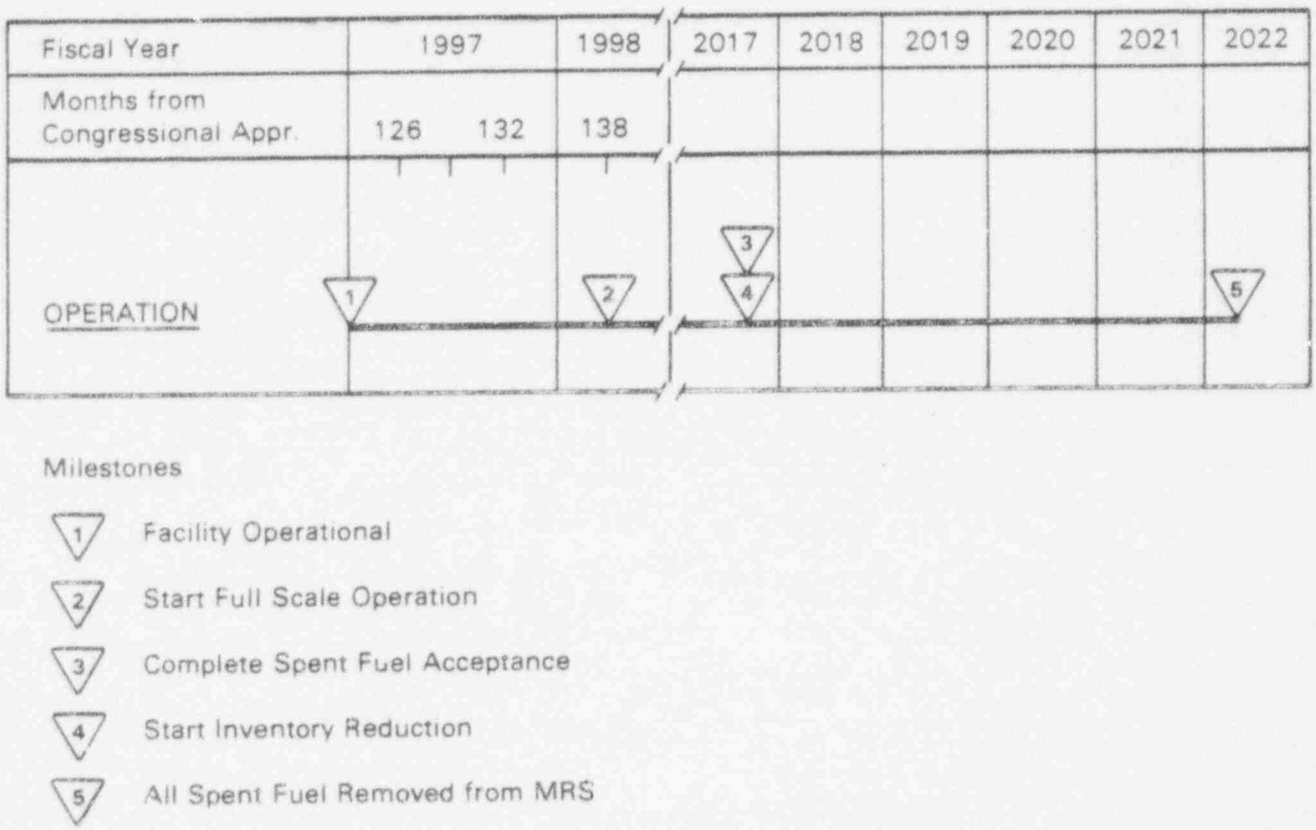


FIGURE 3.6. Schedule for Operation

Spent fuel shipments to the repository will commence in January 1998 and will gradually increase to the planned rate of 2500 to 3000 MTU per year in 2003. Full-scale operation will continue until 2017 when spent fuel acceptance will cease and inventory reduction will begin. Facility operations will cease when all waste stored at the MRS facility has been removed in 2022.

Shipments of spent fuel arriving at the MRS facility will enter the site through an inspection gatehouse. Following inspection, the shipment will be transported to the receiving and shipping area of the R&H building. Here the cask handling crew will remove the impact limiters, personnel barriers, tie-downs, etc. from the cask and vehicle. The cask will then be lifted from the rail car or truck trailer and placed upright onto a cask transfer cart. The rail car/trailer will then be surveyed for radioactive contamination and decontaminated if necessary.

The transfer cart and cask are moved into the cask unloading room and mated to a shielded process cell loading port. A shadow shield is closed around the top of the cask, personnel leave the room, and a shielding door is closed, thereby shielding the cask unloading operation from the rest of the building. The remotely operated in-cell crane then removes the cell loading port shield plug and the cover of the shipping cask. The fuel assemblies are then remotely removed from the cask, identified, inventoried, and placed in an in-process lag storage vault. After all fuel has been removed from the shipping cask, the cask interior is checked for contamination, and cleaned if necessary. The cask lid is then returned to the cask and the cell access port is closed. The cask is surveyed for contamination and decontaminated if necessary before being placed on the rail car or truck trailer for shipment.

In the shielded process cells, spent fuel assemblies are remotely removed from the in-process lag storage vault, identified, and disassembled. The disassembly operation consists of cutting off the end fittings and pulling the spent fuel rods from the spent fuel assembly. The fuel rods are then consolidated into a tight bundle and placed in a canister. The fuel assembly hardware is shredded and placed in sealed drums for interim storage onsite in sealed storage casks.

The canister of consolidated fuel is then filled with an inert gas. The end cap is then welded on and the canister decontaminated, leak tested and ultrasonically tested for weld integrity. The canisters of consolidated fuel are then moved either to an adjoining lag storage vault for temporary retention, to a cask discharge port for loading into a sealed storage cask for onsite interim storage, or to a cell discharge port and loaded directly into a shipping cask for shipment to the repository. The disassembly, consolidation, welding and testing operations, and handling of fuel assembly hardware are performed remotely using cranes, robots, and master-slave manipulators. Viewing windows and closed-circuit television are used to observe operations and for visual inspection.

Decontamination and maintenance of in-cell equipment will be performed remotely either in the process cells or in the maintenance cell. Contact maintenance will be permitted in those instances when equipment can be successfully decontaminated to an acceptable level.

Radioactive wastes generated during operation of the MRS facility will fall into two general classifications: 1) high-activity wastes (HAW) requiring remote handling and shielded storage, and 2) low-level wastes (LLW) and contact handled TRU wastes (CHTRU) permitting contact handling and nonshielded storage. Wastes requiring shielded storage will be packaged in sealed drums or canisters and stored in sealed storage casks similar to those used to store spent fuel, until they can be retrieved and shipped offsite for disposal. Low-level wastes and CHTRU wastes that do not require shielded storage will be stored in a covered, compartmentalized vault until shipment. All liquid radioactive wastes resulting from decontamination or other onsite operations, will be concentrated, solidified in a concrete matrix, and packaged in sealed drums. No radioactive liquid effluents will be discharged from the MRS facility.

To ensure that all spent fuel and waste packages are properly constructed, tested, identified, documented, and inventoried, a dedicated staff of operations inspectors, quality control inspectors, and quality assurance personnel will observe R&H building operations and ensure that operating procedures adequately provide for quality.

A staff of health physicists will be assigned to the R&H building to monitor operations in radiation zones, perform radiation surveys, direct decontamination operations and prescribe special procedures and attire to be used when performing work in radiation or contamination zones.

Storage facility operations consist of transporting empty concrete storage casks from the cask manufacturing plant (not a part of the MRS facility) to the R&H building, welding the outer lid on the cask after loading it with fuel or waste, transporting the cask to the storage facility, and placing it on a storage pad. As appropriate, casks will be connected to a monitoring system with remote displays in the R&H building control room. The monitoring system will monitor the cask liner temperature. In addition, gas samples and pressure readings will be taken periodically from representative casks to verify continued integrity of the canisters of consolidated fuel. Removal of the canisters from the concrete storage casks for loading into a shipping cask prior to transport to the repository will be the reverse of the above operations. Air samples for radiation monitoring will be taken both inside and at the perimeter of the storage facility to detect any unexpected release of airborne radioactive materials.

To support the storage operation, a sealed storage cask manufacturer will be required to fabricate, cure, age, inspect and deliver up to a maximum of about 30 casks per month to the MRS facility over a period of about 8 years. It is likely that the manufacturer will construct a fabrication plant adjacent to or at least near the MRS facility. It is estimated that a work force of about 115 people will be required to perform these activities during this time period in order to provide storage casks for 15,000 MTU of spent fuel and associated waste.

The three major parts of the MRS facility are the receiving and handling (R&H) building, the support facilities, and the storage facilities. A total plant operating staff of about 600 employees will be required when the plant is operating at the planned throughput rate. About half of the operating staff will work in the R&H building. Their work assignments will be in the following areas: hot cell operations; cask and material handling operations; maintenance and plant operations; nuclear material accountability; quality assurance, quality control and inspection; health and safety; laboratory and sampling; general support and administration.

The other half of the operating staff will work in the various support facilities. Their work assignments will be in the following areas: maintenance and shops; safeguards and security; fire protection; quality assurance; quality control; health and safety; laboratory and sampling; training; facilities operations, transportation and general support; and plant management, administration, and support. An operating staff of about 5 people will be assigned to the storage facilities for emplacement and retrieval operations.

During routine operation at the design throughput rate the MRS facility will be operated continuously on a 24 hour-per-day/5 days-per-week schedule. The facility will be in a standby mode 2 days per week. However, the MRS facility design includes sufficient flexibility to allow the facility to adapt to reasonable mission changes and/or operational perturbations. For example, the four disassembly/consolidation stations permit routine operation at the design throughput rate on a 3 shifts-per-day/5 days-per-week operating schedule. If need be, a cell can be taken out of production for an extended period to permit equipment modifications, or it may be set up to accommodate a special batch of fuel while the other three cells, operating on a 7-day week, can keep up the throughput until the fourth cell becomes available for routine operation again.

3.7 DECOMMISSIONING

The objective of the Decommissioning element is to release the site for unrestricted use after MRS operations are completed by decommissioning (and decontaminating as necessary) all facilities and equipment.[a] Work involved in this element includes decommissioning the sealed storage casks, the storage area, the R&H building, the protected area, the radwaste treatment facility, the analytical laboratory, the support facilities, and the limited access area for the MRS facility, as well as disposal of the residual radioactive materials.

(a) The present plan for decommissioning the MRS facility assumes a starting point when the facility is no longer needed to accept spent fuel from utilities for packaging and shipment to the first repository. This plan may change depending on whether the MRS facility is used to service another approved repository or if the facility is put on a standby basis for possible involvement in waste retrieval operations as required under Section 122 of the NWPA.

3.7.1 Background

The Criteria for Decommissioning, 10 CFR 72.76, state that an MRS facility shall be designed for decommissioning. In consideration of this, the conceptual design for the MRS facility includes provisions to:

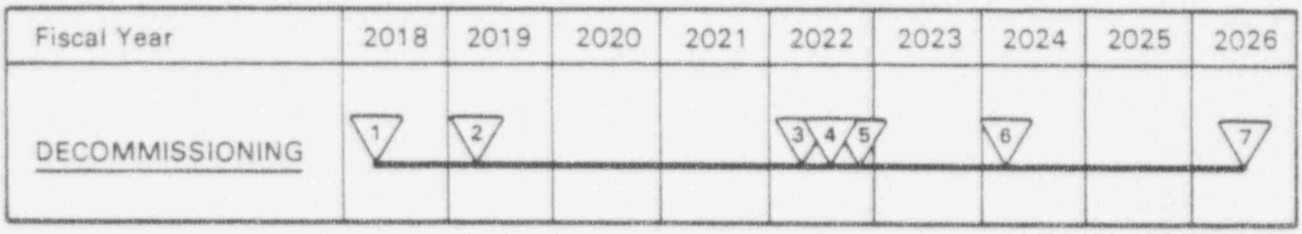
- facilitate decontamination of structures and equipment
- minimize the quantity of radioactive wastes and radioactively contaminated equipment
- facilitate the removal of radioactive wastes and radioactively contaminated materials at the time the facility is being permanently decommissioned.

To identify how the decontaminating and decommissioning could be accomplished, a decommissioning plan for the conceptually designed MRS facility was prepared. The decommissioning plan describes practices and procedures for decontaminating the site and facilities and for the disposal of residual radioactive materials. The proposed decontamination practices and procedures are designed to ensure that the decommissioning activity and the decommissioned facility will not jeopardize the safety of the public.

3.7.2 Planned Activities

The schedule for decommissioning the MRS facility is shown in Figure 3.7. All buildings and internal components will be decommissioned after all spent fuel and waste packages have been removed. However, complete removal of all structures, particularly the R&H building, is not planned. The R&H building will be designed to facilitate the entire decontamination and decommissioning efforts. Those facilities and equipment that cannot be decontaminated will be packaged and shipped to a final disposal site. Following thorough decontamination of the R&H building and disposal of items that cannot be decontaminated, permanent decommissioning will be accomplished by disposal of the major equipment that is not contaminated.

The decommissioning effort is divided into phases. The phases overlap to provide continuity of the decommissioning work. The first phase consists of decontaminating and decommissioning the sealed storage casks and those portions of the R&H building that are not needed for the load-out operations (e.g., the disassembly cells). As the waste is removed from the sealed storage casks for shipment to the repository, the casks will be decontaminated and decommissioned. Since the spent fuel and waste are placed in sealed canisters before being emplaced in the sealed storage casks, it is expected that little or no decontamination of the casks will be required. The radioactive waste treatment



Milestones

1. Start SSC Decommissioning
2. Start Disassembly Cell Decontamination
3. Start R&H Building Decommissioning
4. Complete SSC Decommissioning
5. Complete Storage Facility Decommissioning
6. Start Support Facility Decommissioning
7. Complete MRS Facility Decommissioning

FIGURE 3.7. Schedule for Decommissioning

facility and analytical laboratory within the R&H building will be kept in service to support this decommissioning effort. This phase is expected to take 4 years to complete.

The next phase consists of decommissioning the remainder of the R&H building including the radwaste treatment facility and the analytical laboratory. This phase is not expected to start until all spent fuel has been removed from the MRS facility. Also included in this phase will be the decommissioning of the remainder of the protected area. This phase is expected to require approximately 4 years beyond completion of the first phase.

The final phase consists of decommissioning the support facilities and the limited access area for the MRS facility. Since radioactive materials will be excluded from this area of the MRS facility during the life of the facility, the decommissioning effort for this area is expected to consist of simply dismantling and removing these facilities and restoring the site.

Disposal of the decontamination and decommissioning wastes will be consistent with the requirements for disposal and the disposal methods in existence at the time decommissioning begins. The details for decommissioning activities will be described in the decommissioning plan to be submitted to the NRC as a part of the license application.

3.8 INSTITUTIONAL INTERACTIONS

The objectives of the Institutional Interactions element are: 1) to ensure timely and full information exchange and appropriate participation between and among the DOE, the public, the state, and local officials relative to the further development and operation of the MRS facility; and 2) to ensure that state and local governments receive fair and reasonable financial assistance for the effects of construction and operation of the MRS facility, as described in the MRS proposal to Congress.

3.8.1 Background

Information exchange on the MRS Program between the DOE, the State of Tennessee and local officials, and the public began in the spring of 1985. At that time a grant was given to the State of Tennessee (which subsequently shared it with potentially impacted local governments) to study the DOE basis for, and proposed actions in, the MRS Proposal to Congress. The intent of this grant was to allow the DOE to benefit from comments from the state and to enable the state to provide a studied judgment on the MRS Proposal to Congress.

The DOE has shared information with state and local officials and has participated in a number of public meetings and meetings of task forces established by state and local governments to study the MRS Proposal. In return, the state and local governments have provided the DOE with information that was considered in development of the proposal. Documentation for the MRS Proposal was provided to the State of Tennessee for early review before it was submitted to Congress.

3.8.2 Planned Activities

The activities in the Institutional Interactions element are of such importance that they have been thoroughly described in the MRS proposal to Congress. They include initiating and establishing Consultation and Cooperation (C&C) Agreements with the State of Tennessee as required by the NWPA; establishing an effective working relationship with state and local governments; providing mechanisms to assure the public that safety and environmental quality will be protected during the operation of the facility and transportation of spent fuel; and providing appropriate and reasonable assistance to affected government units.

Immediately following congressional approval of the MRS Proposal, the DOE will initiate interactions with the State of Tennessee directed toward establishing formal C&C Agreements for MRS activities. These agreements are expected to be signed within six months after approval of the proposal, as shown in Figure 3.8. It is anticipated that the local governments will work with the state to determine the nature and extent of their involvement in these agreements.

A public information program will be established to provide information on the MRS facility. This public information program will not be limited to the State of Tennessee, but will also address the national public information needs of the improved-performance waste management system, which includes the MRS facility. The MRS public information activities will be part of the coordinated OCRWM public information plan.

For specific details of the proposed interactions, the MRS Proposal to Congress should be reviewed.

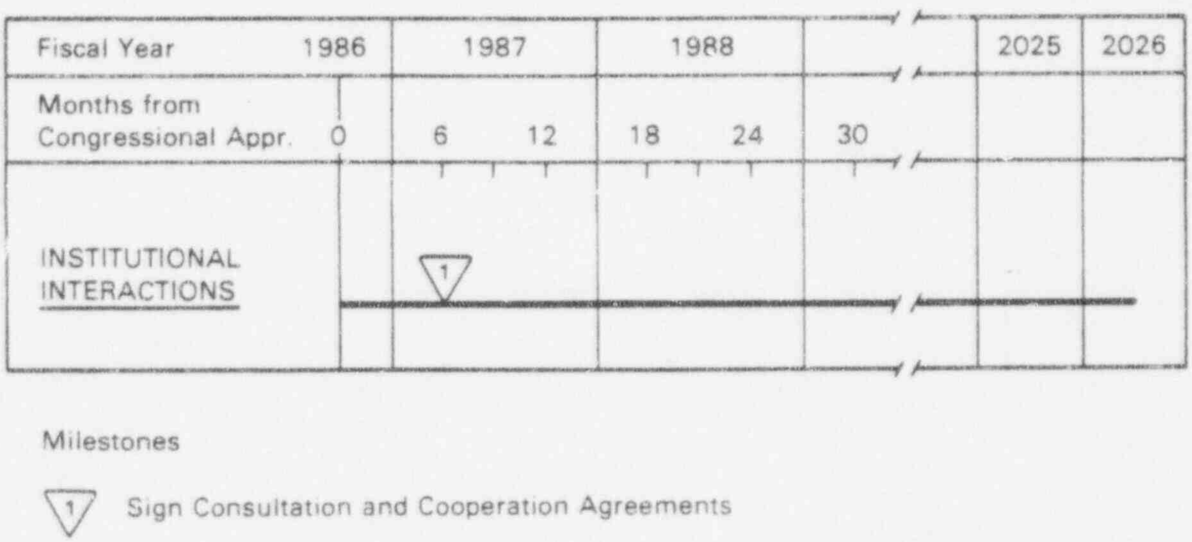


FIGURE 3.8. Schedule for Institutional Interactions

3.9 PROGRAM MANAGEMENT

The objective of the Program Management element is to manage the MRS Program in such a manner that program objectives are met within safety, quality, cost, and schedule goals. The work involves organizing, staffing, monitoring, controlling, and reporting all program activities.

3.9.1 Background

The DOE has established a project management system for programs that have a special significance in terms of national importance, exceed a specific dollar value (normally facilities with acquisition costs of $200 million or more), and are identified by DOE upper management as requiring special attention in project planning and control. Such projects are designated as Major Systems Acquisitions. The MRS Program has been designated as a Major Systems Acquisition and thus will be managed in accordance with the requirements of the DOE Project Management System (DOE 1983b). The DOE project management system was developed primarily for the management of projects that are executed by the DOE Operations Offices, and is therefore well suited to the management and control of the MRS Program.

3.9.2 Planned Activities

A schedule of planned activities for the Program Management element is shown in Figure 3.9. An MRS Project Office within the Oak Ridge Operations Office will be established and staffed upon congressional approval of the MRS proposal. Initial activities of the MRS Project Office will include finalization of the acquisition strategy for contracts involving design, construction, and operation of the facility. Maximum utilization of the private sector will be assured through competitive procurements for contractor-supplied goods and services, where possible.

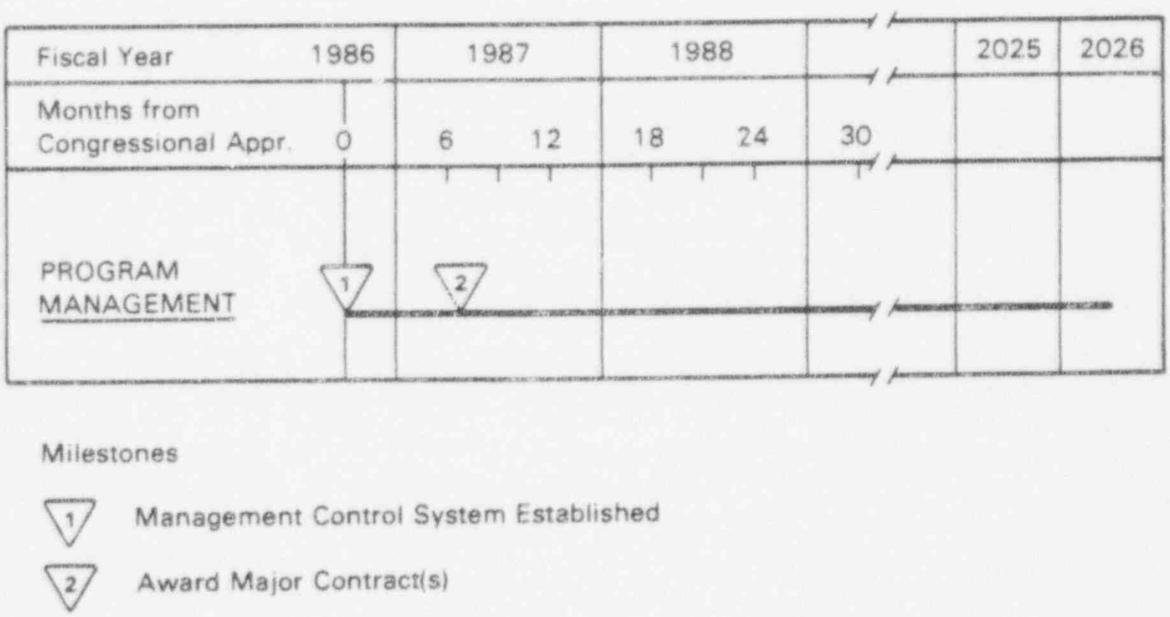


FIGURE 3.9. Schedule for Program Management

A DOE management structure was established and staffed for development of the MRS proposal. This structure will require expansion and additional staffing for implementation of the MRS program if it is approved by Congress. The principal addition will be the creation and staffing of the MRS Project Office in Oak Ridge, Tennessee. These staffing additions will not result in a significant increase in the overall management resources required for OCRWM activities and will not deplete the management resources for the other OCRWM programs (e.g., repository program).

The principal contractor manpower needs are for design, construction and facility operation. Nuclear related experience will be necessary. Designers (about 250) will be needed primarily for the period from FY 1987 through FY 1990. The maximum manpower required for construction is about 700 workers. Construction will extend over about a 4-year period ending in FY 1995. For operation of the MRS facility a staff of about 600 individuals will be required. These manpower requirements are modest and there are many firms qualified to perform these functions. A significant pool of qualified workers already exists in the area of the proposed MRS site.

A project management system will be developed and implemented that meets the requirements of the DOE Project Management System for major system acquisitions (DOE 1983b). Supporting management procedures will be developed and implemented for control, monitoring, and reporting progress of program activities.

A Quality Assurance Program consistent with the applicable QA criteria of DOE Order 5700.6A (Quality Assurance), the NRC's 10 CFR 50, and ANSI/ASME Standard NQA-1 will be established and implemented. All quality-related activities of the program will be planned, scheduled and documented to provide objective evidence of procedural adequacy and compliance. Quality overview will be provided by the OCRWM headquarters Quality Assurance Manager. To ensure that the proper degree of attention and authority are provided to QA in all MRS Program activities, the Quality Assurance Manager will report directly to the MRS Program Manager and will not be given any competing assignments. A clear line of responsibility and authority for QA throughout the program will be established and maintained.

The OCRWM has developed an overall Systems Engineering Management Plan for all of its activities. A System Engineering and Configuration Management activity will be established to implement the OCRWM Systems Engineering Management Plan and to expand and extend it to the MRS Program. This activity is responsible for developing and maintaining the MRS Program technical baseline documentation. These baselines will initially consist of the Systems Requirements Document, the System Design Description, and a System Studies Plan. The MRS Program technical interfaces with the transportation program and the repository program will be documented and subjected to change control procedures to ensure that proper, up-to-date design information is available to all system participants.

A Program Planning and Control activity will be established to maintain program schedules, measure and analyze performance, and provide budget and schedule forecasting. This activity will support the Systems Engineering and Configuration Management function in analyzing schedule compatibility with the transportation system and the repository programs.

3.10 MASTER SCHEDULE

This section describes the MRS Program master schedule, and discusses the critical path. The schedules discussed in Sections 3.1 through 3.9 were taken from the program master schedule shown in Figure 3.10. They showed the program milestones by program element. The program elements are all interdependent, so that information developed in one element is needed to complete milestones in other elements. The program master schedule, Figure 3.10, shows major constraints as vertical dashed lines. The milestones at arrowheads cannot be completed until after the connected milestones are complete. The figure also shows the critical path to facility operation. For activities on the critical path, extensions of the time for their completion potentially delays facility operation day-for-day.

For these activities, extra effort was expended to verify the reasonableness of the time estimates. The construction schedule is based upon a detailed analysis by the architect-engineer of the many parallel and sequential activities that would occur during construction. The licensing schedule and its uncertainties were discussed with the NRC staff. The NRC staff agrees that 30 months is a reasonable planning base, recognizing that only their review schedule, and not the schedule for public hearings, is under their control. The MRS facility, as designed, does not require research in unproven areas of technology. Thus, the DOE has confidence in the schedule.

Sections 3.1 through 3.9 provide detailed discussions of the milestones for the individual elements. Discussion here will concentrate on the critical path and the constraints which led to identification of the critical path. Following congressional approval, the critical path intially goes through the Design element. The two critical early activities are 1) confirmation and collection of site data for design and 2) award of major contract(s). While

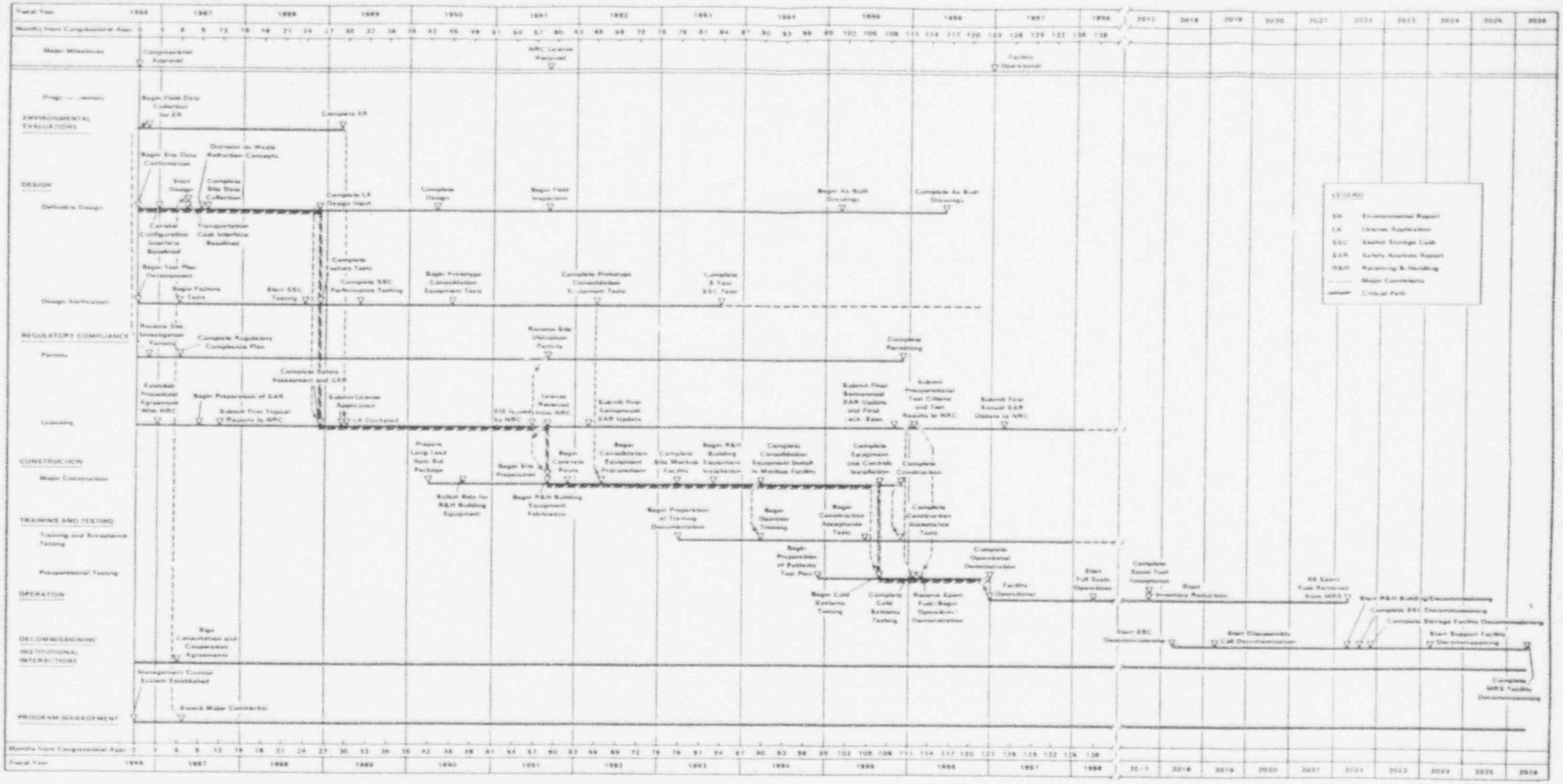


FIGURE 3.10. MRS Program Master Schedule

extensive site data is on hand and needs only to be verified, additional geotechnical data will need to be collected for the foundation designs and for the Safety Analysis Report to the NRC. Site investigation permits might be required to collect the additional environmental, geologic, and hydrologic data. Data collection is scheduled to take approximately ten months. The ten-month period is considered to be a reasonable amount of time to obtain this standard design information because extensive data already exists from excavation and design for the canceled Clinch River Breeder Reactor.

Procurement of the major contractor(s) is scheduled to be initiated immediately upon congressional approval of the MRS proposal. Procurement is on an expedited schedule. The initiation of design activities is not dependent upon having complete site data, so that design and data collection can proceed simultaneously for several months.

It is planned that sufficient information will be available by the midpoint in the design to complete the design input to the license application. The key inputs are safety assessments of the site and the MRS facility. These assessments are required to complete the Environmental Report and the Safety Analysis Report. These reports are the most time-consuming of the efforts required to prepare the license application. The NRC review of the license application and the potential hearings held by the licensing board then become the critical path activities. They are expected to take about 30 months, during which time the remainder of the design work will have been completed. Extensive coordination and consultation between the NRC and DOE staffs, which was begun during the preparation of the MRS proposal, is expected to limit the number of environmental and safety issues which will arise during the license review.

The DOE will not initiate construction of the MRS facility until a license is received from the NRC. After receipt of the license, site preparation and construction can begin. Construction of the R&H building becomes the critical path because of its size and the need to sequentially pour concrete for one floor of the R&H building at a time and then cure and remove the shoring of the upper floors before installation of services in the lower floors. The completion of the building constrains the installation of the handling, disassembly, and consolidation equipment in the R&H building.

The procurement and demonstration of reliability of the disassembly and consolidation equipment is important to achieving the schedule. However, it is not on the critical path because it appears that sufficient time exists from the completion of design (which constrains procurement of all long-lead-time items) to installation of the equipment in the R&H building.

Operator training cannot take place in the mockup training facility until the equipment is installed. However, there is sufficient time for training, so that construction remains on the critical path until the major equipment, services, and controls are completely installed in one of the R&H building receiving and handling cells. At this point the operators will have been trained on prototype equipment in the training facility and will be ready for a complete systems check on the first receiving and handling cell. The preoperational systems tests then remain on the critical path through the completion of the operational demonstration. During this testing and demonstration period, construction of other facilities will proceed, and each building or system will be accepted from the construction contractor as it is completed.

Operational testing and demonstration is scheduled to take 16 months. Demonstration activities include both cold and hot testing: a series of cold systems test; operations using spent fuel to test the waste treatment systems, shielding, and remote operations; and the ramp-up to significant processing rates. The facility is scheduled to be operational 123 months after congressional approval (in October 1996, if approval is received in July 1986). The ramp-up to full-scale operations is scheduled to take about 15 more months, until January 1998.

4.0 INTEGRATION PLAN

This chapter discusses the interfaces and integration of the MRS Program with the schedules of other OCRWM programs and with other storage and disposal facilities authorized in the NWPA.

The analysis of the integration of the MRS schedule for compatibility with the schedules of the other DOE waste management programs, e.g., the reference schedule for the first repository (DOE 1985b) and the transportation program schedule (DOE 1985c), is based on congressional approval of the MRS proposal by July 1986. Both technical and administrative interfaces were considered. The schedules of the other programs were reviewed to determine their compatibility and constraints. In some instances, integration of the MRS facility into the waste management system will require additional or changed activities in the other programs. For example, additional early definition and configuration control of technical interfaces involving waste forms and shipping casks will be required.

To ensure the required and continued functional integration of the waste management programs, the DOE is preparing a Systems Engineering Management Plan. This plan will implement a systems engineering approach to the integration of the repository program, the transportation program, and the MRS Program. The plan includes preparation of documents and management procedures to describe the waste management systems in terms of its component facilities; the allocation of functional requirements of the system to its components; establishment of technical baselines, including interface requirements, and change control procedures for each component; and provision for management assessments and reviews. In addition, the current OCRWM management system provides a disciplined cost and schedule control capability that ensures effective program management. The following discussion of interfaces and schedule integration is based on the integrated waste management schedule presented in Figure 4.1.

The Idaho National Engineering Laboratory is conducting a Prototypical Consolidation Demonstration Project which will demonstrate rod consolidation, canister welding, and non-fuel bearing component volume reduction techniques. Although this project was initiated to support the design of the surface facilities at the first repository, its results will be used for the MRS facility, if approved by Congress.

The Prototypical Consolidation Demonstration Project will provide confirmation of MRS design concepts and identify potential problem areas requiring resolution. The MRS facility design will be completed shortly after the completion of the demonstration project.

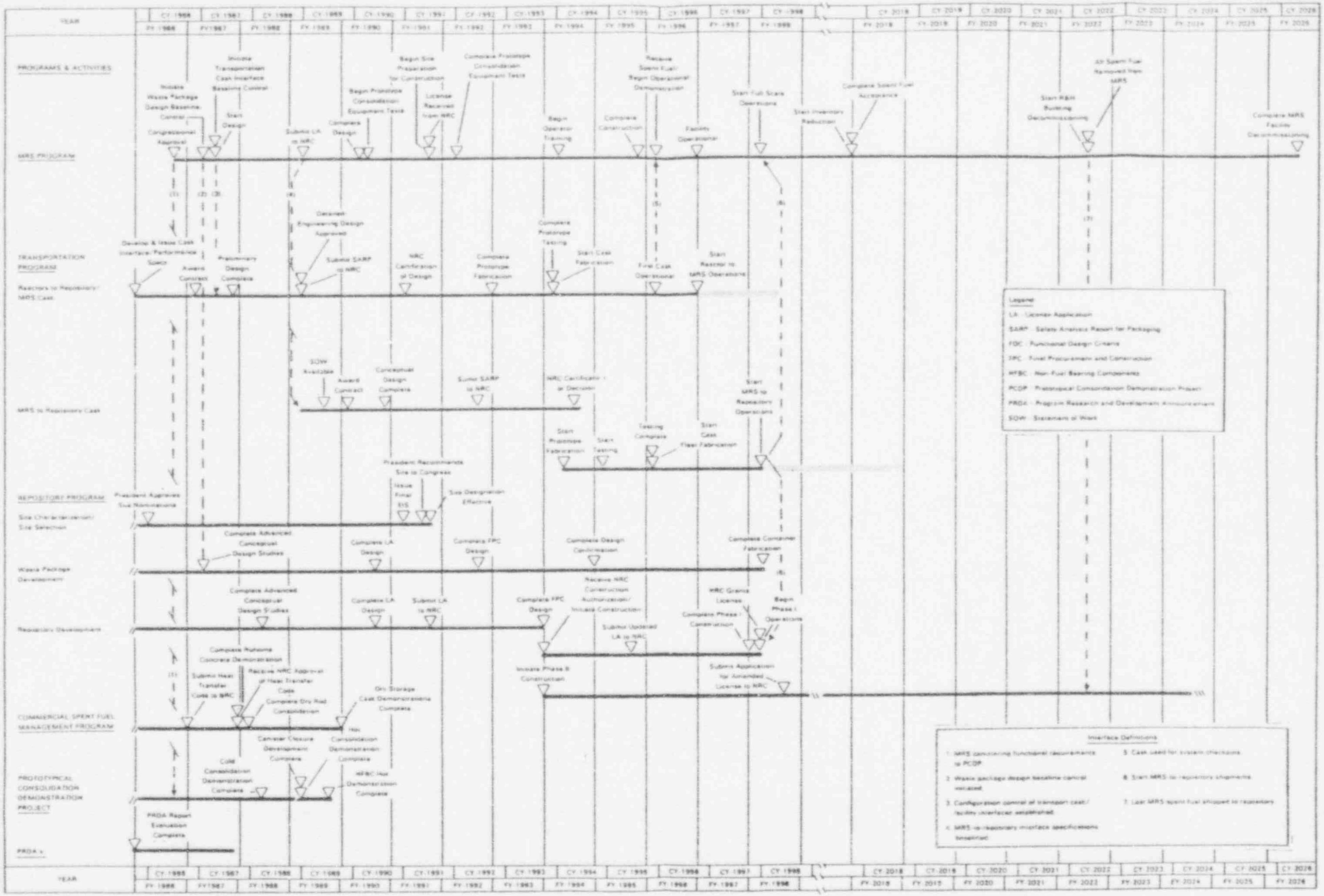


FIGURE 4.1. OCRWM Integrated Schedule

The transportation system schedule for the design of shipping casks is compatible with the MRS design data needs for cask interface and handling information. However, joint control with the transportation program of cask interface configurations must be established at the start of MRS design.

The schedule for the advanced conceptual designs for the repository will not be affected by the integration of an MRS facility into the system. However, the surface facility design requirements will be simplified because the MRS facility will do much of the spent fuel packaging currently included in the repository program plans. The site for the repository will not be selected until 1991. Currently, each repository program is considering a different configuration of waste canister and disposal container. The MRS design will be sufficiently flexible to accept whichever physical configuration is required for the selected geologic medium. An OCRWM Waste Package Coordination Group is currently studying the possible design of a common canister. An agreement between the MRS Program and the repository program on an envelope of possible waste canister designs will be reached by December 1986 to meet MRS and repository design requirements.

The DOE's Commercial Spent Fuel Management Program is developing spent fuel storage and consolidation information. The particular areas of interest to the MRS Program are:

- The NUHOMS[a] dry storage demonstration (in conjunction with Carolina Power and Light Co.) in concrete modules. This program was started in March 1984 and will be completed in September 1987. The program will demonstrate dry storage of PWR spent fuel assemblies in metal casks inside concrete modules. Confirmation of heat transfer, shielding design, and dry storage will be obtained.

- The Dry Rod Consolidation Demonstration (in conjunction with Virginia Power Co.). This program was started in June 1985 and will be completed in February 1988. The program will demonstrate dry consolidation of about 100 PWR spent fuel assemblies at INEL, followed by dry storage in two metal casks. The stored fuel rods in canisters will be used to validate and qualify heat transfer codes for application to dry storage of consolidated spent fuel rods.

The MRS Program will monitor these programs for compatibility with MRS designs.

(a) Nuclear Horizontal Modular Storage (NUHOMS) is a concrete storage module housing a double-sealed metal cask containing up to seven intact PWR assemblies.

In early 1984, the DOE issued a broad Program Research and Development Announcement aimed at identifying and researching various concepts that would enhance the overall performance of the waste management system. The majority of the concepts being evaluated under the Program Research and Development Announcement address various hardware developments that could be applied on a system-wide basis to enhance system efficiency and reduce system costs. These concepts include the use of various spent fuel canister shapes and configurations, the system-wide usage of extra large shipping casks, the evaluation of a mobile fuel rod consolidation system for at-reactor consolidation, and the feasibility of metallic cask systems for storage, transportation and disposal purposes. The preliminary results from these studies indicate that system benefits can potentially be accrued from the implementation of some of these concepts. The final results of the studies are not due until early 1986. When the studies are completed and their findings fully evaluated, those features having sufficient merit will be considered for further development and possible application in the waste management system.

The transportation program schedule for providing the first operational reactor-to-MRS facility shipping cask is compatible with the MRS Program schedule. The MRS Program will work with the transportation program to ensure that the transportation system cask fleet procurement schedule meets the waste management system shipping needs.

The shipment of spent fuel from the MRS facility to the repository is dependent upon the existence of the large rail casks suitable for dedicated trains. The date by which the transportation program will be ready to initiate such shipments (see Figure 4.1) is also compatible with the MRS Program schedule. MRS facility spent-fuel shipment rate requirements will be coordinated with the transportation program upon approval of the MRS proposal by Congress.

The MRS facility operation will conclude with shipment of the last stored spent fuel to the repository in the year 2022. The MRS facility will then be decommissioned.

In summary, the schedule for the waste management system with an MRS facility as an integral component of the system has been thoroughly analyzed and the MRS schedule integrated with those of the other system components. The DOE has also established management systems and procedures for controlling the interfaces in the development and operation of an improved performance waste management system.

5.0 FUNDING PLAN

The NWPA requires that the MRS proposal shall include "...a plan for the funding of the construction and operation of such facilities, which plan shall 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." The NWPA also establishes "...a separate fund, to be known as the Nuclear Waste Fund"..."for purposes of...the identification, development, licensing, construction, operation...of any...monitored retrievable storage facility constructed under this Act."

The DOE has considered different approaches to fund the MRS Program including the imposition of special charges on owners and generators of high-level waste and spent fuel in lieu of using funds from the Nuclear Waste Fund. Based on the analyses and supporting information presented in Appendix E of this Program Plan, the DOE is recommending that the MRS Program be financed through the Nuclear Waste Fund. With this approach, all generators and owners of high-level waste and spent fuel will pay for the MRS facility through the fee of 1.0 mill per kilowatt hour of electricity generated as specified in Section 302(a)(2) and (3) of the NWPA.

The proposed approach of financing the MRS facility through the Nuclear Waste Fund is administratively simple and conforms with the philosophy and provisions of the NWPA. Furthermore, the MRS facility confers benefits directly or indirectly to all contributors to the Nuclear Waste Fund through improvements in waste management system development, deployment, integration and performance, and through provision of a cost-effective capability to accommodate potential repository schedule changes (Volume 2, of this submission to Congress, Environmental Assessment for a Monitored Retrievable Storage Facility, Part 1, "Need for and Feasibility of Monitored Retrievable Storage").

The plan for funding the MRS Program is as follows:

1. The MRS Program will be financed through the Nuclear Waste Fund.
2. Although the federal waste management system is self-financing, the amount of money allowed to be spent from the Nuclear Waste Fund is governed by the federal budget process. The NWPA requires that a budget be submitted for the Nuclear Waste Fund and that appropriations be subject to triennial authorization. A Fund Management Plan (DOE 1984b) has been developed for implementation. The budgeting and financial management of the MRS Program will be in accordance with the DOE Fund Management Plan.

3. Each year, the annual costs from the most recent update of the MRS Program cost estimates will be converted into a budget request and incorporated into the overall Nuclear Waste Fund budget request. This budget request will go through the federal budgeting process and be subject to congressional authorization and appropriation.

4. Disbursement of authorized and appropriated funds for the MRS Program will be controlled and reported according to DOE Order 2200, "Financial Management of Civilian Nuclear Waste Activities" (DOE 1984c).

5. The DOE will continue to conduct an annual review of the 1-mill per kWh fee for waste disposal to determine whether the revenues will be sufficient to finance the total system costs of the federal waste management system, including the cost of the MRS facility. If it is determined that the fee is inadequate to assure full cost recovery, an adjustment to the 1-mill per kWh fee will be proposed.

The life-cycle cost of deploying, operating, and decommissioning an MRS facility employing the sealed storage cask design at the Clinch River site in Tennessee is estimated to be $2.9 billion.[a] However, this life-cycle cost includes the cost for the necessary preparation and packaging of spent fuel prior to emplacement in a repository. With the transfer of this function from the repository to the MRS facility, the reduction in the cost of spent fuel preparation and packaging facilities and operations at the repository is estimated to range from $1.0 to $1.4 billion. In addition, the change in the cost of spent fuel transportation with the proposed MRS facility in the federal waste management system is estimated to range from -$0.1 to +$0.1 billion. Thus, the net increase in federal waste management system life-cycle cost with the proposed MRS facility in the system is estimated to be in the range of $1.4 billion to $2.0 billion.

According to the 1985 fee adequacy review (Engel 1985), total waste management systems costs, excluding an MRS facility, range from $24.5 to $30.6 billion in constant 1985 dollars. (An inflation rate of 3.8% was used to convert the cost estimates in the 1985 fee adequacy review from constant 1984 dollars to constant 1985 dollars.) Therefore, the increase in the total system cost is between 5% and 8%, which is within the uncertainty of current estimates of total system cost without the MRS facility. Appendix E, Section E.5.4, discusses total system cost changes more fully.

Based on results of the 1985 fee adequacy review, and the DOE's assessment of the projected growth of the U.S. nuclear economy, the Nuclear Waste

(a) All costs and funding requirements presented in this chapter are quoted in 1985 dollars.

Fund generated by the current 1-mill per kWh fee will be adequate for funding the improved-performance waste management system (including an integral MRS facility). Consistent with the funding plan described above and with past practice, the annual review of fee adequacy for FY-1986 is currently being conducted, using updated waste management system cost estimates and revenue projections. If this review should indicate that the 1-mill per kWh fee does not generate sufficient revenue to achieve full-cost recovery for the improved performance system and if the improved performance system is approved by Congress, an adjustment to the fee will be submitted for congressional approval.

Table 5.1 presents the annual funding schedules for the proposed MRS Program. The funding authority required through 1996, when operation starts, is about $1 billion, including about $700 million in capital funds for facility design and construction. The annual funding requirement will be heaviest during the construction and initial operation years of 1991 through 2001, ranging from about $80 million in 1991 to about $190 million in 1993. When the MRS facility is in steady-state operation, the annual funding requirement is estimated to be about $70 million per year. The funding requirement for facility decommissioning is about $80 million.

Cost data for the six site-design combinations, and the methods and assumptions used for cost and funding evaluations are discussed in Appendix E.

TABLE 5.1. Estimated Annual Funding Authority Required for the MRS Program[(a)]

Stage or Item	Fiscal Year	Millions of 1985 Dollars[(b)]
Congressional approval	1986	7
	1987	25
	1988	37
	1989	39
	1990	40
Construction begins	1991	79
	1992	164
	1993	191
Training begins	1994	188
Construction complete	1995	131
Operation starts	1996	97
	1997	112
Full-scale operation	1998	133
	1999	127
	2000	125
	2001	86
	2002	72
	2003	71
	2004	72
	2005	71
	.	.[(c)]
	.	.
	2015	71
	2016	72
	2017	60
Start decommissioning	2018	25
	2019	25
	2020	26
	2021	27
All spent fuel removed	2022	26
	2023	21
	2024	18
	2025	14
Complete facility decommissioning	2026	9
TOTAL MRS FACILITY		2900

(a) Source: Appendix E.
(b) Rounded.
(c) Identical pattern (72, 71, ...) for intervening years.

6.0 REFERENCES

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7.0 GLOSSARY

ALARA - as low as reasonably achievable.

ANSI - American National Standards Institute.

ANSI NQA-1 - American National Standards Institute Quality Assurance Requirements for Nuclear Facilities.

ASME - American Society of Mechanical Engineers.

canister - The first material envelope surrounding a waste form (e.g., spent fuel rods) to provide containment for handling and storage purposes.

CFR - Code of Federal Regulations.

consolidation - The disassembly and packaging (reconfiguration into a close-packed array) of spent fuel rods to achieve volume reduction, thereby reducing the space required for storage, transportation, or disposal.

container - A metal barrier placed around a waste canister prior to disposal to meet the requirements of 10 CFR 60. The container provides the second level of containment.

containment - The sealed isolation (complete retention) of radioactive waste within a designated boundary or vessel in a manner that prevents its release to or contact with the surrounding environment.

decommissioning - The removal from service (at the end of its useful life) of an MRS facility and its related components in accordance with regulatory requirements and environmental policies.

decontamination - The removal of radioactive material from an MRS facility, its surrounding soils, and its equipment by washing, chemical action, mechanical cleaning, or other techniques.

disposal package - The primary container that holds, and is in contact with, solidified high-level radioactive waste, spent nuclear fuel, or other radioactive materials, and any overpacks that are emplaced at a repository.

DOE - U.S. Department of Energy.

DOE-OCRWM - Office of Civilian Radioactive Waste Management, U.S. Department of Energy.

dry storage - Storage of spent nuclear fuel or high-level waste surrounded by one or more gases (e.g., air, argon, helium) and no use of cooling liquids (e.g., water).

EA - Environmental Assessment.

EIS - Environmental Impact Statement.

ER - Environmental Report.

field drywell - An individual, stationary, inground, metal-lined cavity for storing one or more canisters or drums containing high-level waste or spent nuclear fuel. Shielding is provided by the surrounding earth and a shield plug. Heat dissipation is by conduction through the plug and earth to the atmosphere and also by thermal radiation.

high-level waste (HLW) - High-level radioactive waste. The highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in the first processing cycle in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations. Also, any other radioactive material that requires permanent isolation, as determined by the U.S. Nuclear Regulatory Commission.

integral MRS concept - The concept whereby an MRS facility would receive, process, package, store, and ship to the repositories all spent fuel and certain other wastes requiring permanent disposal, and thus serve as an "integral" part of the federal waste management system. In this role, sufficient storage would be provided to accommodate disruptions in operations.

MRS - monitored retrievable storage.

MRS facility operations - All functions at an MRS site leading to and involving the handling and/or storing of radioactive waste and spent fuel in the facility, including receiving, onsite transport, handling, packaging, consolidating, canistering, emplacement, retrieval, and load-out for equipment to a repository.

MRS support facilities - All permanent facilities constructed to support the operation of the MRS receiving and handling building, including structures, utility lines, roads, railroads, and similar facilities, but excluding the storage facility.

MTU - metric tons of uranium.

NRC - U.S. Nuclear Regulatory Commission.

NWPA - Nuclear Waste Policy Act of 1982.

package - The act of preparing spent nuclear fuel for storage, shipment, and/or final disposal. Includes disasembly and consolidation of the spent fuel, placement of the consolidated spent fuel in canisters, and placement of canisters into disposal containers.

R&D - research and development.

receiving and handling (R&H) building - The primary operating building of an MRS facility. The R&H building is designed to physically contain and control all radioactive material being handled or generated by process operations and includes space and equipment for all spent fuel operations (e.g., receiving, disassembly, packaging) and all HLW and RHTRU operations (e.g., canister receiving, handling, and shipping).

repository - A facility consisting primarily of mined cavities in a deep geological medium and associated support facilities for the permanent disposal of spent nuclear fuel and high-level waste.

site evaluation - Activities undertaken to establish the environmental, meteorological, socioeconomic, and geologic conditions and the ranges of the parameters of a site relevant to the location of an MRS facility, including borings, surface excavations, and in-situ testing needed to evaluate the suitability of a site.

spent nuclear fuel - Irradiated nuclear reactor fuel that has reached the end of its useful life.

storage - The retention of radioactive waste in a retrievable manner that requires surveillance and institutional control.

throughput - The average rate at which an MRS facility can receive, inspect, consolidate, and package spent fuel.

APPENDIX A

OPERATIONAL CHARACTERISTICS OF THE IMPROVED-PERFORMANCE SYSTEM

APPENDIX A

OPERATIONAL CHARACTERISTICS OF THE IMPROVED-PERFORMANCE SYSTEM

The Mission Plan for the Civilian Radioactive Waste Management Program (DOE 1985a) discusses two alternative federal waste management systems for spent nuclear fuel and high-level radioactive waste. In the first, the "authorized system," the primary federal facilities are two repositories, the first of which has been authorized by Congress, and a federally managed waste-transportation system. The second system, the "improved-performance system," contains in addition an integral MRS facility such as the DOE is proposing to construct. This appendix describes the operational characteristics of the improved-performance system, with emphasis on the MRS facility's role in that system.

The basic facilities and materials flows involved in the improved-performance system are shown in Figure A.1. The components involved in operating this system are:

- The nation's commercial power reactors, owned and operated by U.S. utilities.

- Two geologic repositories: the first, authorized by Congress, is scheduled to begin operation at a western or southern site in 1998; the second is not as yet authorized but is assumed to start up at an as yet unselected site in the year 2006.

- An MRS facility, which the DOE proposes to be located at the Clinch River Breeder Reactor site near Oak Ridge, Tennessee.

- A federally managed transportation system, utilizing commercial carriers, for shipments of spent fuel and high-level waste.

Based on evaluations of draft environmental assessments for several candidate geologic repository sites, three locations have been proposed by the DOE for recommendation for site characterization: 1) Yucca Mountain, Nevada, which features tuff as the geologic medium; 2) Hanford, Washington, with basalt; 3) and the Deaf Smith site in Western Texas, with salt. These three sites were considered in the analyses of the improved-performance system. The second repository was not considered in the analyses. However, the effect of spent fuel acceptance at the second repository on the age of the spent fuel received was considered in the analysis in Section A.6.

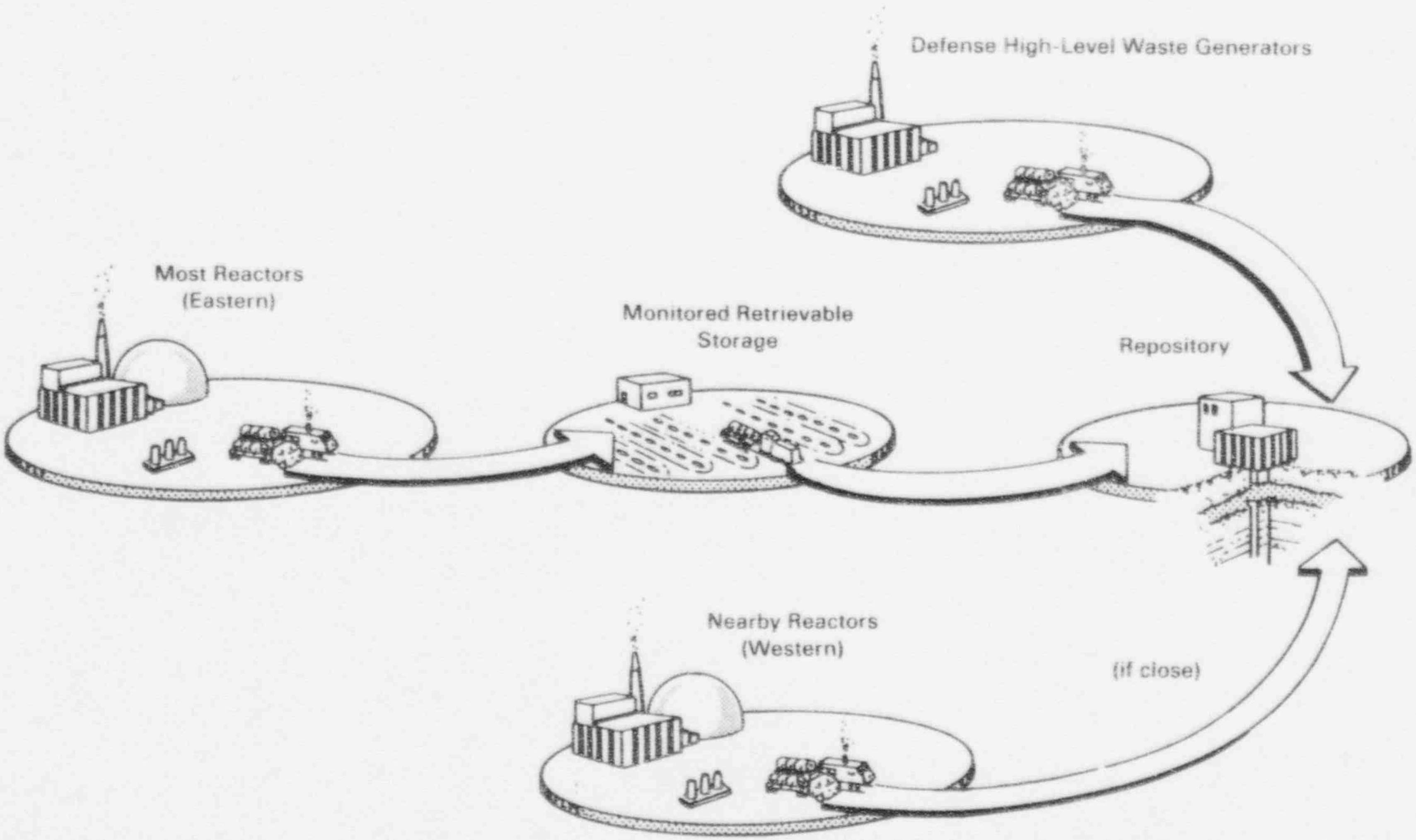

FIGURE A.1. Improved-Performance System

As proposed, the MRS facility would be capable of receiving spent fuel from reactors, disassembling the fuel assemblies, consolidating the fuel rods and encasing them in canisters, and shipping the canisters to a repository for final packaging (i.e., the addition of an overpack, which is the repository-specific barrier to radionuclides) and disposal. Current planning assumes the use of the MRS facility only in conjunction with the first repository; discussions in this appendix follow that assumption. Alternatively, depending on the location and geologic conditions of the second repository, it may prove advantageous for the MRS facility to serve the second repository as well.

The current plan, shown in Figure A.1, is to ship spent fuel from reactors near the repository (in the case of a western repository, reactors in Arizona, California, Oregon and Washington) directly to the first repository. An alternative scenario considered was to ship all spent fuel destined for the first repository to the MRS facility for consolidating and sealing in canisters.

Defense wastes and other high-level wastes will be shipped directly to the repository.

A.1 RECEIPT RATES, SHIPPING RATES, AND INVENTORIES

Under the current assumptions, 62,000 metric tons of uranium (MTU) in the form of spent fuel would be accepted for disposal by the first of the two repositories.[a] If western fuel were to be shipped directly to the repository, the MRS facility would receive and process about 53,000 MTU of spent fuel; the remainder of the first-repository inventory of spent fuel, about 9,000 MTU, would be shipped directly to the repository.

Current assumptions are that only spent fuel will be received and handled at the MRS facility. The facility is designed, however, to handle both spent fuel and high-level waste. If desired it can accept, after vitrification in steel canisters, the high-level waste currently in storage at West Valley. This waste, from the reprocessing of 228 MTU of spent fuel prior to 1972 (DOE 1985b), is scheduled to be vitrified during 1988-1989; it is estimated that about 300 waste canisters, 24 inches in diameter, will be produced.

Projected system flows and inventories of spent fuel are shown in Table A.1 assuming western fuel goes directly to the first repository, and in Table A.2 assuming the MRS facility accepts all fuel for the first repository. The following discussions are based primarily on the information in Table A.1.

(a) The repository will also receive additional defense high-level waste.

TABLE A.1. Projected System Flows and Inventories with Western Spent Fuel Shipped Directly to the First Repository (in MTU)

Year	MRS Receipt Rate	Shipments: MRS to First Repository	MRS Inventory	First Repository Receipts From Western Reactors	Total First Repository Receipts	First Repository Inventory
1995	0	0	0	0	0	0
1996	400	0	400	0	0	0
1997	1,800	0	2,200	0	0	0
1998	2,500	350	4,350	50	400	400
1999	2,500	350	6,500	50	400	800
2000	2,500	325	8,675	75	400	1,200
2001	2,500	825	10,350	75	900	2,100
2002	2,500	1,700	11,150	100	1,800	3,900
2003	2,500	2,800	10,850	200	3,000	6,900
2004	2,500	2,650	10,700	350	3,000	9,900
2005	2,500	2,550	10,650	450	3,000	12,900
2006	2,500	2,550	10,600	450	3,000	15,900
2007	2,500	2,550	10,550	450	3,000	18,900
2008	2,500	2,550	10,500	450	3,000	21,900
2009	2,500	2,550	10,450	450	3,000	24,900
2010	2,500	2,550	10,400	450	3,000	27,900
2011	2,500	2,550	10,350	450	3,000	30,900
2012	2,500	2,550	10,300	450	3,000	33,900
2013	2,500	2,550	10,250	450	3,000	36,900
2014	2,500	2,550	10,200	450	3,000	39,900
2015	2,500	2,550	10,150	450	3,000	42,900
2016	2,500	2,550	10,100	450	3,000	45,900
2017	2,500	2,550	10,050	450	3,000	48,900
2018	800	2,550	8,300	450	3,000	51,900
2019	0	2,550	5,750	450	3,000	54,900
2020	0	2,550	3,200	450	3,000	57,900
2021	0	2,550	650	450	3,000	60,900
2022	0	650	0	450	1,100	62,000
2023	0	0	0	0	0	62,000
2024	0	0	0	0	0	62,000
2025	0	0	0	0	0	62,000

TABLE A.2. Projected System Flows and Inventories with All Spent Fuel Shipped Directly to the MRS Facility (in MTU)

Year	MRS Receipt Rate	Shipments: MRS to First Repository	MRS Inventory	First Repository Inventory
1995	0	0	0	0
1996	400	0	400	0
1997	1,800	0	2,200	0
1998	3,000	400	4,800	400
1999	3,000	400	7,400	800
2000	3,000	400	10,000	1,200
2001	3,000	900	12,100	2,100
2002	3,000	1,800	13,300	3,900
2003	3,000	3,000	13,300	6,900
2004	3,000	3,000	13,300	9,900
2005	3,000	3,000	13,300	12,900
2006	3,000	3,000	13,300	15,900
2007	3,000	3,000	13,300	18,900
2008	3,000	3,000	13,300	21,900
2009	3,000	3,000	13,300	24,900
2010	3,000	3,000	13,300	27,900
2011	3,000	3,000	13,300	30,900
2012	3,000	3,000	13,300	33,900
2013	3,000	3,000	13,300	36,900
2014	3,000	3,000	13,300	39,900
2015	3,000	3,000	13,300	42,900
2016	3,000	3,000	13,300	45,900
2017	2,800	3,000	13,100	48,900
2018	0	3,000	10,100	51,900
2019	0	3,000	7,100	54,900
2020	0	3,000	4,100	57,900
2021	0	3,000	1,100	60,900
2022	0	1,100	0	62,000
2023	0	0	0	62,000
2024	0	0	0	62,000
2025	0	0	0	62,000

The rate of acceptance of spent fuel at the MRS facility can only be projected at this time. The DOE/utility spent-fuel disposal contract (10 CFR 961 1985) calls for acceptance schedules to be specified beginning in the year 1991. Based on current projections of spent-fuel-generation rates and of increases in need for at-reactor storage, it is currently estimated that 3000 MTU/year of spent fuel would be accepted for storage or disposal during and after 1998. The acceptance rate at the MRS facility is assumed, after the initial ramp-up, to be 2500 MTU/yr spent fuel, whereas 450 MTU/yr, and 9000 MTU total, are assumed to be shipped directly to the first repository from western reactors. Shipments from the MRS facility to the repository, once the repository is operating at full scale, would be at a rate of 2550 MTU/year, depleting the amount stored by 50 MTU/yr and maintaining a repository receipt rate of 3000 MTU/year.

Alternatively, all spent fuel could be shipped through the MRS facility, at a rate of 3000 MTU per year, as shown in Table A.2.

The MRS facility is currently envisioned to become operational in October 1996, following a 10-month period of operational demonstrations using spent fuel. The projected amount of fuel received in 1996, including that received both during the demonstration period and the initial 3 months of operation, is 400 MTU. In 1997 the acceptance of spent fuel would increase to 1800 MTU, and in 1998 the amount for full-scale operation (2500 MTU) would be received. In its current state of conceptual design, the MRS facility is capable of receiving (and concurrently shipping to the repository) 3600 MTU per year. Before definitive design, the MRS design capacity will be finalized, after consideration of the economics of facility capital cost and various modes of facility operation.

The MRS facility is planned to have a storage capability of 15,000 MTU, including storage of fuel in sealed storage casks and a lag storage vault in the receiving and handling building. The lag storage capacity is intended as a buffer for decoupling fuel-acceptance activities from shipment to the repository for disposal. It would compensate for operational mismatches or for short-term disruptions in the system without resort to retrieval from the sealed storage casks. The cask storage capability is expected to be used primarily to permit fuel acceptance before and during the startup period of the first repository. As discussed later, the cask storage system would also permit "tailoring" of the heat generation rates of fuel shipped to the repository, by aging fuel in the storage casks, to provide canisters with a more uniform heat output for disposal in the repository.

A.2 TRANSPORTATION CHARACTERISTICS WITH MRS

The transportation link for shipping spent fuel from the utility reactors to the MRS facility, and from the MRS facility to the repository, is planned as a system of NRC-certified shipping casks transported by commercial truck and rail carriers. The mode of shipment from the reactors will be governed primarily by the capabilities of each reactor; currently some 40 reactors either have no rail capability or have some degree of restriction on rail capability. Recently completed reactors have full rail capability; presumably, all reactors to be built in the future will also have this capability. Thus, shipments from the reactors are assumed to be a mixture of truck and rail; current estimates are that about 70% (by weight) of the fuel will be shipped by rail. The use of marshaling yards or transloading of shipping casks could increase the rail shipments.

It is planned that shipments of canistered spent fuel from the MRS facility to the repository will be by dedicated train, in groups of five or more large casks (100- to 150-ton weight).

A.3 TIME REQUIREMENTS FOR TRANSPORTATION AND MRS OPERATIONS

The time required to ship spent fuel from the utility reactors to the MRS facility, and from the MRS facility to the repository, plays an important role in determining the size of the cask fleet required for system transportation. The cask turnaround times (loading or unloading and associated idle time) at the MRS or repository are also important. The time required to handle the received fuel and prepare it for reshipment affects the lag storage size requirements and the basic throughput capability of the MRS facility.

Transport times for shipments between reactors and the MRS facility vary considerably with differing distances and routes, but are estimated to average 1 to 2 days for truck shipments and 9 to 10 days by rail. From the MRS facility to the repository, by dedicated train, transport times will vary from 2 to 10 days, depending on the location of the repository. Return trips in each case would require equivalent times. In addition, turnaround times at each facility (the time from receipt of a cask until it is returned to the carrier) average 1.5 days for truck casks and 2.5 days for rail casks at reactors; equivalent times are assumed at the MRS facility. For shipment from the MRS facility to the repository, turnaround times of 4.5 days for a five-cask dedicated train at each facility are projected.

Based on the above assumptions, it is estimated that a total fleet would consist of about 15 to 20 truck casks and 20 to 25 rail casks for shipments from the utility reactors, and 30 to 40 100-ton rail casks (or 10 to 15 150-ton casks) for shipments from the MRS facility to the repository. The ranges in numbers of casks servicing the reactors reflect uncertainties in priority allocations of fuel shipments in a given year; thus the fleet would tend to the high side of that range. For the MRS-to-repository casks, the ranges depend on the shipping times to the repository location.

A.4 PLANNED OPERATIONAL MODE FOR MRS

The MRS facility is intended to receive spent fuel from utility reactors at rates to be determined by the final DOE/Utilities contract (10 CFR 961), to consolidate and canister the fuel, and to reship the canistered fuel to the first repository for final packaging and disposal. The excess fuel accepted in the early years of MRS facility operation, before full operation of the repository, would be temporarily stored in sealed storage casks until it can be shipped to the repository without disrupting the acceptance from utilities. The basic flows and inventories for this operation are shown in Table A.1.

A.5 PLANNED REPOSITORY OPERATING MODE

The first geologic repository is scheduled to begin operation in 1998, initially receiving fuel at the rate of 400 MTU per year. This rate would be gradually increased, as indicated in Table A.1, until it reaches a full-scale rate of 3000 MTU per year in the year 2003. The 3000-MTU-per-year rate would be continued until the repository reaches its 62,000-MTU capacity of spent fuel.

In shipments from the MRS facility, the repository is expected to receive about 2550 MTU per year of spent fuel consolidated into canisters. The canisters would be packaged (overpacked) as appropriate for the geologic medium, lowered to the disposal area, and emplaced.

The fuel shipped directly to the repository from the western reactors, nominally at 450 MTU per year (Table A.1), is expected to be received primarily as intact spent-fuel assemblies; some utilities, however, may choose to consolidate and canister fuel. Upon arrival at the repository, the fuel would be packaged for disposal, with or without an inner canister as appropriate, and disposed of underground.

In an alternative plan (Table A.2), with all fuel shipped to the MRS facility, the only functions of the repository would be to receive, package and dispose of the consolidated and canistered fuel from the MRS facility. No "bare" (uncanistered) fuel would be handled in routine operations.

With the repository filled to capacity, backfilling of the emplacement tunnels would be completed after approval is received from the NRC. Fuel receipt and disposal activities would then be focused solely at the second repository.

A.6 ALTERNATIVE MRS OPERATIONAL MODES

Inventory-management techniques within the MRS facility can be varied, if desired, to modify the characteristics of the fuel. The MRS storage facilities can be used to age the accepted fuel, thus providing the repository with fuel exhibiting lower and more uniform heat-generation rates.

In accordance with 10 CFR 961, the DOE is committed by contract with the utilities to receive fuel as young as five years after discharge. Such fuel would have heat-generation rates more than 50% greater than the 10-year-old fuel on which many repository design studies have been based. Fuel exposed to higher burnup than today's levels would have similar characteristics. Disposal of fuel with higher heat output, depending on the disposal medium, could require development of larger underground facilities, at increased cost, to permit greater dispersal of the heat.

At the time the DOE begins acceptance of spent fuel, there will be large stocks of aged fuel, 10 years and older. However, at the projected acceptance rates shown in Table A.2, this aged fuel will be largely depleted within about 10 years; the average age of fuel received may approach 5 to 7 years after that.

The fuel inventory in MRS may be managed to provide additional aging of the fuel, reducing the heat-generation. The simplest method is by rotating the storage inventory on an "oldest fuel out" basis. In such a scheme, all short-term-cooled fuel received at the MRS facility would be sent to storage. The oldest fuel received or in storage would be shipped to the repository. The effects of such a fuel-management scheme are illustrated in Figures A.2 and A.3. Figure A.2 shows the estimated age spread of fuel upon receipt at the MRS facility (based on a case assuming that all first-repository fuel is handled at the MRS facility). In the later years of fuel acceptance, after about 2009, most or all of the fuel received is aged less than 10 years since discharge; much of this fuel is projected to be in the 5- to 7-year category. Figure A.3 shows the same fuel received at the repository after age-tailoring as described. With this MRS operational mode, virtually all of the fuel shipped to the repository is aged 10 years or more from discharge.

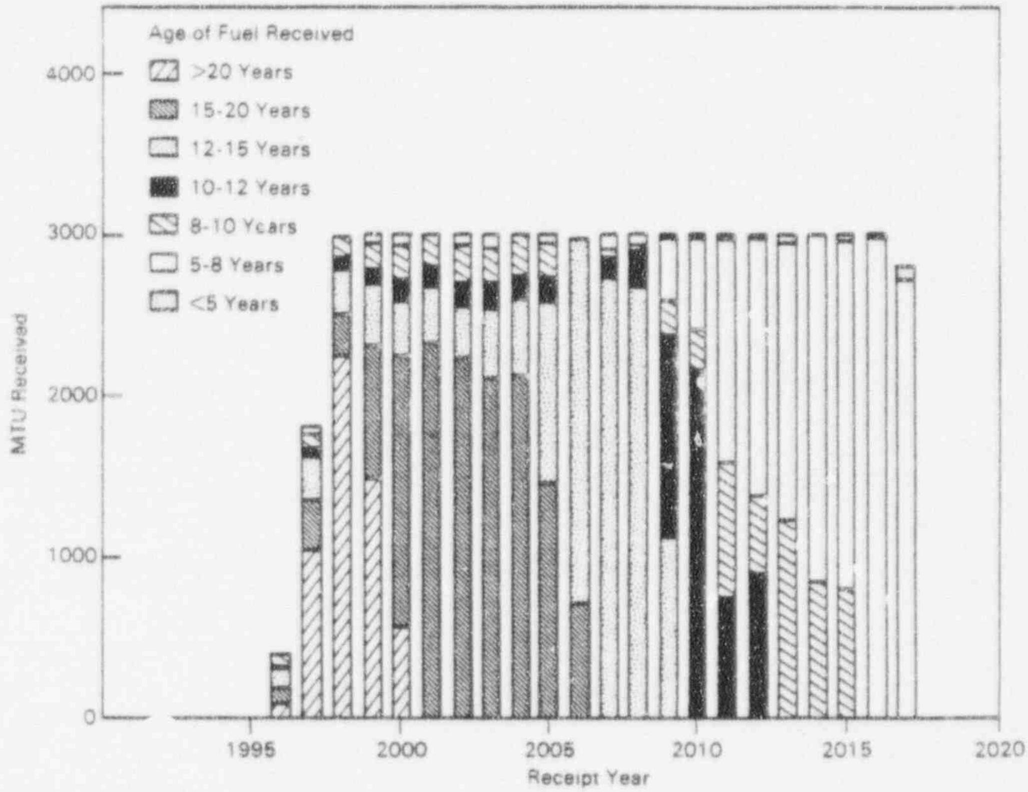

FIGURE A.2. Age Distribution of Fuel Receipts at the MRS Facility

Other potential alternative modes of MRS facility operation include options for the handling of western fuel, previously discussed, and the use of the MRS facility to service the second utility as well as the first. The advantages of the latter alternative MRS role (or alternatively the use of a second MRS facility) would depend heavily on the location of the second repository. The role currently proposed for MRS does not include its use with the second repository. However, if it proves desirable at a later date, it could fulfill this function.

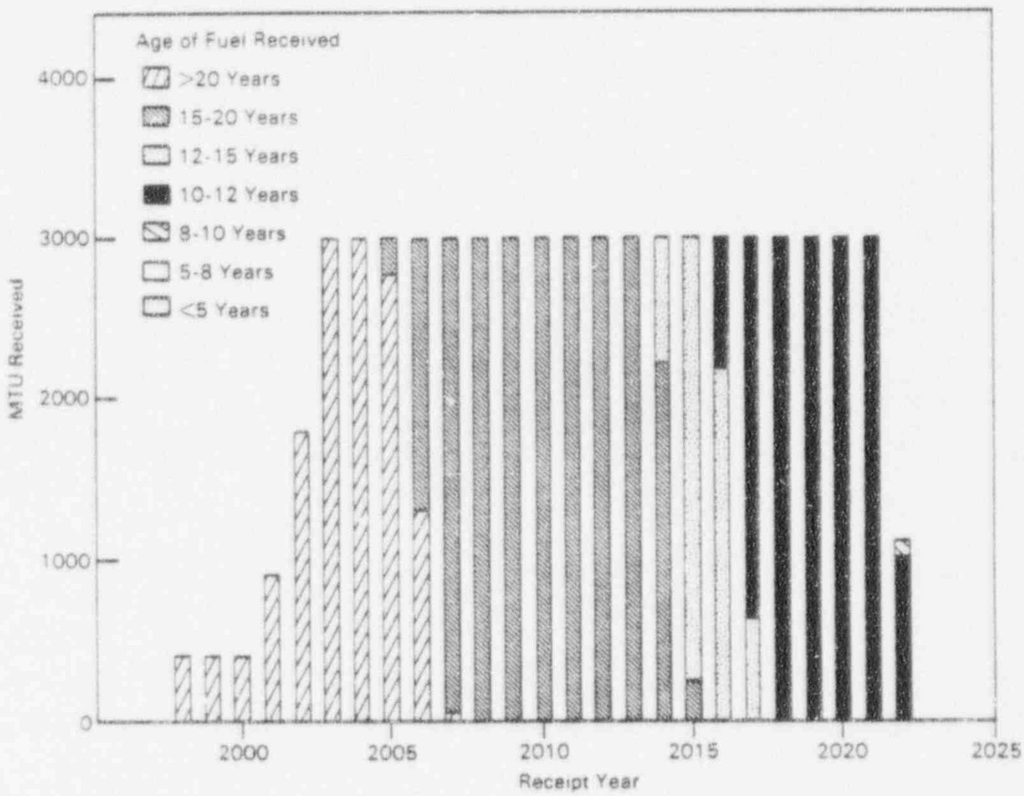

FIGURE A.3. Age Distribution of Fuel Receipts at the First Repository After Age-Tailoring at the MRS Facility

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APPENDIX B

DESCRIPTION OF MRS FACILITY OPERATIONS

APPENDIX B

DESCRIPTION OF MRS FACILITY OPERATIONS

This appendix provides a brief description of MRS facility operations based on the conceptual design (R. M. Parsons Company 1985).[a] Section B.1 presents an overview of the requirements and capabilities of the MRS facility. Section B.2 describes the receiving and handling building, which contains the main operating areas in the MRS facility, and Section B.3 discusses MRS storage facilities and related operations.

The MRS conceptual design satisfies the design criteria stipulated in the NWPA and the functional requirements for an integral component of the waste management system. The latter requirements are documented in the Functional Design Criteria (PNL 1985).

B.1 OVERVIEW OF MRS REQUIREMENTS AND CAPABILITIES

The integral MRS facility is intended to serve as a centralized receiving and packaging facility for commercial spent nuclear fuel. In addition, the facility will provide contingency storage capability to accommodate surges or disruptions in any operational element of the federal waste management system.

To achieve these goals and the design criteria above, the facility is designed to receive, process and ship offsite or store onsite, a minimum of 3600 metric tons of uranium (MTU) per year primarily as spent fuel and a small amount (less than 300 canisters total) as high-level waste (HLW).[b] The MRS facility will have in-building lag storage capacity for up to 1000 MTU of consolidated fuel in canisters, plus outdoor storage capacity for up to 15,000 MTU of spent fuel. The design assumes a spent fuel mix of 60% PWR/40% BWR by weight, based on 0.462 MTU per PWR assembly and 0.186 MTU per BWR assembly. It will also be capable of retrieval, overpacking as required, and shipment of at least 3600 MTU or equivalent per year of canistered spent fuel and waste to a geologic repository for disposal. Capability will be maintained

(a) Design verification activities, see Appendix C, may result in some changes in specific processes or equipment; however, the general operations will be as described in this appendix.

(b) The design criteria in the NWPA require that the MRS facility be capable of handling commercial HLW. Although there exists a small amount of commercial HLW at the closed West Valley, New York, reprocessing facility, the DOE plans to receive only commercial spent fuel at the MRS facility.

to receive and ship concurrently at those rates. Surge capacity will be included in the design of receiving, handling, and storage systems to obviate the impacts of credible offsite and onsite disruptions of spent fuel, waste, and material flows.

Hot cell space will be included to accommodate overpack equipment capable of sealing consolidated fuel canisters in a repository-type overpack suitable for disposal. However, the equipment for overpacking is not included in the design.[a]

The MRS facility must be licensed by the NRC. In addition, the design, construction and operation of the facility will be performed in conformance with all applicable industry codes and standards and in compliance with applicable state laws and federal regulations.

The principal operations to be performed in the MRS facility are receipt, disassembly, consolidation and packaging of spent fuel for interim storage, as needed, and ultimately shipment offsite for disposal. The facility provides short-term lag storage capability for intact and consolidated fuel in the R&H building vaults. Long-term storage capability is provided externally in concrete sealed storage casks. The overall layout of the MRS facility, including administrative and support buildings, is shown in Figure B.1. The general layout of the R&H building including the process cells and lag storage vaults is illustrated in Figure B.2.

Reference heat generation rates and levels of radioactivity of spent fuel that will be received, handled and shipped or stored in the MRS facility are listed in the FDC. The facility is designed for spent fuel having exposures of about 30,000 MWD/MTU and having been cooled at the reactor for 10 years. However, the facility can handle up to 10% of the spent fuel with only 5-year cooling with this exposure and 10-year-cooled spent fuel with up to 55,000 MWD/MTU exposure.

B.2 R&H BUILDING DESCRIPTION

The receiving and handling (R&H) building contains the main operating areas of the MRS facility. The general layout of the R&H building is essentially symmetric about a line passing between the canyon cells in the center of the building and in the general direction of material flows. Approximately half of the R&H building is illustrated in the cut-away view in Figure B.2.

(a) At this time it appears to be operationally preferable to perform the overpacking at the repository site.

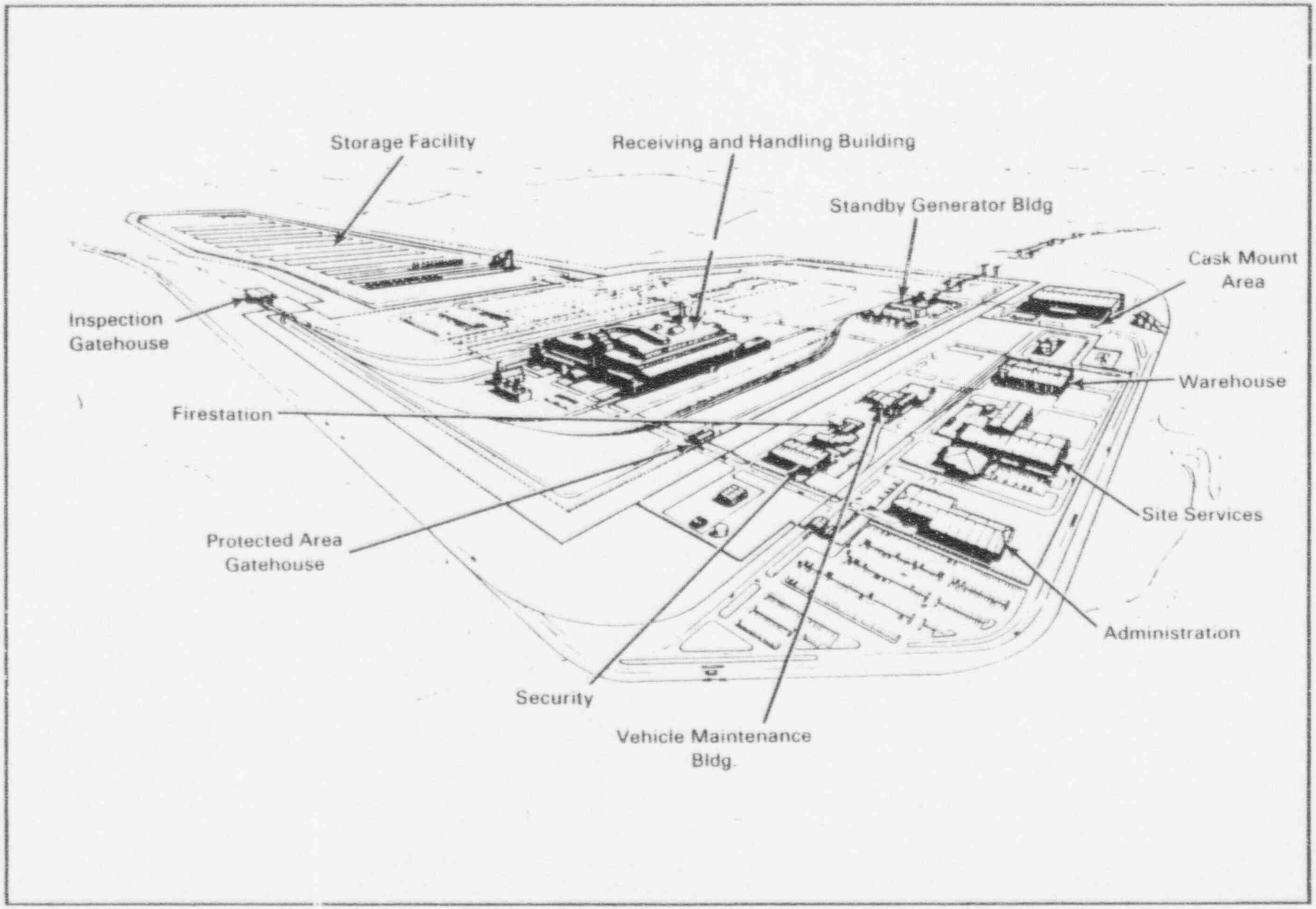


FIGURE B.1. Overview of the MRS Facility Layout

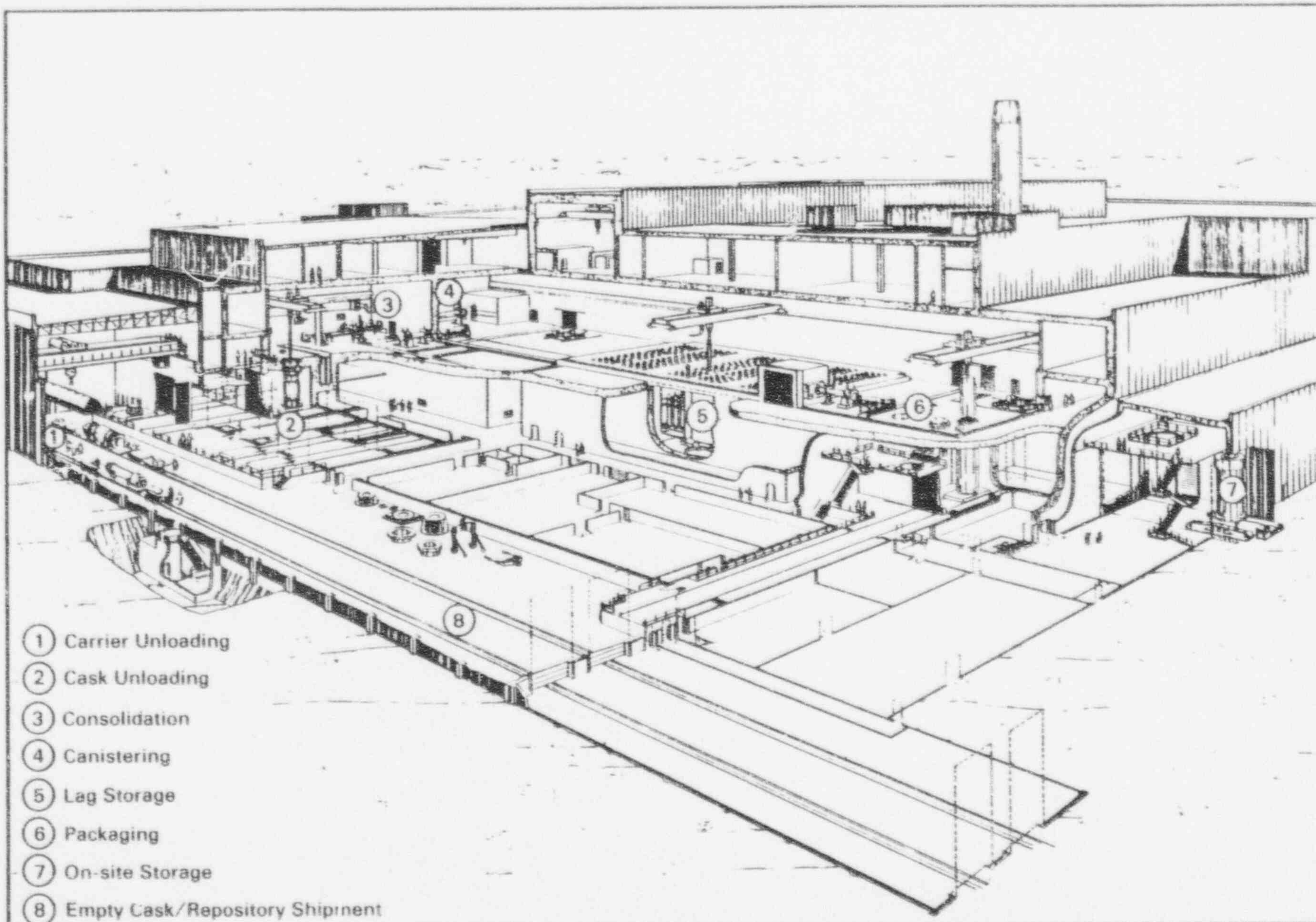


FIGURE B.2. Overview of the MRS Receiving and Handling Building

The principal operating areas and associated operations are as follows:

- fuel receiving and handling areas
- main process cells
- canister weld stations
- lag storage vaults
- sealed storage cask/field drywell loadout/retrieval areas
- overpack installation area (optional)
- transport cask loadout areas.

As previously noted, only the space (no equipment) needed for the installation of overpacks for disposal is provided in the current design.

Other areas of the building include: administration, radwaste treatment, and building services. The administration area contains offices, a lunchroom, a conference room, change rooms and toilet rooms, and the health physics facilities. These areas provide services specifically for the operations and management and support personnel housed within the R&H building.

The radwaste treatment area is separated into two areas: the high-activity waste (HAW) area, for processing highly radioactive wastes, and the low-level waste (LLW) area. The LLW area is further divided into liquid and solid waste treatment areas. The liquid LLW treatment system reduces the volume of the waste by evaporation. The non-radioactive liquid effluent is recycled within the R&H building; the sludge is sent to the solid LLW treatment system. The solid wastes, except HEPA filters, are mixed with a cement grout and placed in 55-gallon drums. The sludge from the liquid radwaste is added to the grout. The drums of waste are cured, decontaminated as necessary and sent through a drum interrogator that determines the presence of transuranic (TRU) material by gamma pulse height analysis. Drums with TRU material (CHTRU) are sent to the onsite CHTRU storage facility. Drums without TRU material (LLW) are sent to the temporary storage area before being shipped to an offsite disposal area. The second- and third-stage HEPA filters are compacted and placed in 55-gallon drums without the cement grout. These drums go through the same decontamination and interrogation process as the grouted drums.

The HAW materials, including the in-cell and first-stage HEPA filters, are processed generally similarly to the LLW materials but are processed within a shielded area using totally remote methods.

The building service areas include:

- analytical laboratory
- aqueous and chemical makeup rooms
- HVAC equipment room

- mechanical equipment rooms
- laundry room
- maintenance rooms
- material receiving and storage rooms.

These areas are typical of most nuclear-related facilities and are not described here.

Spent fuel transport vehicles (trucks and rail cars) enter the R&H building by means of rail lines and paved roads on either side of the building. There are four independent processing cells, two on either side of the canyon cells, each with its own receiving and handling area. Two independent weld stations, accessible from any of the four process cells, are installed in the canyon near the "input" end of the R&H building. The majority of the central canyon is occupied by the air-cooled canister storage vaults. There are two independent canister loadout areas for loading of transport casks for shipment to a repository. These are situated beside the process cells and facing into the canyon near the "output" end of the building. Two independent sealed storage cask loadout/retrieval areas are located at the extreme output end of the canyon cells from which sealed storage casks are loaded for emplacement in the storage facility. The area reserved for canister overpacking is also located in the canyon. Brief descriptions of operations performed in each of the principal operations areas are presented in the subsequent subsections.

B.2.1 Fuel Receiving and Handling

Four independent transport cask unloading areas are located under each of the main process cells, as illustrated in Figure B.3. The R&H cells connect to the rail/truck receiving areas on either side of the R&H Building. Spent fuel casks arriving at the facility are inspected, lifted from the transport vehicle and mounted vertically on a cask transport cart. This cart is then moved into the cask handling and decontamination room where gas samples are taken, the outer cask lid removed, and other preparation tasks completed. The cask is then moved into the cask unloading room, the cask is mated to the operating cell fuel input port, a special "skirt" is lowered over the cask to provide contamination control for fuel unloading operations, and the shield door is closed and sealed.

The cell port cover and cask inner lid are then removed. Fuel assemblies are removed from the cask one at a time, inspected and transferred either to the disassembly table or to the in-cell lag storage pit using a crane in the cell.

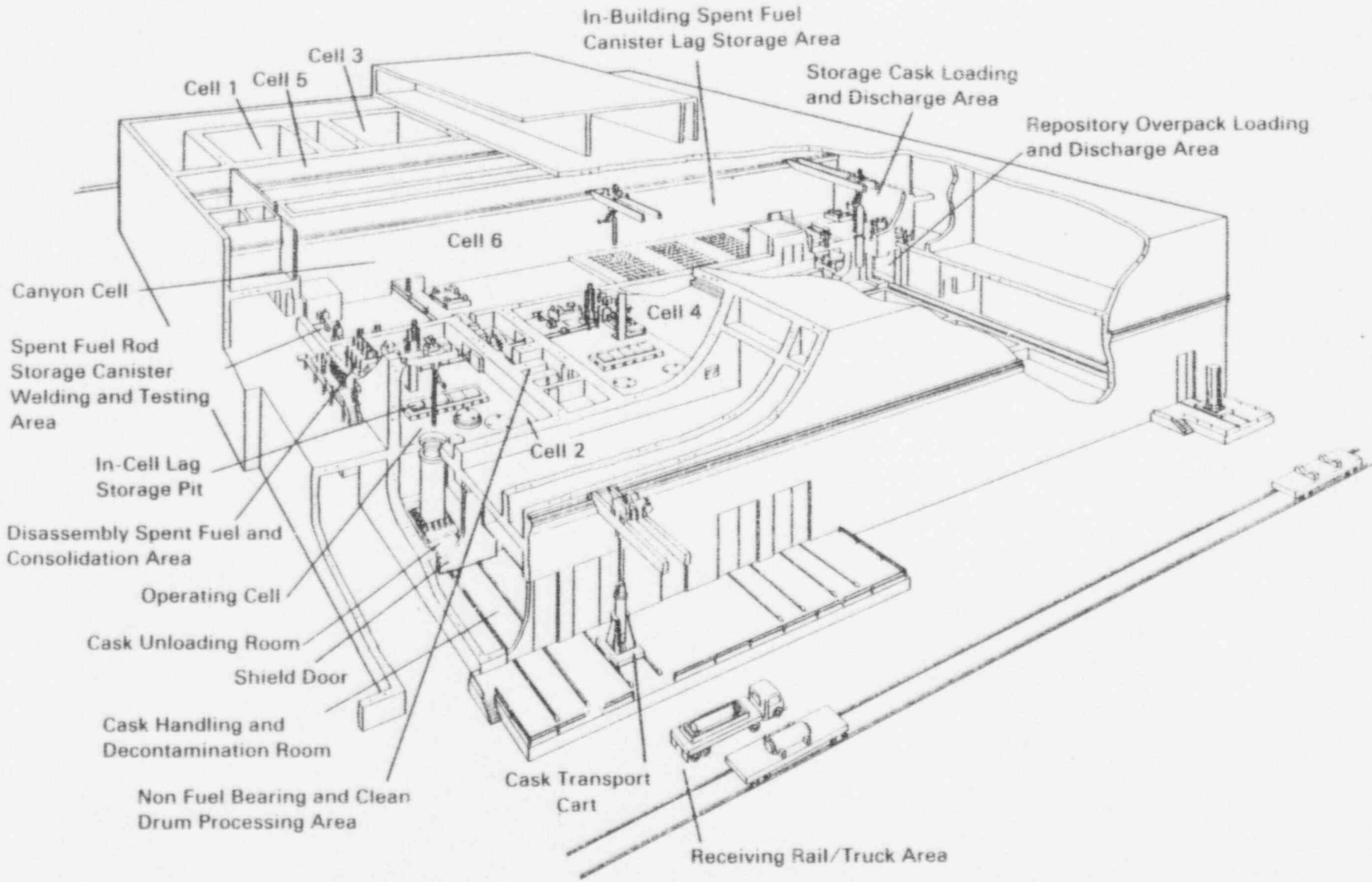


FIGURE B.3. Illustration of the Transport Cask Receiving, Handling and Unloading Facilities

After unloading is completed, the inner cask lid is replaced and sealed, and the port cover is replaced. The unloading port skirt is then withdrawn and the cask disengaged from the cask unloading port. The unloading room door is then opened and the cask is transferred to the cask handling and decontamination room where the cask surfaces are checked and decontaminated if needed and the outer lid is replaced. The cask is then moved to the receiving area where it is lifted off the cart, placed on a transport vehicle and released for dispatch to a reactor for another load. Once the cask is transferred out of the cask unloading room, the room is inspected and decontaminated if needed.

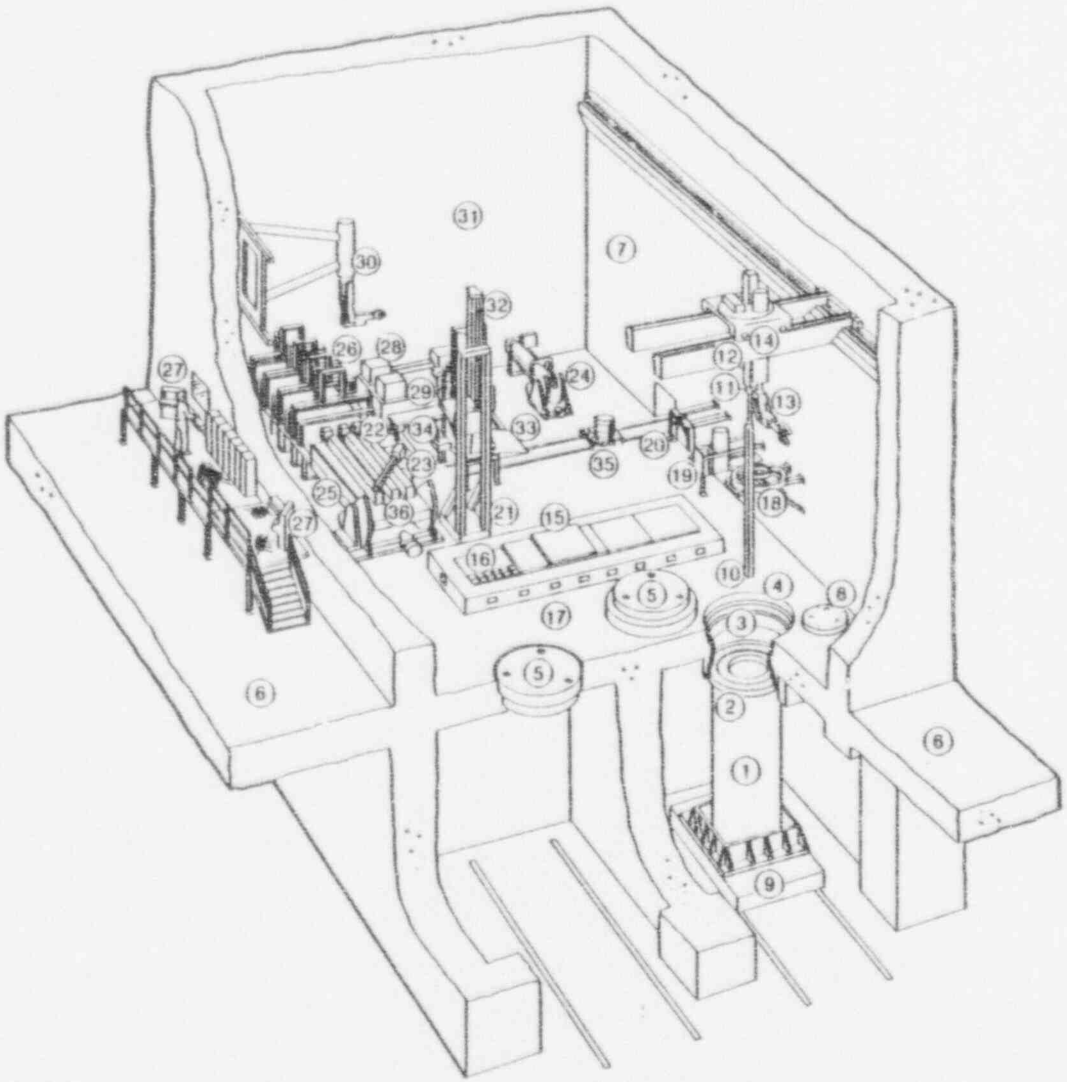
B.2.2 Main Process Cells

The principal operations performed in the four heavily shielded process cells are the disassembly of fuel, bundling and insertion of the rods into a canister and compaction and packaging of the residual fuel hardware. All of these operations are performed remotely. The disassembly equipment is illustrated in Figure B.4. Although each cell can handle either PWR or BWR fuel, they would normally be set up such that two cells would handle PWR fuel and two cells BWR fuel.

Fuel assemblies removed from a cask or from in-cell lag storage are first placed in the fuel assembly upender/disassembly clamping fixture. The fixture will hold either 3 PWR or 7 BWR assemblies for simultaneous processing. The upper fuel rod tie plate/nozzle assemblies are then removed with the upender fixture in the vertical orientation using a computer-controlled laser cutter. The upender fixture is then rotated to the horizontal orientation and the lower fuel rod tie plate/nozzle fixtures are removed using the laser cutter.

The fuel rods are then removed by a mechanical pulling operation in which mechanical grippers or collets individually engage the ends of all rods in either the 3 PWR or the 7 BWR assemblies in the fixture. A system of vertical and horizontal combs is inserted between the rods to support them during the pulling operation. Each rod gripper is designed to release if pulling forces exceed preset limits, thus preventing damage to stuck rods. Special equipment and procedures will be provided to remove and handle stuck or damaged rods.

When the pull is completed, the horizontal combs are removed allowing the loose rods from all of the disassembled fuel assemblies to drop a short distance vertically downward into a semicircular sling-and-die rod reconfiguration system. This device reconfigures and holds the rods in a cylindrical close-packed bundle for insertion into the canister. The cover on the process cell fuel outlet port is then removed. A "pusher" moves the compacted bundle of rods through the process cell outlet port into an empty canister that is mated



1. Shipping Casks
2. Cask Adapter for Contamination Barrier
3. Contamination Barrier
4. Entry Port
5. Entry Port Shield Plugs
6. Operating Gallery
7. Shielded Process Cell #2
8. Shipping Cask Cover
9. Cask Cart
10. Spent Fuel Element
11. Spent Fuel Grapple
12. Power Mast
13. Manipulator
14. 20 Ton Hot Cell Crane
15. Lag Storage Covers
16. Lag Storage
17. Lag Storage Cooling Ducts
18. Port Grapple
19. Fuel Assembly and Pintle Grapples
20. Module Lifting Yokes
21. Laser Cutting System
22. Laser Cutting Head
23. Robotic (Auxiliary)
24. Intact Fuel Assembly Upender
25. Fuel Disassembly Station
26. Fuel Rod Consolidation Station
27. Process System Control Console
28. Maintenance Hatch Jacking Mechanism
29. Maintenance Hatch
30. Wall Mounted Manipulator
31. Shielded Process Cell Contamination Barrier
32. Secondary Waste Shredding System
33. Drum Lidding Station
34. Grid Infeed Chute
35. Drum/Filter Cart
36. Fuel Disassembly Module

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FIGURE B.4. Illustration of the Fuel Disassembly Equipment and Operation to the port and held in a fixture in the central canyon area. After closure of the cell port cover, the canister is removed and transferred to the canister weld station for final closure.

The hardware remaining after fuel disassembly is reduced in volume and packaged in drums in the process cell, as illustrated in Figure B.5. The spacer grids, instrument tubes and other relatively "light" hardware are placed into a shredder that reduces them to smaller pieces and feeds them vertically downward into a drum. The massive end fittings are placed in the drums intact. The drums are then sealed and transferred into the drum decontamination cell for further processing, loadout or storage.

B.2.3 Canister Weld Stations

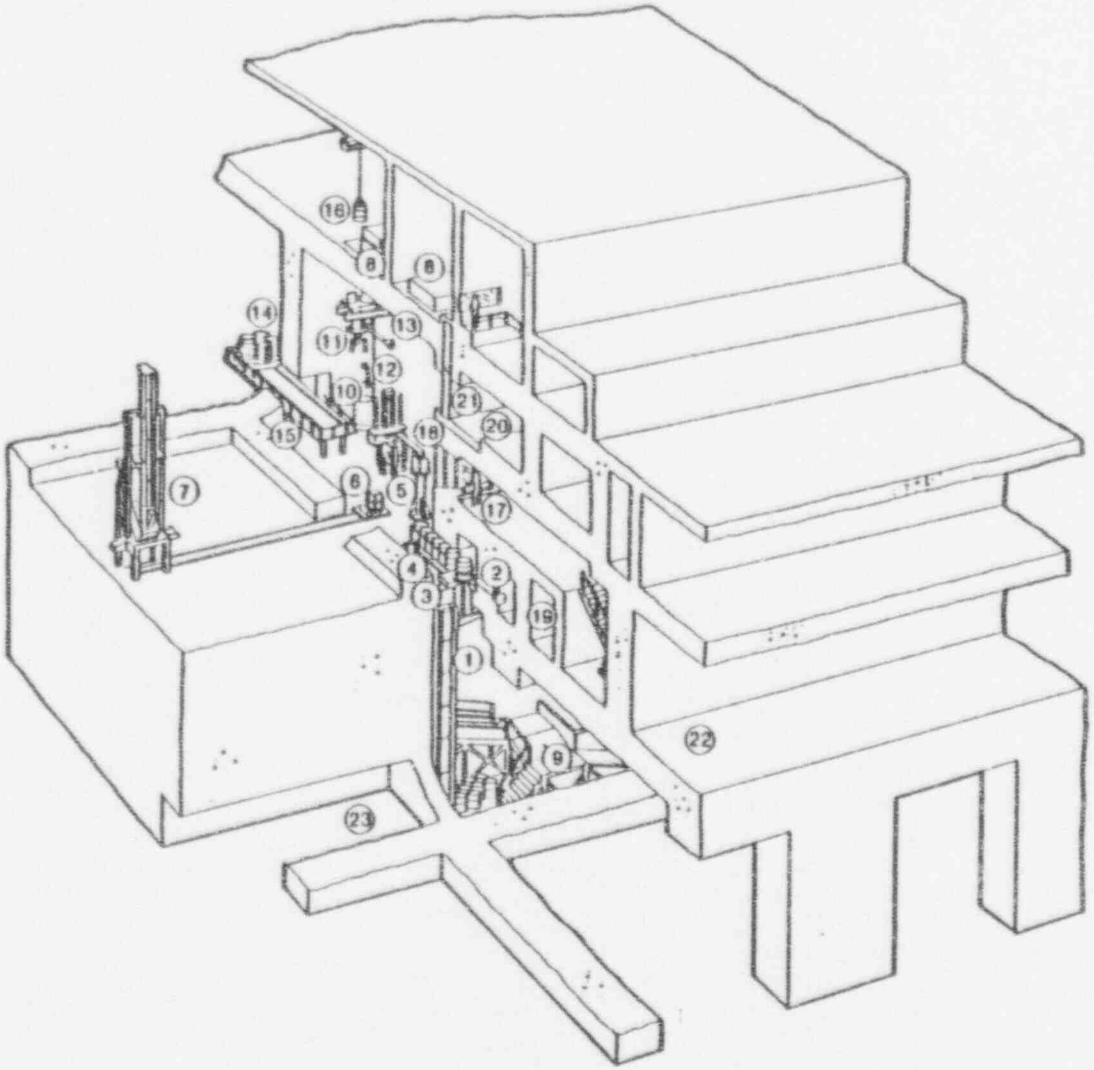
The filled canisters received from the process cells are seal-welded, decontaminated and inspected at the welding stations. Each weld station normally serves the two nearest process cells; however, either station can serve any of the four cells if necessary.

In the canister closure system, illustrated in Figure B.6, loaded canisters are shuttled from the process cell to the weld station on a remotely controlled transfer cart. The canister is inserted into a weld station chamber and the chamber is closed for canister welding operations. The air in the chamber is purged and replaced with an inert gas. The canister lid is installed and seal-welded using a resistance-upset welding device. The welder generator, controls and associated hardware are housed in a shielded room behind the weld station where they are routinely accessible for operation and maintenance. Only the canister clamps and electrodes are located in the weld chamber.

After welding is [illegible]pleted, the canister is decontaminated and leak-tested while still in the weld [illegible]mber. The chamber is then opened, the canister withdrawn into the canyon, checked for contamination, and examined with an acoustic NDT system to verify weld integrity. When certified as sealed and free of contamination, the canister is transferred to the vault for short-term storage, to the sealed storage cask loadout cell for emplacement in long-term storage, or to the transport cask loadout area for shipment to the repository.

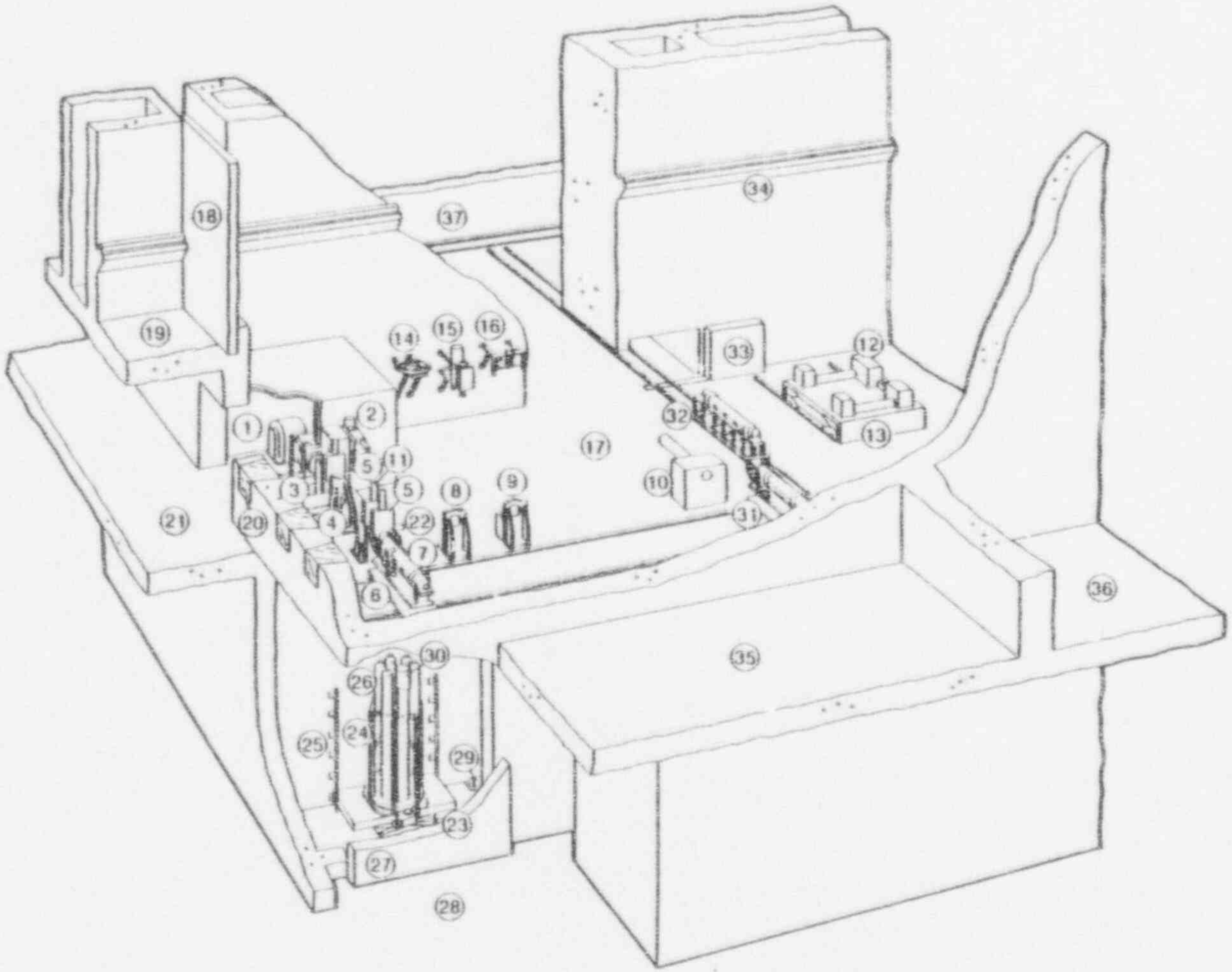
B.2.4 Lag Storage Vault

Air-cooled lag storage vaults for temporary storage of consolidated fuel canisters occupy the bulk of the central operating canyon cells. There are eight canister compartments in the vault, each designed to hold 16 canisters.



1. Clean Drum Elevator
2. Drum Push Mechanism
3. Shield Valve
4. Drum Guidance System
5. Jib Crane w/Drum Grapple
6. Drum Transfer Cart
7. Secondary Waste Shredding System
8. Maintenance Hatch
9. Ramp
10. Drum Decontamination Station
11. Drum Grapple w/Decontam. Station Lid
12. Drum Swipe Arm
13. Overhead Crane w/Manipulator
14. Filled Drum Transfer Cart
15. Filled Drum Transfer Platform
16. HVAC Filter Drum
17. Secondary Waste Processing and Decon System Control Station
18. Observation Window
19. Airlock
20. Crane Maintenance Room
21. Crane Maintenance Shield Door
22. Operating Gallery
23. Clean Drum Storage

FIGURE B.5. Illustration of Fuel Hardware Shredding and Packaging Equipment



1. Welding Power Generator/Equipment Room
2. Canister Lid Supply System
3. Canister Welding Station
4. Canister Decon/Helium Leak Test Chamber
5. Chamber Isolation Valves
6. Canister Upender No. 1
7. Storage Canister
8. Ultrasonic Test Station
9. Canister Cutting Station
10. Fuel Rod Bundle Push Rod System
11. Forge Press Restraint
12. Maintenance Hatch Jacking Mechanism
13. Maintenance Hatch
14. Plug Grapple
15. Pintle Grapple
16. Equipment Lifting Yoke
17. Shielded Canyon Cell #6
18. Maintenance Area Shield Door
19. Crane Maintenance Room
20. Observation Window
21. Operating Gallery
22. Clean Canister and Lid Supply Port
23. Carousel Lift Mechanism
24. Carousel Canister Rack
25. Guide Rail Lift Mechanism
26. Clean Canisters
27. Shield Door
28. Access Corridor
29. Lift Mechanism Hydraulic Pump System
30. Canister Lid Supply Support Tube
31. Canister Upender No. 2
32. Canister Pass-Thru Cart
33. Canister Pass-Thru Shield Door
34. 35 Ton Crane Rails
35. Shielded Process Cell #2
36. Decon Cell
37. Shielded Canyon Cell #5

FIGURE B.6. Illustration of Canister Welding System

Cooling air from a central supply is individually ducted to each compartment and then recollected into a common exhaust. Air is circulated through the vaults by means of fans in the exhaust leg of the circuit. The air is filtered at the inlet to remove dust particulates and insects to keep the ducts clean and at the outlet to preclude the possible spread of contamination from a leaking or contaminated canister. To further protect against the possible spread of contamination, the pressure in the cooling system is maintained below atmospheric but above canyon pressure. In this way, any air leakages that occur will be inward and ultimately into the plant HVAC filters, thus assuring containment of any potential releases from the fuel.

Cooling of fuel canisters is provided by forced ventilation. Heat is removed from the compartments by continuous circulation of cooling air, with cool air entering at the bottom and warm air exiting from the top. Cooling air also passes around the outside of the compartments to keep the concrete wall temperature below specified limits.

Fuel canisters are loaded into and unloaded from the vault through ports in the floor of the canyon cell. Each port is fitted with a removable shield plug. In loading operations, the shield plug is first removed and set aside using the canyon overhead crane. A fuel canister is then obtained from a weld station, transported to the open port, lowered into the vault and the plug is replaced using the same overhead crane. The reverse procedure is used for removing canisters from the vault prior to sealed storage cask or transport cask loadout operations.

B.2.5 Sealed Storage Cask Loading Area

The facilities for loading sealed storage casks are on the extreme output end of the R&H building canyon cells. There is one loading area in each of the canyon cells and canisters from anywhere in the canyon cells can be loaded through either loading area. Loading may occur directly from the canister weld stations or from lag storage. In retrieval operations, canisters removed from sealed storage casks can go back to lag storage or to the transport cask loading areas for shipment to a repository.

In the sealed storage cask loading operation, the casks are first loaded onto a crawler/transporter and transported from the cask staging area into the R&H building. The loading area shield doors are opened to admit the crawler and closed during loading operations. The cask, prepared for loading, is positioned beneath the loading port, engaged to the loading port interface and the outer shield lowered around the top of the cask. The in-cell overhead crane is used to remove the loading port plug and the shield plug of the cask, which are set inside the cell during the loading. Canisters brought in from the weld stations or from lag storage using the crane are loaded one at a time into the sealed storage cask until it is full. The shield plug and loading port plug are replaced and the cask is disengaged from the loading port. The cask is then prepared for closure, with a metal lid installed, seal welded and inspected, and the cask inspected for contamination prior to transfer to the storage facility for emplacement. Retrieval follows essentially the reverse of the above operations.

B.2.6 Transport Cask Loading Area

Two independent transport cask loading areas are located beside the primary operation cells on either side of the canyon cells. Fuel canisters can be brought to either of these cells from the weld stations, from lag storage or from the sealed storage cask loadout areas using the canyon cell overhead crane systems. The procedure for loading transport casks are analogous to those identified above for loading sealed storage casks. However, the lids on the transport casks are mechanically sealed, not welded. When loaded, inspected and certified for release, the cask is removed from the loading cell, lifted off from the transfer cart, laid down horizontally and secured on a railcar for shipment to the repository.

B.3 STORAGE FACILITIES AND OPERATIONS

The MRS facility provides facilities for short-term "lag" storage and longer-term storage to accommodate surges in receipt, processing and/or loadout of spent fuel that may result from routine operating variability and from disruptions in various portions of the waste management system. Facilities in the R&H building for in-cell lag storage of intact fuel and the air-cooled lag storage vault for storage of canisters are described in Section B.2. Facilities provided for long-term storage in sealed storage casks are described here.

The sealed storage cask design developed for the MRS Program for storage of canisters of consolidated spent fuel is illustrated in Figure B.7. The design of sealed storage casks for storage of other materials are similar but with varying cavity dimensions.

The sealed storage cask is a cylindrical vessel with steel reinforced concrete walls, a concrete shield plug, a carbon steel cavity liner and a carbon steel lid. The outside diameters of all sealed storage cask designs are 12 ft except for the top 36 in., which is stepped to 12.7 ft to provide a circumferential lifting surface. The exterior height of a sealed storage cask is 22 ft.

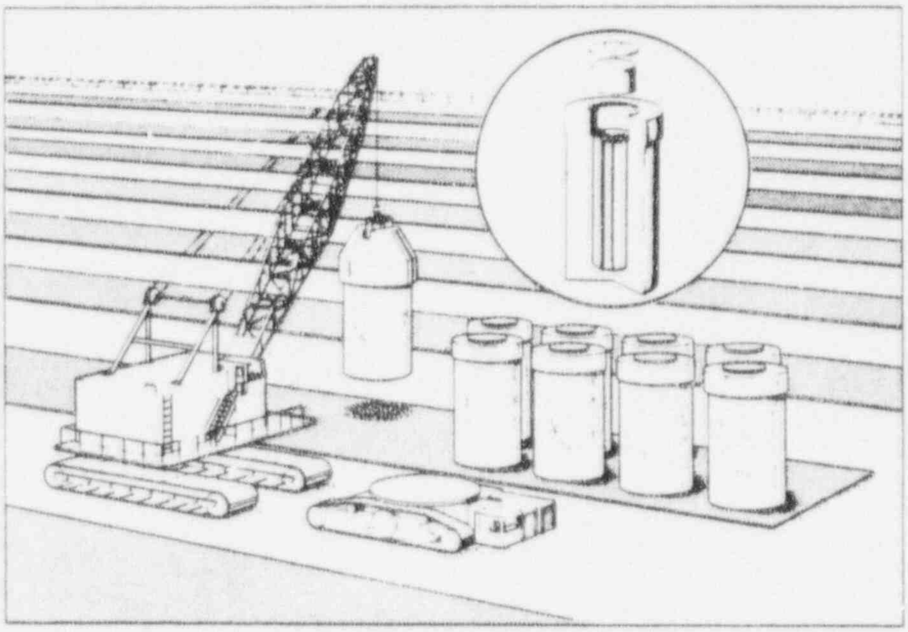


FIGURE B.7. Illustration of Storage Facility Operation and Emplacement for the Sealed Storage Cask

The cavity of the spent fuel cask is 68 in. ID by 194 in. long. The thickness of the walls and bottom of the carbon steel cavity liner are 2 in. and 1/2 in., respectively. The 2-in.-thick carbon steel lid is seal-welded to the top of the cavity liner after the sealed storage cask is filled. The principal function of the liner is to provide containment. However, the 2-in.-wall thickness was established to enhance shielding and heat transfer functions.

Canister support plates are located near the top and bottom of the cavity to laterally constrain the canisters. The canisters rest on the bottom of the cavity liner, but are not otherwise vertically constrained.

Both the inside and outside of the cavity are finned to enhance heat transfer. There are four short and four long 1.5-in.-thick aluminum fins in the cavity between the two support plates. These fins are bolted to the cavity wall. In addition, there are sixteen 3/4 in. by 3.5-in.-long carbon steel fins or ribs on the outside of the liner embedded in the concrete.

The walls and bottoms of sealed storage casks are made of carbon steel reinforced concrete. The rebar cage consists of vertical, radial and circumferential hoop members that are attached to each other and to the fins on the liner surface. The normal functions of the reinforced concrete are shielding and physical protection of the stored wastes. However, the quantity of radial rebar was established primarily to enhance heat transfer through the concrete walls. The carbon steel-encased shield plug fills the top of the cavity resting on a step in the inside diameter of the cavity liner.

Each sealed storage cask contains features to facilitate monitoring of its condition. Three thermowells attached to the liner wall are provided to monitor the temperature at the concrete/liner interface. These temperature measurements will permit assessment of whether the fuel and cask materials are maintained within acceptable limits. Gas sampling ports are also provided on each sealed storage cask to permit periodic sampling and analysis of the cavity gas content and pressure. The gas analyses will be used to monitor canister containment by the presence/absence of tag gases and/or radioactive gases or particulates. Pressure (vacuum) can be used to determine sealed storage cask containment integrity. Area monitors and air monitors in the storage field will be provided to continuously monitor any releases to the atmosphere or degradation of sealed storage cask shielding effectiveness.

The equipment and operations used in sealed storage cask loading/emplacement operations are briefly described in Section B.2 and illustrated in Figure B.7. In a typical loading operation, a sealed storage cask is loaded on the crawler in the cask staging area using a crane; the crawler transports the sealed storage cask to the R&H building where it is loaded with canisters and sealed, and then the crawler transports the loaded sealed storage cask to the storage area where it is lifted off the crawler and emplaced on a pad beside previously emplaced sealed storage casks. Retrieval operations follow essentially the reverse procedure.

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Pacific Northwest Laboratory (PNL). 1985. Functional Design Criteria for an Integral Monitored Retrievable Storage (MRS) Facility. PNL-5673, Richland, Washington.

Ralph M. Parsons Company (Parsons). 1985. Integral Monitored Retrievable Storage (MRS) Facility. Conceptual Design Report. Design Description, Vol. I, Book II. MRS-11, Ralph M. Parsons Company, Pasadena, California.

APPENDIX C

DESIGN VERIFICATION PLAN

APPENDIX C

DESIGN VERIFICATION PLAN

This appendix summarizes the tests and demonstrations needed to optimize the design and support the licensing of the proposed MRS facility. Section C.1 outlines the objectives of MRS design verification testing. In Section C.2, testing needs for each of the MRS functions are identified and discussed. Section C.3 describes several DOE waste management programs that potentially may interface with MRS development. A schedule for the planned MRS design verification tests is provided in Section C.4.

C.1 OBJECTIVES

The MRS system, if approved by Congress, will be designed, licensed and constructed by 1996 in accordance with the DOE's plans outlined in the June 1985 Mission Plan. Although current plans for MRS indicate that this date can be met, the schedule for design, licensing, construction, and preoperational testing of the MRS facility must be carefully planned and integrated to ensure operability and reliability of all components and systems.

The objectives of MRS design verification testing are to support licensing of the MRS facility and to optimize the design for cost and operability. The goal of verification testing is to identify and verify design improvements that will increase safety, reduce complexity, improve operability and efficiency, reduce costs of construction and operation, and demonstrate operability of the facility at the required throughput rates. Although no specific tests have been identified as being critical to the safe design of an MRS facility, verification testing will reduce the design conservatism that licensing considerations would otherwise require. In turn, this would reduce costs. Results of the planned tests will be reflected in final design, equipment procurement, and operational procedures. Verification of the procured systems will be provided during preoperational testing of the facility.

Two principal types of tests are planned for design verification: feature tests and systems demonstrations. Feature tests comprise those tests of individual components or processes before their incorporation into the final MRS facility design. Systems demonstrations are tests of major subsystems or complete systems of the MRS facility intended to demonstrate systems operability under the typical operating conditions.

If Congress approves of the MRS proposal, the DOE will develop detailed test plans and coordinate these plans with other interfacing testing and development activities being performed by the DOE or by private utilities. These DOE activities are the Commercial Spent Fuel Management Program (including the DOE/utility cooperative agreements), the Prototypical Consolidation Demonstration (PCD) Project, the Defense Waste Management Programs, and the Nuclear Waste Treatment Program.

C.2 TECHNOLOGY STATUS AND NEEDS ASSESSMENT

The discussions in the following subsections identify testing needs for each of the MRS functions, such as spent fuel handling, packaging, and storage. Specific areas are identified where experience or data are lacking and general descriptions are given of tests that will be performed to obtain the needed data.

C.2.1 Spent Fuel Receiving and Handling

The operations for receiving, handling, and packaging spent fuel that will take place at the MRS facility are similar to current industry practice, except for the expected size and numbers of casks and spent fuel assemblies to be handled. The scope of these MRS facility operations is illustrated in Figures B.2 through B.6, Appendix B.

Preliminary calculations of occupational radiation exposure indicate that the current MRS design meets the NRC regulatory limits. However, the design may not meet the DOE design objective (20% of the NRC limit) for occupational exposure. The analyses also indicate that the highest exposure arises from handling large numbers of shipping casks. The application of the ALARA (As Low as Reasonably Achievable) principle to the definitive design will probably result in automation of this task that has traditionally been a "hands-on" operation. An interface with the transportation program will be maintained so that the design of the fleet of shipping casks is compatible with the final design of the MRS handling systems. Design prudence dictates that, if found to be economically feasible, the automated or "robotic" systems for handling casks be tested to verify operability and reliability prior to their installation in the MRS facility.

Robotics could be beneficially employed at the MRS facility in removal of cask lids, gas sampling, and other preparation activities prior to unloading the casks. Potentially related testing is currently in progress in the DOE's defense waste program. Incorporation of MRS needs for specific feature testing into existing programs will be deferred until the MRS facility is approved by Congress.

Tests are needed to demonstrate optimum techniques for dealing with radioactive scale that coats the surfaces of the fuel assemblies. There is evidence from West Valley operations that the scale spalls during dry shipment of spent fuel, which may require cleaning of the interior of shipping casks prior to their return to service. Tests will be performed to establish the nature and extent of contamination during dry shipment of spent fuel so that processes and procedures can be developed to clean the casks' interior, if necessary, before their release from the MRS facility. This information is needed to reduce worker radiation dose at the MRS facility as well as at the utilities and to optimize the waste treatment systems.

C.2.2 Spent-Fuel Disassembly and Consolidation

The principal functions of the spent-fuel disassembly operation are: removal of the fuel assembly end-fittings and nozzles, extraction of the fuel rods from the remaining grids and support structure, reconfiguration of the loose rods, and insertion of the rods into a suitable canister. The MRS design that has been submitted with the proposal contains conceptual designs for equipment to perform these functions.

The PCD project at the Idaho National Engineering Laboratory (INEL) will develop prototypic spent-fuel disassembly and consolidation equipment that will be used at the authorized repository projects. Therefore, this program will also support the MRS Program. If Congress approves the MRS proposal, specific needs identified by the MRS conceptual design will be incorporated into the PCD project. The objective is to provide testing of disassembly/consolidation equipment and processes before development of the final designs of this equipment.

The PCD project will also provide data on the nature, frequency, and consequences of rod sticking and breakage for representative types of spent fuel. Data will also be obtained on properties, behavior, and quantities of radioactive scale that may be scraped off during disassembly and handling. In addition, data will be obtained on the possible quantities of zirconium fines generated during disassembly and on the related risk of fires. These data and experience will help optimize the design of radioactive waste collection and treatment systems as well as spent-fuel disassembly/consolidation equipment.

A full-scale demonstration of spent-fuel disassembly and consolidation is proposed that will consist of a prototype production line like that to be used at the MRS facility. This test will demonstrate the capability of achieving the reliability and production rate goals for a large sample of fuel and fuel types. These tests will be done cold (without use of radioactive materials). A decision on the nature and extent of hot tests that may be needed can be delayed until after the PCD project tests and cold tests are completed.

C.2.3 Spent-Fuel Packaging

The design of the canister to be used to store consolidated fuel at the MRS facility will be influenced by repository needs. One option is to package spent fuel into small triangular or rectangular canisters whose shape would allow them to be efficiently bundled into larger packages for disposal. Another option is to package the fuel into large round canisters of a size and type suitable for disposal at a specific repository. The MRS receiving and handling (R&H) building design can remain flexible to adapt to a wide range of canister sizes and types, but canister design reflects back directly to the design of the disassembly and consolidation equipment. Interface drawings for spent-fuel packages will be developed in concert with the repository program and baselined under change control, as shown in the MRS Program Master Schedule (Figure 3.10, Chapter 3).

Important aspects of consolidated fuel packaging are canister welding, weld inspection and leak detection, canister decontamination processes, and integrity under impact loads. Specific processes will be selected for cold feature testing in the PCD project. The selection will be governed by the needs of the MRS conceptual design if construction of the facility is approved by Congress.

The technique selected for the MRS conceptual design for canister welding is upset resistance welding. Although this method has been used in industrial applications and for high-level defense waste canisters, it has not been used for the large-size welds needed for MRS canisters. Demonstration of the quality of weld, process rate, and reliability is needed to support the MRS design. Other welding processes may be identified in definitive design and tested in the PCD project. The welding concept finally selected will also be verified in the disassembly and consolidation systems demonstration described above.

Processes for inspection and leak testing of canister welds will be developed and tested in conjunction with the welder design in the PCD project. These tests will be done as cold feature tests. Again, however, the optimized processes for MRS will be included in the prototypic systems demonstrations.

Freon has been selected as the most promising decontaminating agent for the MRS facility. Radiolytic and thermal decomposition of Freon may result in corrosion that could compromise the long-term integrity of the canister. Therefore, an experimental study will be conducted of Freon decomposition at the temperature and radiation levels that would be experienced in MRS canister decontamination operations. A hot prototypic demonstration will be performed to establish the efficiency and reliability of the canister decontamination system. These tests will also provide data on the necessary size of the waste treatment equipment.

Tests will also be performed to determine the integrity of canisters and welds under impact-loading conditions. Such conditions could occur at the MRS facility as a result of canisters being dropped or otherwise impacted during handling.

C.2.4 Waste Volume Reduction

The principal concerns in the area of volume reduction are the cost and safety of the processes that will be finally selected and the waste acceptance requirements at the repository. Also important are the related problems of collection and control of radioactive wastes during volume reduction and packaging.

The conceptual MRS design specifies a mechanical shredder for volume reduction of the fuel assembly hardware. The shredder is designed to reduce the grids and other hardware, less the end-fittings, into small pieces that can be efficiently packaged for disposal. Shredders of the type needed for MRS have been developed and demonstrated for volume reduction of low-level waste. A potential safety concern to be addressed by further testing is the possible production of zirconium particles sufficiently small to be ignited and thereby cause a zirconium fire. Another concern is the control of radioactive scale that will be dispersed in this mechanical operation. Testing will examine the effectiveness and cost of shrouds and vacuum or airflow systems in collecting the scale material, and will determine filtration needs and filter change frequencies. These data are needed to estimate dose rate buildup within the hot cells and its effect on worker dose. However, other means for volume reduction of fuel assembly hardware may prove to be preferred. In particular, a melting process being developed by DOE in their Nuclear Waste Treatment Program may be superior to shredding. Further design studies will examine all options for cost, safety, and reliability. Tests on appropriate processes will be done as cold and hot feature tests in the PCD project. Final tests of the MRS-specific design will be done in the MRS prototype systems demonstrations.

Volume reduction of combustible waste streams may be cost effective for the MRS facility. Organic materials in the ventilation filters could be oxidized to provide compact packages for the repository. Removal of organics may turn out to be necessary if the final repository acceptance criteria excludes organics. A decision on design and testing of this equipment will be made in consultation with the repository program within one year after MRS approval.

C.2.5 Sealed Storage Casks

At the MRS facility, sealed storage casks are recommended for the long-term storage of spent fuel canisters and drums of compacted fuel hardware.

Tests are needed to optimize and demonstrate the shielding, structural and thermal performance of these casks. The sealed storage cask concept is illustrated in Figure C.1.

The principal performance requirements for the sealed storage casks are that they safely contain and protect the stored materials while dissipating the decay heat and attenuating the direct radiation. The casks must be able to perform these functions during an extended period of storage and during design basis earthquakes and tornadoes. Both short- and long-term performance tests of sealed storage casks are needed to verify that design objectives have been

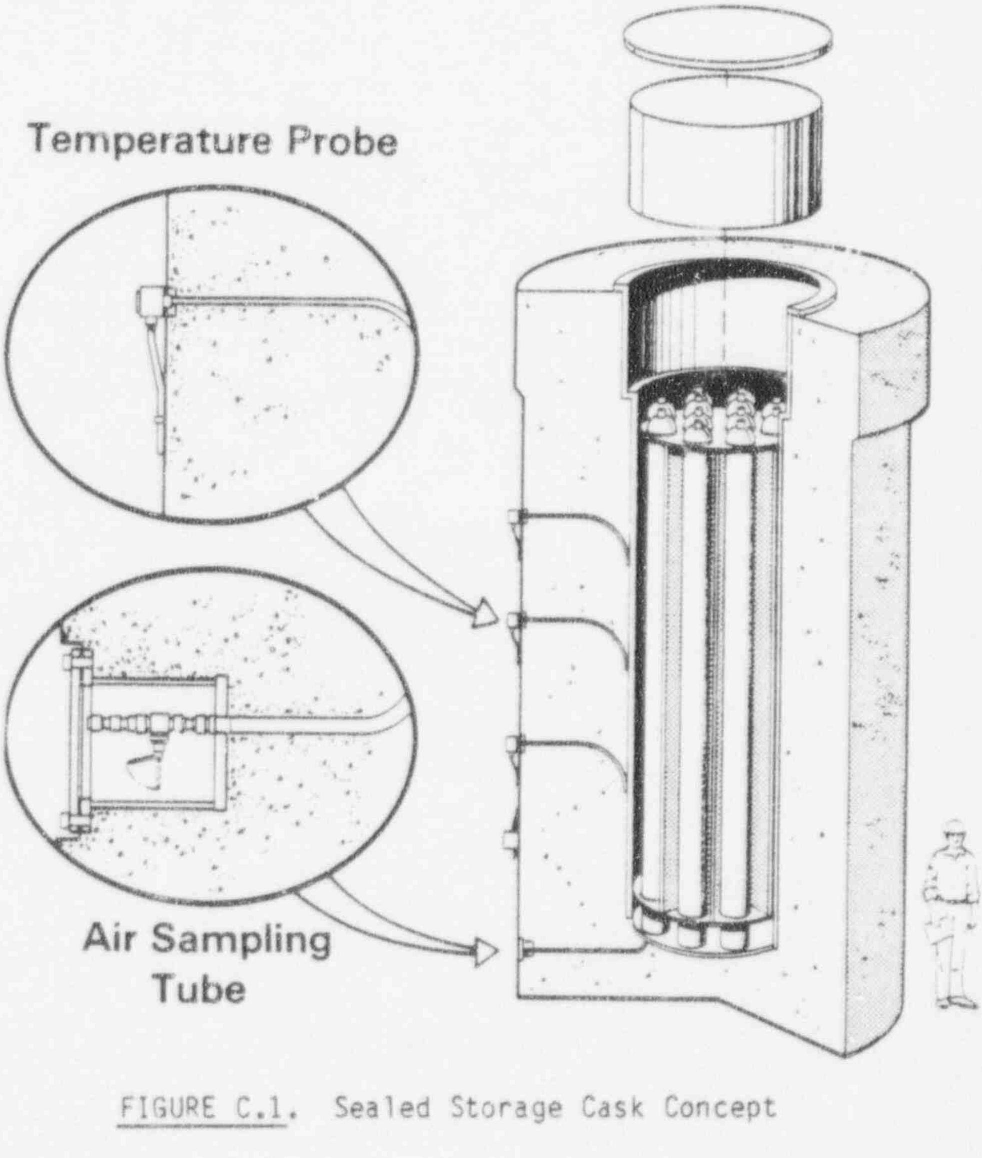

FIGURE C.1. Sealed Storage Cask Concept

achieved and that any degradation over time will not impair their safety function. This information is needed to support the license application and to optimize cost and occupational exposure.

In the short-term tests, sealed storage casks will be filled (at least in part) with instrumented canisters of spent fuel. Measurements will include surface radiation dose and temperature distributions in the fuel canisters and casks. After completing the short-term performance measurements, observations will be continued over the long term to detect degradation of the casks. Samples in the form of plugs will be tested to establish the degradation within the cask body. After a number of years, supplemental heat will be added to determine the limits of satisfactory operation. These performance tests will provide evidence of problems, if any, before MRS operations begin. Information gained from these measurements will be incorporated into the designs.

Structural tests of prototype sealed storage casks will be performed to demonstrate their capability to ensure containment and retrievability under a number of hypothetical accidents. These tests will include drops from heights consistent with cask handling operations and impacts from tornado-generated missiles. The results of the tests will support licensing and design optimization.

C.2.6 Concrete Selection

Concrete is used in the R&H building and in the sealed storage casks. These applications require separate, and different, considerations. The seismic Category I structure surrounding the lag storage vault is designed to remain below the limit of 150°F specified in ANSI/ACI 349-76, the industry standard for concrete. In the event of complete loss of power to the ventilation fans, the wall temperatures would rise slowly, but are not predicted to reach temperatures which, over the short term, would damage their strength. Power outages do not normally last more than a few minutes, or hours at most. However, portable generators could be procured if the outage continued for a few days. The walls of the in-process lag storage pits, though not a containment barrier, will reach temperatures of about 200°F when they are filled with spent fuel assemblies. The pits are cooled by natural convection. Although the walls appear to be structurally adequate, the specification of a high-temperature concrete may afford a cost saving.

The second concrete component, the sealed storage cask, is designed to operate at temperatures far above the normal structural limit of 150°F over much of its volume. However, the function of the concrete is to provide shielding, while the steel rebar and steel liner carry the normal structural and hypothetical impact loads from tornado-generated missiles. Although confirmation of this design has been discussed in the prior section on long-term testing, there are potential economic advantages in selecting high-density, high-thermal conductivity, high-temperature concrete. The design optimization studies to be conducted as a first part of definitive design should have the benefit of a series of short-term accelerated temperature testing in the laboratory to justify the final selection of additives and mix. These tests will be conducted as soon as possible after congressional approval of the MRS proposal.

C.3 RELATED DEVELOPMENT AND TESTING PROGRAMS

The DOE is currently supporting development and testing activities in a number of related waste management programs that interface with MRS development. If the MRS proposal is approved by Congress, MRS design verification test plans will be coordinated with these programs. Brief descriptions of the major related programs and potential areas of commonality with the MRS Program follow.

Transportation Systems Development Program: Spent fuel and waste transport casks developed in the DOE's Transportation Systems Development Program will need to interface with the MRS cask receiving and handling facilities. Cask designs evolving from this program will be issued under change control and used in the final MRS design and design verification tests.

Geologic Repository Programs: The design of spent fuel disposal packages, including the canister shape and size, may be dependent upon the chosen geologic repository media. Thus, MRS design and design verification planning will encompass the needs of all three repository programs until a repository site has been selected for the first repository. The canister type and size, overpack design, and the facility chosen for overpack installation could influence MRS design and design verification needs. Therefore, interface design requirements will be jointly baselined with the repository programs.

Commercial Spent Fuel Management (CSFM) Program: The DOE's CSFM Program is pursuing a number of activities to assist utilities with storage of spent fuel until the MRS facility or repositories become available. These activities include fuel integrity tests to establish spent fuel degradation mechanisms and consequences for dry storage, performance tests of dry storage casks, computer code qualification, fuel consolidation demonstrations, and other potentially applicable studies. The CSFM Program is also supporting a number of DOE/utility cooperative agreements covering a wide range of waste management activities which could be applicable, at least in part, to the MRS design verification program. International agreements coordinated by the CSFM Program could provide useful input to the MRS Program. These activities will be integrated with the MRS design to minimize duplication of effort.

DOE-PRDA Studies: The DOE's Program Research and Development Announcements (PRDA) are currently supporting a number of studies for improving the waste management system. These range from unique, efficient designs of canisters, consolidation systems, casks and other equipment, to alternatives encompassing the entire waste management system. The results of these studies and any follow-up work that may result will be coordinated with MRS activities.

Prototypical Consolidation Demonstration Project: The PCD project was recently initiated by the DOE to develop and test dry spent fuel disassembly, consolidation, packaging, and hardware compaction equipment for use at geologic repositories. The project is managed by DOE-Idaho at the Idaho National Engineering Laboratory. The objective of the project is to test, at or near prototypic scale, a fuel consolidation system. If Congress approves the MRS proposal, the MRS Program will participate by incorporating its testing needs into the PCD project

C.4 SCHEDULE

The schedule for MRS design verification has been integrated with the design, licensing, and procurement activities. The relationship of the MRS test program to other DOE R&D activities depends upon the timing of congressional approval of MRS. The schedule for MRS design verification testing is shown in Figure C.2.

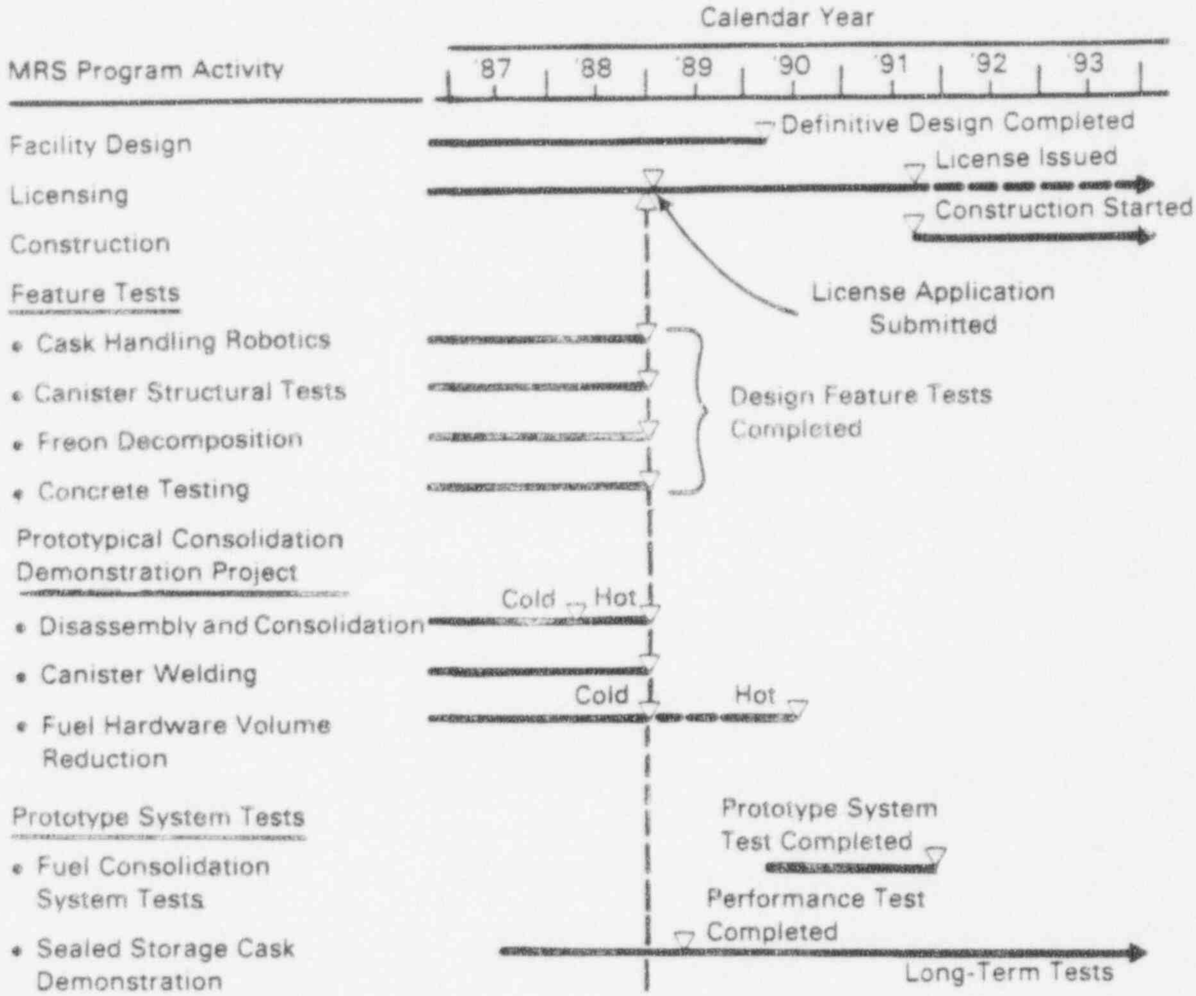

FIGURE C.2. Schedule for MRS Design Verification Testing

APPENDIX D

LICENSING PLAN

APPENDIX D

LICENSING PLAN

The NWPA requires that the MRS facility, if approved by Congress, be licensed by the NRC. The DOE, as the applicant for a license, will be responsible for the design, licensing, construction, operation, and quality assurance of the facility.

The regulations contained in Title 10, Part 72 of the Code of Federal Regulations will be used by the NRC to license the MRS facility. These regulations contain requirements for all project activities from conceptual design to the end of decommissioning. Although the license issued by the NRC will authorize the receipt, possession, and transfer of spent fuel and high-level waste, the requirements of Part 72 relate mainly to the features of the facility and site that afford protection to the public, the working staff, and the environment during operation. The license application provides an assessment of the safety of all structures, systems, and components that are important to safety; it cannot be prepared and submitted to the NRC until after design of these features is complete. The issuance of a license will therefore depend upon actions taken prior to submittal of the application.

This plan summarizes the efforts of the DOE to comply with the requirements of Part 72, mainly by reference to published documents, and the activities planned to obtain a license and to adhere to the conditions of the license. The plans for postlicensing activities are only summarized, since they will be described in detail in several reports that are enclosures to a license application.

The major documents that describe recent accomplishments related to licensing are the MRS Functional Design Criteria (PNL 1985); the MRS Conceptual Basis for Design (R. M. Parsons Company 1985a); the MRS Conceptual Design Report in seven volumes (R. M. Parsons Company 1985b), but especially Volume II, "Regulatory Assessment Document" and Volume VII, Geotechnical Description of the Clinch River Site; the MRS Environmental Assessment (Volume 2 of this submission to Congress); and the Design Verification Plan, Appendix C of this document. All work performed to date has been done in accordance with the quality assurance requirements of the DOE for their nuclear facilities. These requirements are derived from 10 CFR 50 - Appendix B and were incorporated, as applicable, into the programs of each DOE contractor.

It is the nature of the design process to iterate between design and evaluation of the design. First, a conceptual design is performed of structures, equipment, and processes that will accomplish the functions desired, and a preliminary evaluation is made of its safety, cost, and operability. The MRS Program is at this stage of the design process. Then, succeeding phases of design entail 1) the optimization of the design relative to the above evaluation factors and 2) the preparation of detailed information for construction and equipment to be procured. Thus, it is inherent in the design process that a preliminary evaluation of the performance of the MRS facility relative to safety, cost, and operability has been determined during the conceptual design, with later refinements to come as the design matures. For the MRS Program the design yet remaining is called definitive design and has two major milestones. The early design activities will concentrate on optimization of the conceptual design and the final design of structures, systems, and components that are important to safety. This design phase will produce complete information for the license application. The remainder of design will complete the drawings and specifications for construction and procurement.

Section D.1 of this appendix summarizes the content of a license application that must demonstrate how the Part 72 requirements have been or will be satisfied. In addition, the corresponding acceptance criteria of Part 72 that the NRC uses in their evaluation of the application are noted. A summary comparison of a preliminary assessment of the MRS performance with the NRC requirements is also made. Section D.2 describes the activities the DOE plans to undertake to provide a license application that will result in a favorable licensing decision by the NRC. In Section D.3 the postlicensing activities that will be needed to adhere to the requirements of Part 72, including probable conditions of the license, are summarized.

This plan cites data for the Clinch River Breeder Reactor (CRBR) site when specificity is required. The conclusions for the other two sites are not significantly different.

D.1 REQUIREMENTS FOR A LICENSE AND MRS COMPLIANCE

The license application (LA) contains a description of what the applicant proposes that he be licensed to do, and how and where the activities will be performed; it also contains an assessment of the compliance of the proposed operations to the requirements of Part 72.

The form and content of an LA for the MRS facility is shown in Figure D.1, and is described in paragraphs 72.14 through 72.20 in Subpart B of Part 72 (boxes 1-9 of the figure). The LA provides general information (box 1) about

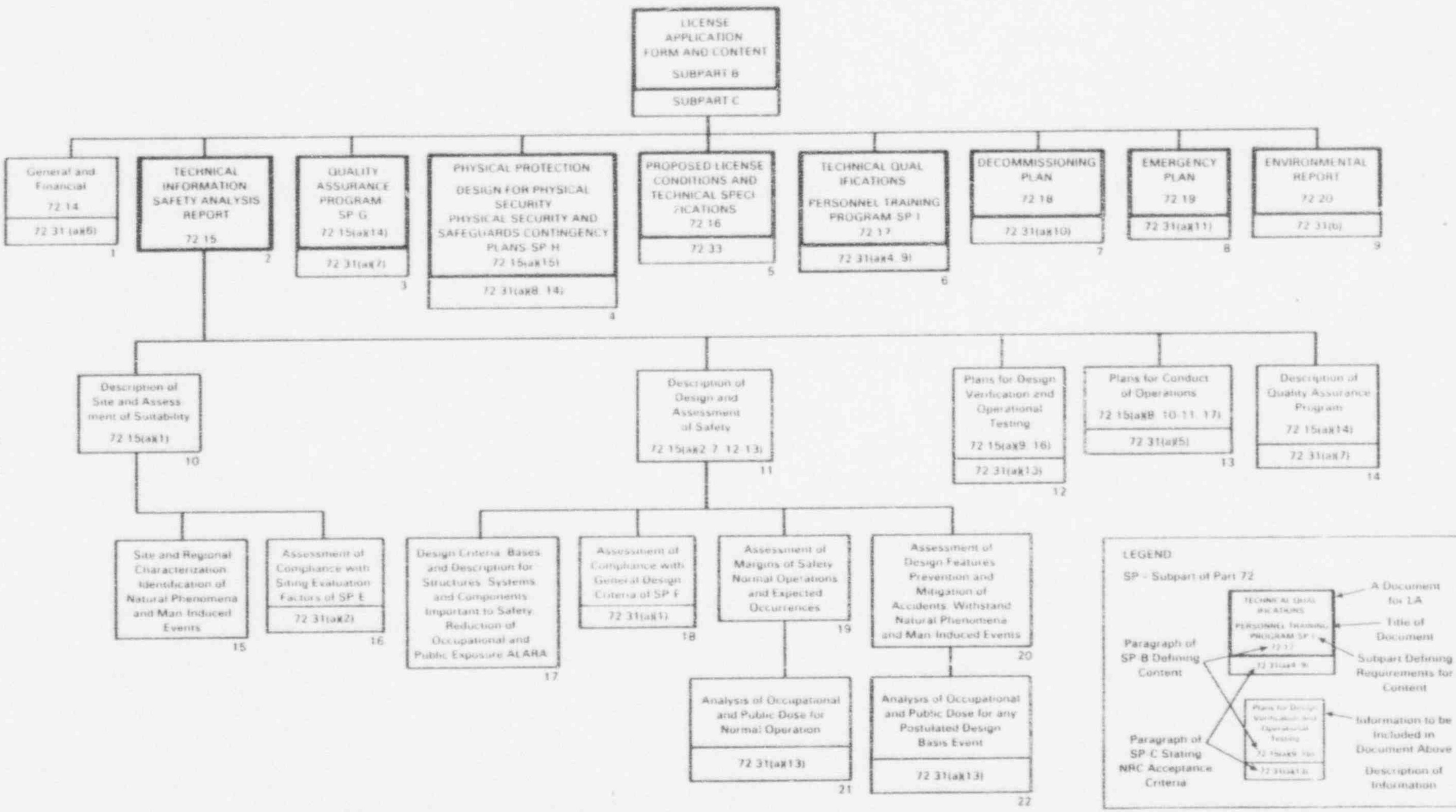

FIGURE D.1. Content and Requirements for a Part 72 License Application the applicant, including his financial capability to construct, operate and decommission the proposed facility; and also summarizes the information contained in other documents (boxes 2-9). These documents are identified by a dark outline in Figure D.1, and are submitted as enclosures to the application. The Safety Analysis Report (SAR) contains the information shown on the third and lower levels. The technical requirements to be fulfilled by the site, facility design, or by the applicant are contained in Subparts (SP) E through I, identified in appropriate boxes in Figure D.1. In an extension below each box (except those containing descriptive information), reference is made to the paragraph in Subpart C, which states the acceptance criteria the NRC will use in making their findings on the acceptability of the related information.

Only two reports, the SAR and the proposed License Conditions and Technical Specifications (boxes 2 and 5), are dependent in large part upon the detailed design of the MRS facility. The site and design information (boxes 10-11) in the SAR are subdivided into site characterization (box 15) and assessment of site suitability (box 16) and into facility description (boxes 17-18) and assessment of facility safety (boxes 19-20). The safety assessment is composed of two parts: the safety under normal operations as measured by the anticipated radiation doses to occupational workers and the public, and the safety under accident conditions or abnormally severe natural events as measured by the calculated doses to the public.

D.1.1 NRC Findings

The regulations require the NRC to make three major findings in their evaluation of acceptability of the LA. These findings relate to public health and safety, and protection of the environment. These findings are described below and are the focus of the discussions in the ensuing sections.

First, on the basis of their review of the application, and especially the analysis of occupational and public radiation doses presented in the SAR (boxes 21-22), the NRC must find that there is reasonable assurance that the operation will protect the health and safety of the public and will be conducted in compliance with Part 72, subject to appropriate conditions on the operations.

Second, on the basis of their review of the application, and especially the Environmental Report (ER) (box 9), the NRC must weigh the benefits and environmental costs of the proposed facility design and construction against the benefits and costs of available alternatives. In accordance with provisions of the NWPA, the NRC may not consider the need for the facility or any alternative to the design criteria stipulated in the NWPA. After these considerations, the NRC must find, pursuant to NEPA, that a license should be issued, subject to appropriate conditions that will protect the environment.

Third, on the basis of the proposed plans for Physical Protection (box 4), the NRC must find that the operation will not be inimical to the common defense and security.

D.1.1.1 Environmental Report

As stated in Sections 3.1 and 3.3 of the MRS Program Plan, the DOE will prepare an ER to be submitted to the NRC with the LA. The environmental information required by 10 CFR Part 51 will be included, as required by paragraph 72.20.

The plans to obtain site and regional data for the ER and facility design will be developed immediately after Congress approves the MRS proposal. These must be obtained before starting definitive design. The dates for obtaining these data are given in the MRS Program Master Schedule (Figure 3.10, Chapter 3).

The 10 CFR regulations require the NRC to evaluate the impact of issuance of a license on environmental values after review of the LA. The DOE will support their efforts by providing additional information as necessary during their review or the environmental hearings.

D.1.1.2 Safety Analysis Report

The SAR will provide the bulk of the information related to the safety of the MRS site, facility, and proposed operations. It also provides a description of the Quality Assurance Program (box 14) that has been used to obtain this information.

The assessment of the suitability of the site (box 16) is made with respect to the requirements presented in Subpart E. NRC's acceptance criterion is stated in 72.31(a)(2), which refers to the requirements of Subpart E. The suitability of the site is based upon the magnitude and certainty of the projected radiological dose to real individuals living outside the controlled area during normal operation and the potential dose to an individual at the boundary of the controlled area after the occurrence of any design basis accident (the maximum hypothetical accident) (boxes 21-22). The maximum acceptable radiological doses given in Subpart E are shown in Table D.1. However, the NRC acceptance criteria require additional assessments by the applicant, especially the possible further reduction of doses to the public during normal operation to values that are as low as reasonably achievable (ALARA).

The assessment of the safety of the facility design is made with respect to (box 18) the requirements of Subpart F, General Design Criteria, which apply to the structures, systems, and components important to safety (SIS), and with

TABLE D.1. Radiological Dose Limits of 10 CFR 72

General Public	Normal Operation (rem, annual)	Design Basis Accident (rem, each)
Real Individual		
Whole Body	0.025	
Thyroid	0.075	
Other Organs	0.025	
Person at Edge of Controlled Area		
Whole Body		5.0
Other Organs		5.0
Occupational Workers		
Operating Personnel[(a)]		
Whole Body	5.0	
Other Organs	5.0	

(a) Referenced from 10 CFR 20.

respect to (boxes 21-22) the dose limits of Table D.1. The NRC safety criteria, stated succinctly in 72.31(13), are that there is reasonable assurance that the activities to be licensed will not endanger the health and safety of the public and will be conducted in compliance with the applicable regulations of Part 72. In addition to compliance with the above requirements, the regulations require consideration of various design features to meet the objective of reducing the dose to occupational workers during normal operation to values that are ALARA.

D.1.2 Preliminary Assessment of MRS Compliance

A SAR is not required at this stage of the MRS Program. However, a preliminary assessment of site suitability and facility safety has been performed to assure a safe facility is being designed and to identify SIS. The final design of SIS (box 17) must meet the requirements of Subpart F of Part 72 (box 18).

An overall summary of the site and facility assessments performed to date is presented here with reference made to documents that provide the detailed results.

D.1.2.1 Site Assessment

Consideration of environmental protection is the responsibility, under NEPA, of both the DOE and the NRC. The DOE has issued an Environmental Assessment (Volume 2 of this submission to Congress) of the six site-design combinations as directed by the NWPA. The conclusion is that the construction, operation, and decommissioning of an MRS facility for any of the combinations would not significantly affect the quality of the environment. The DOE expects that the NRC would be able to make a similar finding for the selected site and final design after review of the LA.

Similar conclusions have been reached in previously published studies on storage of spent fuel and high-level waste. Among them are the DOE's Final Environmental Impact Statement on Management of Commercially Generated Radioactive Waste (DOE 1980) and two NRC studies: Final Generic Environmental Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel (NRC 1979) and Environmental Assessment for 10 CFR Part 72 (NRC 1984). The conclusions of both NRC studies are conditioned, however, upon compliance of any proposed operations with the requirements of Part 72, particularly with respect to the safe handling of spent fuel and the engineered confinement features. The last cited study was prepared to specifically assess the impacts of licensing the long-term, dry storage of consolidated or unconsolidated spent fuel and high-level waste in an MRS facility for a 70-year period of time.

The safety assessment of the site is based upon a characterization of the site and its surrounding region (box 15). The magnitude of natural phenomena and the certainty with which they may be predicted, for example, bears on the safety of a site. The DOE used site suitability as a dominant factor in its site screening process by recommending 3 out of 11 sites which had previously been considered for nuclear activities. Data on the preferred Clinch River Breeder Reactor (CRBR) site has been obtained from the CRBR files, including that documented in their preliminary SAR (PMC 1975) and amendments to the PSAR (PMC 1982), and some additional information published in the open literature since their PSAR was filed. A description of the geology and hydrology of the site has been prepared as Volume VII of the Conceptual Design Report (R. M. Parsons Company 1985b). It characterizes the seismic, flooding, and ground stability of the site and region and confirms the applicability to the CRBR site of the corresponding design parameters specified in the Functional Design Criteria for the MRS.

The safety of the site is assessed (box 16) with respect to the limits of Table D.1. The radiological impacts on the public have been calculated, documented in the EA, and are presented for the CRBR site in Table D.2 for comparison with the limits of Table D.1.

TABLE D.2. Radiological Doses at CRBR Site

General Public	Normal Operation From Annual Release (rem)[a]	Design Basis Accident From Each Occurrence (rem)[a]
Real Individual		
Whole Body	0.00024	
Thyroid	0.0013	
Other Organs	0.00024	
Person at Edge of Controlled Area		
Whole Body		0.0044
Other Organs		0.03
Occupational Workers		
Operating Personnel		
Whole Body	3.7-4.9[b]	

(a) 50-year dose commitment.
(b) Maximum dose for two crafts.

The calculated maximum doses to individuals living outside the controlled area from normal operation and from anticipated abnormal operation given in the table are 0.00024, 0.0013, and 0.00024 rem per year for doses to the whole body, thyroid, and other organs, respectively. These doses are to be compared to the limits of Table D.1 of 0.025, 0.075, and 0.025 rem per year, respectively. Any assumptions that are made in the calculations are believed to be conservative. The doses from MRS operations are realistically expected to be more than forty times less than the regulatory limits. For comparison, the annual background dose at the CRBR site is approximately 0.15 rem per year.

The EA also describes the maximum hypothetical accidents postulated at the MRS facility and presents their radiological consequences. For the CRBR site and the sealed storage cask concept, the maximum potential release of radioactivity results from dropping a PWR fuel assembly, having a 55,000 MWD/MTU irradiation exposure. Assuming that all the fuel rods are broken and using conservative assumptions, the whole body dose to a person at the edge of the controlled area is calculated to be 0.0044 rem and 0.03 rem to the thyroid. This dose is only 20 times higher than that resulting from normal operation over a year's period of time, and less than one-hundredth of the regulatory limit.

For the drywell concept there is one hypothetical accident that could result in substantially higher doses, which are still below the NRC limit. In this accident it is postulated that an earthquake occurs as a fully loaded canister is being lowered into a drywell. It is further assumed that the transport vehicle is shifted in such a manner that the canister and its fuel assemblies are sheared with the escape of volatile fission products. The probability of such an accident would be very low and could be made vanishingly small by added design features.

A description of the manner in which the design complies with each requirement of the Siting Evaluation Factors of Subpart E is described in the Regulatory Assessment Document (RAD), Volume II of the Conceptual Design Report referred to earlier.

D.1.2.2 Facility Design Assessment

The MRS design and its intended manner of operation (box 17) are described in the Conceptual Design Report, Volume I, Book II, Design Description. Book I of Volume I contains an Executive Summary. The RAD, as discussed earlier, contains a preliminary assessment (boxes 18-20) of its safety. The material presented in these volumes is detailed, even if only conceptual.

The RAD presents the MRS design criteria and describes the way in which they meet the NRC General Design Criteria of Subpart F. The RAD also establishes a basis for later assessments of the margins of safety by developing a preliminary set of expected occurrences, abnormal events, and potential accidents that the conceptual design should, and does, accommodate with appropriate design features. From this analysis the structures, systems, and components important to safety (SIS) were preliminarily identified and the criteria of Subpart F were applied, as appropriate for conceptual design.

The SIS were classified, using engineering judgment at this early stage of design, in accordance with their importance to safety: as Category I if they must remain functional after a design basis earthquake or tornado; and as Quality Assurance Level I or II, according to whether their failure could have offsite radiological consequences beyond the limits of Table D.1 to the public (Level I) or whether their failure would affect the immediate area of, and have consequences beyond Table D.1 to, the working staff (Level II). The exact definitions of these terms and the preliminary classification of the SIS are in the RAD.

The features of the facility which provide the primary boundary for containment of radioactive material are of the most importance to safety. They are the shipping casks, concrete walls of the hot cells in the receiving and handling (R&H) building, filters and tornado dampers in the R&H building ventilation system, and the steel canisters into which the spent fuel is placed for storage. Safe design of these features is well understood from many years of experience inside and outside the nuclear industry. They are neither novel nor new. A favorable assessment of their safety therefore depends upon 1) the quality of their construction and installation, 2) their testing during operation to assure their continued performance, and 3) an acceptable backup or margin of safety in the event of their unexpected failure.

The results of analyses of the maximum occupational doses to two classes of workers from exposure to radiation performed to date are presented in Table D.2, and are to be compared to the NRC limits of Table D.1. The calculated occupational doses are not very meaningful at this stage of design since optimization for ALARA is performed in definitive design (see Sections D.2.1.5 and D.2.2.2). The indicated occupational doses, although less than the limits of the NRC, are above the guidelines of 1 rem per year in the DOE Orders for facilities under their ownership. During definitive design additional shielding, remote operations, and other design features will be provided so that expected occupational doses will be as low as reasonably achievable.

The DOE believes that the conceptual design, described in the seven volumes of the Design Report, provides a detailed starting point for definitive design; and that its safety can be demonstrated in a future license application.

D.1.2.3 Assessment of the Design for Physical Protection

The details of the design and plans for security of the plant and the radioactive materials possessed (box 4) are withheld from the public by the NRC as a deterrent to potential sabotage. However, the measures that are used to provide physical protection are not withheld. The conceptual design report and the RAD describe the features to be provided and their compliance with the requirements. Figure D.2 shows the fence that is the boundary of the controlled area of the CRBR site and the two security fences, with an alarm zone between them, which surround the protected area. Nuclear materials are not handled or stored outside of the protected area.

Since these matters are common to all licensed facilities, they are not discussed further in this plan. The detailed designs and plans will be provided to the NRC with the LA.

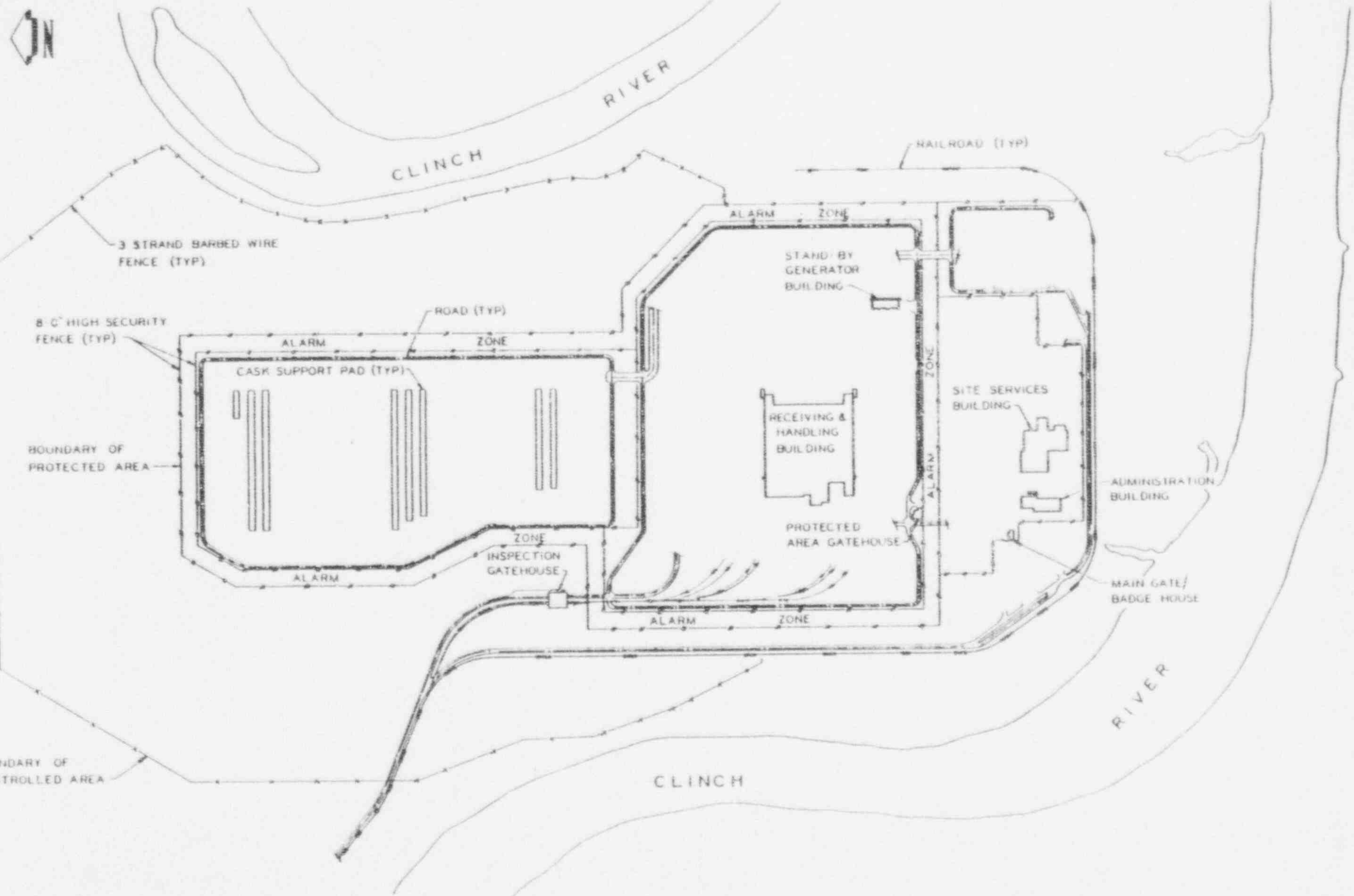

FIGURE D.2. Layout of MRS Installation at CRBR Site

D.2 PRELICENSING PLANS

This section describes the major activities that are planned to develop an LA for the MRS facility, if approved by Congress. The activities are discussed according to the time sequence in which they will be performed. In contrast, Section D.1 presented the informational needs and site and facility design requirements that the activities must satisfy.

The activities needed to obtain a license span almost the entire breadth of the project activities, so that brief, or no, mention is made of some activities which, though important, are not unusual for the MRS facility. The activities will be described with reference to Figure D.3, which shows the general sequence of activities related to licensing. Since the figure is not a detailed logic network, only major interfaces of activities are shown, and the detailed feedback of information within an activity or, from one activity to another, will take place as needed. The schedule for these activities are shown in the MRS Program Master Schedule (Figure 3.10, Chapter 3).

The activities described will be performed by the DOE and their contractor(s). The DOE will obtain expert services for the design, procurement, construction, technical support during design and licensing, and operation of the facility.

The preproposal activities are shown to illustrate the DOE's intent to adhere to the NRC requirements in performance of these activities.

D.2.1 Preparation for Definitive Design and Environmental Report

The purpose of the first column of activities after congressional approval, shown in Figure D.3, is to plan and collect data for development of the ER and the facility design. These activities are summarized, from the top down. They are then described in more detail in subsequent sections.

Early interactions with the NRC staff will provide input to a Regulatory Compliance Plan, which will provide guidance to other program activities, and will contain detailed plans and schedules for the assessment of site and facility safety. In parallel, site and regional data will be confirmed, and new data obtained where necessary, for the ER and facility design. The scope of environmental data to be contained in the ER will be determined after consultation with the State of Tennessee, the NRC, and the EPA. Finally, to prepare for definitive design, the Mission Plan, guidance from Congress, and the existing EA and conceptual design documents will be used to establish the technical baseline for the approved MRS facility.

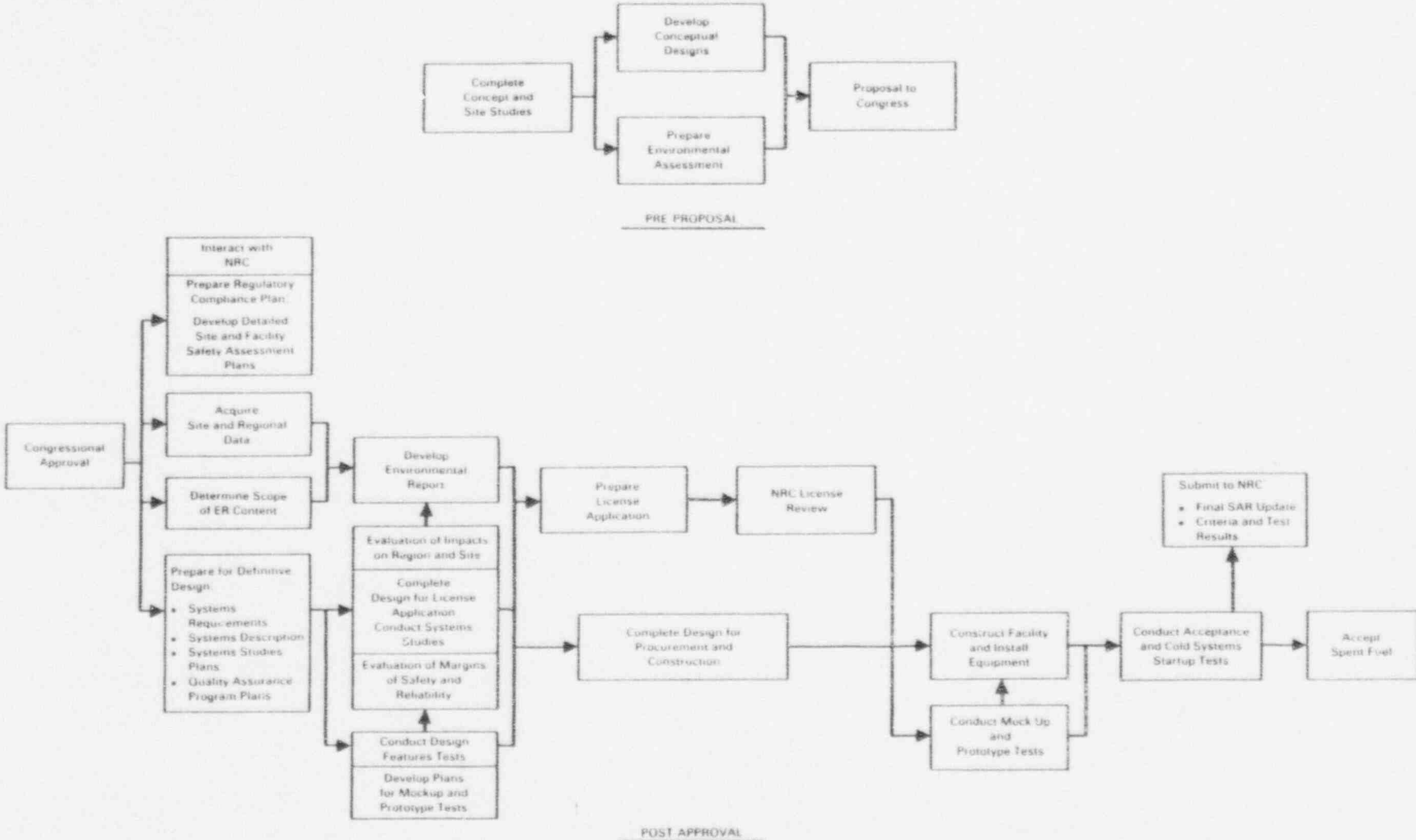

FIGURE D.3. Activities Related to NRC Licensing of an MRS Facility

D.2.1.1 Interactions with the NRC

As soon as possible after congressional approval, the DOE proposes to enter into a Procedural Agreement with the NRC to foster cooperation on planning of licensing activities and an open information exchange between the DOE and the NRC. The Procedural Agreement will provide for agreement on plans, schedules, and the responsibilities, including NEPA, of each agency. The existing Procedural Agreement (NRC 1983) between the DOE and the NRC for the conduct of the geologic repository program could be extended to include the MRS Program.

The Procedural Agreement will provide for meetings prior to submittal of a license application at which appropriate management personnel of both agencies could discuss plans, review progress, and facilitate the resolution of problems. Similarly, provisions will be made for technical meetings for review and discussion of technical matters, such as interpretations of requirements, design data or options, and the adequacy and sufficiency of information or data. The schedule for meetings will be published in advance, and they will be open to attendance by interested parties. Summary minutes of the meetings will be made available to interested parties.

Any meetings to be held after submittal of an application for a license will be conducted in accordance with existing NRC procedures since the DOE would then be an Applicant subject to NRC regulations.

The Procedural Agreement will also provide for exchange of documents and other information or data developed by either party. NRC observers will be encouraged to review the progress of design and development activities. The DOE will request that the NRC staff review and comment on topical reports that the DOE and the NRC mutually agree upon. The purpose of these reports will be to receive a degree of assurance from the NRC staff, before submittal of the license application, that the DOE efforts are meeting the requirements foreseen by the NRC. In turn, review of these reports will provide the NRC with early information on the MRS Program. Examples of such reports that would facilitate early activities and later NRC review of the license application are:

- the MRS Quality Assurance Program
- Quality Assurance Plans for: acquisition of site and regional data, definitive design, procurement, construction, and design verification testing
- seismic design methodology and codes
- design for prevention of criticality

- validation and verification of heat transfer codes

- canister and storage cask designs and testing

- hypothetical accidents for analysis for SAR.

D.2.1.2 Regulatory Compliance Plan

In parallel with discussions with the NRC, a Regulatory Compliance Plan will be developed to provide guidance to other program elements on the 1) requirements each is to satisfy and 2) plans, in the form of a logic network, of information and data that will be needed for the preparation of the LA, particularly for the safety assessment of the site and facility design. The Regulatory Compliance Plan will contain schedules and identify feedback loops for the iterative sequence of: development of data used as input to the design, validation of design methods, identification of structures, systems, and components important to safety (SIS), performance of design studies, and evaluation of the margins of safety during operation. These activities are interdependent and are essential to the timely preparation of the LA. The plan will need to be maintained up-to-date as the program develops.

D.2.1.3 Site and Regional Data Acquisition

From many prior studies of the CRBR site and surrounding region, a broad scope of data is available. The additional needs are 1) confirmation of the validity and applicability of existing data, 2) updating of data that may have changed with time, and 3) development of some detailed data not now in hand, such as an engineering characterization of site properties for the placement and foundation design of MRS facilities. Part of this information will be obtained immediately upon the start of definitive design to confirm the acceptability of the layout and conceptual design of the MRS facilities. Baseline environmental data for the ER, if current data is found to be insufficient, would take one year to span a complete cycle of seasonal variations of meteorology and climatology.

After collecting and analyzing the data, the results will be input to the ER and definitive design. The information required in box 15 of Figure D.1 can be assembled and submitted as a topical report. The report would characterize the geology, hydrology, seismology, meteorology, demography, and nearby industrial or other activities in the region and interpret the information in terms of design criteria for earthquakes, flooding, tornados, and protection against man-induced events. An NRC review of the report would reduce the risk of later design changes, provide the MRS staff with experience in interacting with NRC staff, shorten the time required for review of the LA, and promote early understanding of MRS design criteria by NRC staff.

D.2.1.4 Scope of Environmental Report Content

An early series of discussions with the state and local entities and federal agencies will scope the issues that may need to be addressed in the ER that are additional to those in the current MRS Environmental Assessment (Volume 2 of this submission to Congress). The data needed to consider these issues or to update data already available will be factored into the site investigation studies. In addition, some of the data may need to be considered in the layout and design of the MRS facility. The ER will contain a comprehensive discussion of the impacts of construction and operation on the environment.

Consultation with the NRC in the early identification of environmental data needs will provide added certainty to the completeness of the ER.

D.2.1.5 Preparation for Definitive Design

A revised and expanded set of project documents will be needed for management and technical control of the definitive design. In accordance with OCRWM policy, this need will be satisfied at the top level by developing an MRS Systems Requirements document. This document will contain the functional requirements and performance criteria for the MRS facility and its subsystems. In addition, a System Description document will be prepared that will describe the design criteria and bases, the system configuration, and the interfaces between each of the MRS subsystems. These documents will be based upon the conceptual design documents listed on page D.1. The documents will be baselined, under change control, for use in the definitive design. Changes will be made in the documents as the iteration between design definition and design evaluation proceeds toward a final design.

A Systems Studies Plan will be developed to schedule and guide the optimization of the MRS system design. Optimization may be performed with respect to any one or more factors such as cost, safety, product performance, and schedule. A number of such studies were identified during conceptual design and deferred to definitive design. These studies are presented in the Conceptual Design Report, Volume I, Appendix G.

Preparation of quality assurance documents, expanded beyond those currently in use, to cover the collection of field data and performance of design and testing will be scheduled for the earliest possible date. The first of such documents will cover the overall DOE management of the program for an MRS facility, and the DOE contractors' program for technical support activities, including design, field investigations, and design features and materials testing. Submittal of these documents to the NRC for review and comment will add to the certainty that the management and technical control of MRS activities meet the NRC requirements.

D.2.2 Development of the Environmental Report and Definitive Design

The activities depicted in the second column of boxes in Figure D.3 will produce the ER and complete the final design information required for a license application. All of the design that bears upon the LA, including the ER, will be planned for completion at the earliest possible time. However, the LA requires complete designs and specifications for all SIS. Therefore, careful planning and sequencing of the design studies are needed to ensure acceptance of the LA by the NRC for review.

D.2.2.1 Development of the Environmental Report

Within one year after the start of definitive design, the conceptual design will have been confirmed and any changes in the magnitude of the impacts on the environment of construction, operation, and decommissioning will be known. The radiological impact on the public, expected to be below acceptable regulatory limits on the basis of the conceptual design, will have been reviewed, with the ALARA concept being the criterion for mitigation of radiological impacts. Information on the use of land and of other resources and the studies of demography, meteorology, background radiation, rare and endangered species and other subjects will also have been developed. The ER will be prepared with particular attention to the requirements of the NRC, as given in 10 CFR 51.

D.2.2.2 Completion of Design for License Application

The first activity in definitive design will be a review of the DOE's Systems Requirements document, System Studies Plans, other baseline management and technical documents, and the plans for site and facility safety assessment. (These documents were discussed earlier.) In parallel, the contractor performing the design will prepare his quality assurance program and procedures for DOE approval. With this understanding, the design activities will concentrate on the optimization of design by performance of studies identified in the Systems Studies Plans or by review of the conceptual design. Three of the more important studies which are related to safety considerations are:

- a study of the wall thickness and steel reinforcement of the sealed storage cask versus the resulting changes in occupational exposure of workers in the storage field, in the temperature and perhaps the lifetime of the concrete, in its ability to withstand tornado-generated missile impacts, and in the cost of manufacture (ALARA and margins of safety).

- a study of the use of additional remotely controlled equipment versus the resulting decrease in occupational exposure but at increased capital and, perhaps, at increased operating cost and lower availability (ALARA).
- a study of the capacity of the lag storage vault versus the resulting changes in operational flexibility, in the vault cooling requirements or changes in lifetime of the concrete walls, in changes in the margins of safety in the event of loss of multiple power sources, and in the cost of the building and support equipment (margins of safety).

In addition to the systems studies, a large number of safety questions will be addressed in this phase of the design. They obviously overlap in an iterative fashion with the evaluation of the margins of safety described in a later section, but are described here for clarity. Some of these have been documented in the RAD or Appendix G of the Conceptual Design Report. A few of those involving considerations of safety are listed in Table D.3. Close inspection of the items listed and comparison with the current conceptual design will reveal that many of the items also pertain to potential cost reduction, or value-engineering studies. As in the usual design process, conservative decisions were made during MRS conceptual design in the absence of final studies on the effects of failures and on existing margins of safety.

Concurrent with the design, parts of the LA will be prepared that are not dependent upon the detailed and final safety analyses. These may be submitted for early NRC review if it appears likely that this would reduce the license review time or would assist in making design decisions. In rough order of their dependence upon final safety assessments, they are:

- Technical Qualifications: Personnel Training Program
- Physical Security Plan
- Safeguards Contingency Plan
- Design for Physical Security
- Decommissioning Plan
- Emergency Plan.

Each of these is described below, following Table D.3.

TABLE D.3. Safety Considerations for License Application Design

- Magnitude of radioactive particulate deposited in cells and on filters and methods of reducing their quantity
- Methods of waste collection, decontamination, and volume reduction of both liquids and solids
- Agreement with repository program on acceptability of encapsulation of contaminated organic materials
- Re-evaluation of need and placement of monitoring equipment for radioactive gaseous effluents, sanitary sewer system, and seismicity
- Re-evaluation of need for various monitoring and control functions to be supplied by uninterruptible power, i.e., rather than offsite or backup generator power
- Re-evaluation of need for various functions to be controlled at both local and remote control rooms under off-normal conditions or design basis accidents
- Re-examination of the basis for the CHTRU building to be resistant to severe earthquakes for operating flexibility or public safety
- Re-examination of possible causes of fires or explosions and any further design features to mitigate their effects
- Final determination of shielding wall thickness to result in occupational doses that are ALARA

The nucleus of an operations staff will review the design for operability and maintainability, providing input to the design. Using this experience, the staff will develop the Personnel Training Program. Training will begin as soon as the full set of prototypic systems are installed in the training cell, as described in Section 3.5 of Chapter 3.

The Physical Security and Safeguards Contingency Plans can, likewise, be prepared after confirmation of the conceptual design and performance of some design work not involving the SIS.

The Design for Physical Security, the Decommissioning Plan, and the Emergency Plan rely on more information than exists in the conceptual design, but could be prepared for the NRC in advance of submittal of the LA.

D.2.2.3 Design Feature and Systems Tests

Some features incorporated into the conceptual design need further testing to justify their choice, may not be optimum among all the choices, or have been assigned operating limits that need to be confirmed by testing. The information needed generally relates to achievement of an acceptable margin of safety. In addition to the tests identified in the conceptual design report, additional tests may be identified during definitive design. Those feature tests that were identified in the conceptual design are described in the Design Verification Plan, Appendix C. Some of these tests will determine performance limits, such as concrete testing at high temperatures, and some will determine the capacity and shielding needed for systems to treat wastes generated at the MRS facility.

In addition to the feature tests, a series of tests will be performed on the disassembly and consolidation system. These are planned to be completed before the LA is submitted to the NRC, as described in Appendix C.

At this stage of design, plans can be developed for mockup and prototype tests to verify operability of the final components to be procured. There are tests already identified in Appendix C that will be considered for completion during design and construction. Augmenting these plans with those for operational testing of the MRS facility after construction will provide information for the SAR (box 12 of Figure D.1).

Planning for the operation of the facility will also be completed to satisfy another of the items in the SAR, Plans for the Conduct of Operations (box 13 of Figure D.1).

D.2.2.4 Evaluation of Margins of Safety and Reliability

After sufficient design information is available on portions of the design of the SIS to warrant reassessment of their importance to safety and their margins of safety, studies of reliability and operability will be performed to assure that the operability goals of the DOE (stated in the Systems Requirements document) and the safety performance requirements of the NRC are met. Some of the input data will be obtained from failure modes and effects analyses. In turn, the results provide input to assessments of the margins of safety between normal operations and operations under either severe natural phenomena or design basis accident conditions. The results will be used in an assessment of the likelihood, and analysis of the effects, of improbable events and design basis accidents. A description of these studies is needed for the SAR (boxes 19 and 20 of Figure D.1).

The conceptual design effort used engineering judgment instead of failure and reliability studies to proceed to the identification of possible off-normal and serious accidents. More than eighty events of varying severity were considered and are presented in the MRS conceptual design report. As mentioned earlier, these considerations allowed a preliminary identification of the SIS.

The quantitative analyses discussed above will be performed using reliability and other data for specific components and systems defined during definitive design. Some of the more important of such studies are listed in Table D.4, although it is acknowledged that, at times, it is difficult to distinguish between design studies like those in Table D.3 and design assessments like those in Table D.4. Again, Table D.4 is derived in part from references already cited.

TABLE D.4. Failure Modes and Effects and Reliability Studies

- Effects of the successive loss of sources of alternative power
- Dynamic analyses to determine pressures versus time upon failure of tornado valve; and to determine their importance to safety and testing requirements
- Consequences of exceeding yield strength of reinforced concrete under high temperature, seismic, or tornado-generated missile stresses
- Human factors study to identify effects of potential operator responses
- Modes and consequences of fuel cladding and canister failure and ultimate temperature limits for safe storage
- Consequences of a design basis earthquake and tornado-generated missile on storage cask and canisters in the storage field and final classification of their importance to safety, including the steel liner in the cask
- Effects of multiple failures, including human

At the conclusion of these studies the information will be used for performing the final analysis of the radiological effects of exceeding the margins of safety (boxes 21 and 22 of Figure D.1). The information will also be used to confirm the final classification of structures, systems and components that are important to safety. This classification is subsequently used in designation of the quality standards to be used in procurement, construction, and testing of the SIS.

D.2.3 Completion of the License Application

The next column of activities in the sequence shown in Figure D.3 involves the use of design and other information to develop the LA. Upon completion of the safety assessments described in previous sections, the SAR will be assembled.

The information for the development of the remaining enclosure to the LA, Proposed License Conditions and Technical Specifications (box 5 of Figure D.1), will be available at varying times during design, but the final specifications can be confirmed only after the analysis of the hypothetical design basis accidents. For example, the license condition which specifies the maximum quantity and characteristics of fuel to be stored under the license will be known early, but specification of the set-points and range for radiation monitors on the stack must await the final determination of the rate and magnitude of the radioactive gaseous effluent from hypothetical accidents.

The LA and its accompanying reports will then be submitted to the NRC and, after their review for completeness, the NRC will docket the application.

D.2.4 Review of License Application

The NRC review process is scheduled to take 30 months from application to issuance of a license. Although a longer review period may be required in the event of serious contentions which require extensive hearings and appeals, a shorter period would be needed in the absence of contentious issues. The DOE believes that the scheduled 30 months is a reasonable allowance of time in view of the proposed extensive prelicensing interactions with the NRC and the opportunities for the public to be involved in the review of technical documents.

Questions from the NRC staff are expected during their review and will be responded to in a timely manner to expedite the license review.

The remaining design of items not important to safety, including detailed drawings and specifications for procurement, construction, and installation, will be completed during NRC review of the application.

D.3 POSTLICENSING PLANS

The requirements prescribed for a licensee are found in Subparts C and D of Part 72. They relate to Conditions of Licenses; and Records, Reports, Inspections and Enforcement, respectively. The activities planned for the MRS Program are shown in Figure D.3. More detailed descriptions and milestones are given in Chapter 3.

After receipt of a license, the DOE will proceed with site preparation and construction. During this period, inspections will be performed to assure that quality standards specified in the design are met for purchased materials and equipment, and for major construction and installation; and that the conditions of the license are met. Resident NRC staff from the Office of Inspection and Enforcement will be housed at the construction site to facilitate their inspection of the work in progress. Inspection and acceptance services will also be provided by the contractor who designed the facility.

Construction of the MRS facility will be scheduled so that the mockup and training cell in the site services building will be completed at the earliest time that is compatible with orderly construction and economy. Advanced procurement of prototypic spent fuel handling equipment will allow installation of these prototypes as soon as the mockup and training cell is complete. After installation, these prototypes will be operated for the dual purposes of training operators and maintenance staff and of operating and testing the equipment under simulated operating conditions. Any desirable design changes may be made during procurement of MRS equipment, or be back-fit if necessary.

During completion of construction and testing, the SAR will be updated and submitted to the NRC every 6 months, with the final submittal not later than 3 months before spent fuel or high-level waste is to be received. The acceptance criteria and test results of the preoperational tests using cold or simulated spent fuel will be submitted to the NRC for their review at least 30 days before spent fuel or high-level waste is to be received.

After the receipt of actual spent fuel, the preoperational tests will be repeated, but under radioactive conditions, sequentially in one cell at a time. The throughput rate of the facility will be judiciously increased during the operational demonstration, as more experience is gained in the use of the operating procedures and in the operating characteristics of the processes and equipment. A ramp-up of the throughput to full operations is expected to take approximately one year after the start of hot operations.

All radioactive operations of the MRS facility will be in accordance with the limits prescribed in the Technical Specifications, which are part of the conditions of the license.

After completion of its mission, the MRS facility will be decontaminated and decommissioned in accordance with the Decommissioning Plan approved by the NRC.

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APPENDIX E

COST AND FUNDING ANALYSES

APPENDIX E

COST AND FUNDING ANALYSES

The purpose of this appendix is to provide further details on the cost estimates and funding plan included in the body of the MRS Program Plan. Section E.1 describes the basic approach and assumptions for cost estimation. Sections E.2 and E.3 present and discuss the details of the cost estimates for the preferred site-design case and the five alternative cases. Section E.4 presents an analysis of cost sensitivities. Section E.5 discusses the alternative funding approaches considered, explains the selected approach, and details the plan for funding the MRS Program. The change in the total cost of the federal waste management system, due to addition of the MRS facility, and the spending and funding schedules are also provided in Section E.5. Section E.6 presents additional detailed cost and data tables.

E.1 COSTING APPROACH AND ASSUMPTIONS

The approach to estimating the costs for deploying, operating, and decommissioning the MRS facility is discussed and an explanation of cost categories and economic assumptions is provided. This is followed by a discussion of the basic assumptions for costing, such as site-design combinations, waste logistics, facility design, and costs not included.

E.1.1 Approach to Cost Estimation

In developing the cost estimates for the MRS facility, the activities in the facility deployment, operations, and decommissioning processes are evaluated and information on the manpower, materials, and capital equipment are developed from the conceptual design of the MRS facility. The assumptions used are consistent with the improved-performance system described in the OCRWM Mission Plan (DOE 1985) and in Appendix A of this document.

Costs were estimated for activities in each of the nine MRS program elements: 1) Environmental Evaluations, 2) Design, 3) Regulatory Compliance, 4) Construction, 5) Training and Testing, 6) Operation, 7) Decommissioning, 8) Institutional Interactions, and 9) Program Management. The costing framework is shown below:

Costing Framework

1.1 Environmental Evaluations
- Environmental report
- Environmental data

1.2 Design
- R&H building
- CHTRU facility
- Support facilities
- Storage facility
- Site design data
- Site improvements
- Utilities
- Design verification
- Design and management support

1.3 Regulatory Compliance
- NRC license application
- Permits
- License review
- License amendments
- Operational reports
- Decommissioning ame [illegible]

1.4 Construction
- R&H building
- CHTRU facility
- Support facilities
- Storage facility
- Site improvements
- Utilities
- Construction management and support

1.5 Training and Testing
- Training and certification program
- Safety and radiological
- Operations and maintenance
- Emergency response
- Offsite systems testing
- Onsite test start-up
- Operational demonstration

1.6 Operation
- R&H building
- CHTRU facility
- Support facilities
- Storage facility
- Environmental surveillance
- Operations management & support
- Capital modifications/additions

1.7 Decommissioning
- Decommission plan
- R&H building
- CHTRU facility
- Support facilities
- Storage facility
- Site improvements

1.8 Institutional Interactions
- Public information programs
- Consultation and cooperation agreements
- Financial assistance

1.9 Program Management
- System engineering and configuration management
- Intergovernmental relations
- Project planning and control
- Subcontract management
- Management services
- Quality assurance

Cost Categories

The nine cost categories represent the nine program elements. A description of activities in each category is presented below.

Environmental Evaluations costs are those associated with the compilation and verification of ecological, hydrological, meteorological, and socioeconomic site data for the preparation of the Environmental Report (ER) and the interactions with NRC required for preparing the ER. Site data collection and evaluations in this cost category include all data except those needed only for design and construction purposes, such as rock and soil mechanics. Manpower requirements for each activity and associated cost were estimated in accordance with the proposed deployment schedule.

Design costs encompass all activities that are required to complete design documents, including drawings, descriptions, specifications, and engineering studies for R&H building, CHTRU facility, storage facility, support facilities, site improvements and utilities. The engineering studies include analyses required for the development of the Safety Analysis Report and other documents needed for an NRC license application. Other preconstruction costs included under this element are those for site data confirmation, design verification, and design management and support. Costs for design engineering support after initiation of operations are included in the Operation element. A contingency of 20% is also included.

Regulatory Compliance costs pertain to permitting and licensing activities throughout the life span of the MRS facility. These activities support applications at local, state, and federal levels. Licensing and permitting fees, if any, are not included in the cost estimates.[a] Preconstruction activities include preparation of the license application to NRC and various permit applications as required, and licensing review support. License amendment support is required throughout construction and operation. Finally, costs for preparing and submitting a decommissioning amendment are also included.

Construction costs cover actual construction of the MRS facility based on the drawings and specifications prepared in the Design element.[b] They include labor, materials, equipment, contingencies, support services, site improvements, utilities and construction contractor management. Construction costs are considered capital investments. These expenditures are of three types: 1) direct costs - paid to construction contractors for expenses on behalf of the project, such as construction of the R&H building (including receipt and inspection facility), CHTRU facility, support facilities, storage facility, utilities and other site improvements; 2) construction management

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(a) See Section E.1.5 for reasons why the licensing and permitting fees are not estimated.

(b) Note that the Design and Construction elements in this costing framework refer to all costs during the design and construction phases, including both capital-funded and operating expense funded costs. In the conceptual design report (Ralph M. Parsons Company 1985), the architect-engineer used the term "construction" to cover the capital-funded portion of the combined design and construction costs. The reconciliation of the difference between these two cost estimates for the combined design and construction categories for the preferred site-design case is explained in Section E.2.1 (Construction). This distinction between the term "construction" used in this appendix and that in the conceptual design report should be kept in mind throughout this appendix as well as the Program Plan.

costs - costs for performing construction management and support services; and 3) contingency costs - a reserve for unexpected events or requirements not specifically foreseen. The latter costs are estimated as a percentage (20%) of the sum of direct costs and construction management costs.

Training and Testing will begin prior to the completion of facility construction to ensure that the MRS facility and operations staff will be prepared to perform their intended functions safely and within quality requirements by the time the facility becomes operational. The training and certification programs will cover safety and radiological monitoring groups, operations and maintenance crews, and emergency response teams. Testing starts with offsite systems testing. Personnel training and operations testing will sequence through the mockup facility in the training cell in the site services building, the cold tests in the R&H building (full complement of equipment installed in the hot cells without using actual spent fuel assemblies), and the hot test (using actual spent fuel assemblies). Also included in the estimates for this program element are costs for preparing the necessary training documentation and a 20% contingency allowance.

Operation costs include salaries and benefits for operating and maintenance personnel and were estimated for activities associated with receiving, consolidating, packaging, shipping offsite, or temporarily storing and then shipping offsite, spent nuclear fuel and the associated waste from handling and consolidating the spent fuel. The costs were developed from the Ralph M. Parsons Company estimates of the numbers of operating and maintenance personnel required for operating and maintaining the R&H building, CHTRU facility, storage facility and support facilities plus administrative and support staff, together with the costs of materials. Additional costs are included in this program element for continuing environmental monitoring during the operational period of the facility, and for operations management and support. Costs for facility improvement and modifications and for storage casks and canisters are also included.

The costs incurred during facility operation include both capital-funded and operating expense-funded expenditures. Capital-funded expenditures include costs for the sealed storage casks and facility improvements. Operating expense-funded expenditures include the following general categories: 1) labor--determined by a composite annual wage rate that includes all labor costs and the number of staff persons; 2) consumables--items used during operation and maintenance of the facility, such as canisters, drums, filters, and miscellaneous items; 3) maintenance, supplies and contract labor--paid to suppliers for parts, supplies, and labor used for facility maintenance and operation; and 4) utilities, including fuel oil/diesel and gasoline. A 20% contingency allowance was made to cover the normal uncertainty in cost estimate at this stage of design.

Decommissioning costs begin to be incurred approximately four years before the end of operations when the decommissioning plan is prepared and the storage casks are unloaded and decontaminated in preparation for decommissioning. The major part of decommissioning costs associated with decommissioning the R&H building, CHTRU facility, and the storage and support facilities will not begin until the last of the consolidated spent fuel has been shipped to the repository. Costs for site improvements or reclamation are included. This cost category also includes a 20% contingency allowance.

Institutional Interactions costs are incurred 1) to provide timely and full information exchange and appropriate participation between and among the DOE, the public, the State, and local officials regarding the development, deployment, operation, and decommissioning of the MRS facility; and 2) to ensure that the State and local governments receive fair and reasonable financial assistance for the effects of construction and operation of the MRS facility. In this analysis, only costs associated with public information programs are estimated, because the other cost elements are still under discussion.[a]

Program Management costs cover the period from congressional approval through operational demonstrations of the MRS facility. Services provided include 1) system engineering and configuration management, 2) project planning and control for a major systems acquisition, 3) management of subcontracts, 4) management services such as procurement, financial services and program office staff, and 5) quality assurance. These costs were based on estimates of the annual level of effort required. During facility operation, all program management costs are estimated under the Operation program element. During the period when the facility is being decommissioned, costs of program management are estimated separately.

Economic Assumptions

Unless otherwise noted, costs included in this appendix are specified in terms of 1985 constant dollars, and thus do not include the effect of general inflation. When making comparisons of cost estimates in future years, it would be necessary to convert the cost estimates in this appendix to the dollar terms of the year in which the new cost estimates are being specified.

E.1.2 Site and Design Combinations

Section 141(b)(4) of the NWPA requires that the MRS proposal include at least three alternative sites and at least five alternative combinations of

(a) Refer to the MRS proposal (Volume 1) for a description of the DOE's proposed program.

such proposed sites and facility designs. The DOE has chosen the sealed storage cask as the primary storage method for the proposed MRS facility. The field drywell was selected as the alternative storage method. The DOE has selected the former Clinch River Breeder Reactor site in the State of Tennessee as the preferred site for locating the MRS facility. Two alternative sites were also identified for evaluation: the DOE Reservation at Oak Ridge, Tennessee, and the former Hartsville nuclear plant site near Nashville, Tennessee. Six site-design combinations were evaluated: one preferred and five alternative cases. Cost estimates have been prepared for all six cases.

E.1.3 Waste Logistics

The waste logistics used in this analysis are based on the schedule for waste acceptance, storage, and shipment from the MRS facility to the first repository, shown in Table 2-3 of the Mission Plan (Waste Acceptance Schedule-Improved Performance System). This schedule indicates a maximum required receipt and shipping rate of 3,000 MTU, total throughput of 62,000 MTU, and expected onsite maximum inventory of 13,300 MTU. For costing purposes, all spent fuel destined for the first repository, including spent fuel from western reactors, was assumed to be shipped first to the MRS facility for consolidation and canistering.[a] The MRS facility will receive spent fuel from reactors from 1996 to 2017, and will ship to the first repository from 1998 to 2022. Defense waste will be sent directly to the first repository and the second repository will operate independently of the MRS facility.

E.1.4 Facility Design

The conceptual design for the MRS facility has a design receipt rate of 3,600 MTU/year and onsite storage capacity of 15,000 MTU. Operations would be on a five-day, 3 shifts/day mode (with a standby mode on the weekends) to accommodate an operating receipt/ship rate of 3,000 MTU per year. A total plant operating staff of about 600 employees would be required at these throughput rates during steady-state operation. For the first few years of operation of the MRS facility, some of the consolidated spent fuel would be placed into temporary storage while other fuel would be shipped to the repository (after 1998). In subsequent years, the facility would serve primarily as

(a) This is different from the position taken in the Need and Feasibility section of the EA (Volume 2 of this submission to Congress), which indicates that spent fuel from western reactors will be shipped directly to the first repository. Shipment of western fuel directly to the first repository would probably lower the MRS receiving rate to approximately 2550 MTU per year and lower the MRS facility cost estimated herein accordingly.

a receiving and packaging facility for the first repository. The major elements of the MRS facility are the R&H building, the CHTRU facility, the support facilities and the storage facility.

E.1.5 Costs Not Included

Certain items are not included in the cost estimates presented in the next sections. These are discussed below.[a]

As discussed in the MRS proposal (Volume 1), it is recommended that financial assistance be made available to local units of government affected by MRS deployment upon congressional approval. When agreements are reached and the costs can be estimated, they will be included in MRS life-cycle cost estimates.

The DOE is recommending that Congress direct that revenues equivalent to taxes be provided to the State of Tennessee and affected units of local government for the MRS facility. This will provide revenues to the State and localities equivalent to those which would be received if a commercial facility were built on the site. When costs have been identified, they will also be included in MRS life-cycle cost estimates.

Pursuant to Section 117(b) and (c) of the NWPA, binding Consultation and Cooperation Agreements will be sought with Tennessee within 60 days after congressional approval of the MRS Program. Since these agreements have not been negotiated, there are no cost estimates available at this time.

Also not included in the cost estimates are licensing and permitting costs associated with other federal, state and local entities. At this time, there is no clear indication whether the federal entities will make these costs part of their request for congressional budget appropriations or whether they may directly charge the Waste Fund under Title 10 Code of Federal Regulations,

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(a) The cost of transporting spent nuclear fuel within the federal waste management system is a major component of the total system life-cycle costs of the federal waste management system. (For the improved-performance system, the other three major components are development and evaluation (D&E) costs, repository costs, and MRS costs.) Hence, any changes in total system costs attributable to the transportation component are being estimated separately, instead of being included in the MRS facility costs. In other words, the impacts on transportation cost of incorporating an MRS facility into the federal waste management system is a valid consideration, but it is more properly evaluated from a total system perspective and is not included as part of the life-cycle cost estimate for the MRS facility per se.

Part 170--Fees for Facilities and Materials Licenses and other Regulatory Services under the Atomic Energy Act of 1954, as Amended. Currently, Part 170 does not discuss MRS. State and local permitting fees have not been identified at this time.

Site acquisition costs have also not been estimated at this time. These costs can vary among the three sites. However, they would not significantly impact the life-cycle costs.

E.2 COST ESTIMATE FOR THE PREFERRED SITE-DESIGN CASE

The preferred site-design case cost estimate is the life-cycle cost of developing, constructing, operating, and decommissioning an MRS facility using the sealed storage cask concept at the Clinch River Breeder Reactor (CRBR) site in Tennessee. This section presents the details of this cost estimate by first explaining individual cost components and then discussing the total facility life-cycle costs. Major uncertainties concerning the cost estimates are then explored. Unless otherwise noted, all cost estimates are expressed in constant 1985 dollars.

E.2.1 Cost Categories

This section presents the details of the preferred site-design case cost estimate by cost category. The nine cost categories were defined in Subsection E.1.1. Due to the need to consider funding categories in the later analysis, whether or not a cost category includes capital-funded or operating expense-funded items is indicated in the following discussion.

Environmental Evaluations

The costs for Environmental Evaluations activities, such as environmental data confirmation and verification and preparation of the ER, are estimated to be $5.3 million. All environmental data collection and documentation will need to follow strict quality assurance (QA) requirements. For example, all existing environmental documentation will be verified by onsite sampling and inspection to comply with QA requirements for an NRC license application. The environmental data collection, confirmation and verification activity accounts for $3 million. Preparation of the ER and public interactions will require that another $2 million and $0.3 million is reserved for responding to questions following submittal of the ER. Costs for this element are expense-funded.

Design

The costs associated with the Design element of the MRS Program are estimated to be about \$97 million, including 20% contingency allowance. The major cost components are as follows:

Cost Item	Millions of Constant 1985 Dollars[a]
R&H building	\$47.3
CHTRU facility	0.2
Support facilities	10.6
Storage facility	2.9
Site data	5.5
Site improvements	1.4
Utilities	2.6
Design verification	17.0
Design management	9.7
Total Design	\$97.2

These cost estimates are based on estimates of the number of drawings required and the assumption that 160 hours of labor is required per drawing. The hourly charge to produce drawings is assumed to \$50 dollars per hour. In addition, cost incurred by the design contractor for design verification (\$1 million) and for licensing support during the license application period are included. These latter cost items are distributed 90% to the R&H building and 10% to the storage facility. \$65 million of the cost in the design phase is capital-funded. All other costs are operating expense-funded.

Regulatory Compliance

The costs for complying with regulatory requirements include those incurred for 1) preparing a license application to the NRC including guidance to and review of designs, 2) obtaining various permits from the State and other entities, and 3) preparing license review supplements prior to construction. Also included in this cost category are the costs incurred for 4) preparing and submitting license amendments during construction, 5) conducting license-related activities during operation, and 6) submitting a decommissioning amendment. The total cost of Regulatory Compliance is estimated to be \$25.7 million and is expense-funded. The major cost components are shown below:

(a) All costs greater than \$0.1 million were utilized in the estimates in this appendix. When summed, the totals may therefore give an appearance of greater precision than actually exists.

Cost Item	Millions of Constant 1985 Dollars
NRC license application	$4.0
Permits	0.6
License review and amendments	2.5
License amendments during construction	3.7
Operation reporting	10.8
Decommissioning amendments	4.1
Total Regulatory Compliance	$25.7

Construction

Total cost in the construction phase is estimated to be $646.4 million, including 22% contingency allowance.[a] The details of this estimate are as follows:

Cost Item	Millions of Constant 1985 Dollars
R&H building	$421.6
CHTRU facility	1.3
Support facilities	38.8
Storage facility	31.4
Site improvements	58.4
Utilities	4.9
Construction management & support	90.0
Total Construction Phase	$646.4

Excluding construction management and support, the others are construction contracts totaling about $556 million. Construction management and support costs include $52 million for construction management, $28 million for field engineering, inspection and review of submittal, and $10 million for operational support to construction. Except for the $10 million for operational support to construction, all costs during the construction phase are capital-funded.

(a) The specific contingency allowances used, by building, are as follows:

R&H Building	25%
CHTRU	10
Site	10
Storage facility	15
Support and utilities facility	10
Average	22% (Ralph M. Parsons Company 1985)

The capital-funded cost of combined design and construction phases of the MRS Program totals $701.4 million.[a] This is composed of the following:

Cost Item	Millions of Constant 1985 Dollars
Design and license support	$65.0
Field engineering and vendor submittal review	28.0
Construction management	52.0
Construction contracts	556.4
Total Design & Construction (Capital-Funded)	$701.4

Training and Testing

Total training and testing costs are estimated to be $62.0 million, including 20% contingency allowance. This total includes costs for developing the operating procedures, training the operators, testing equipment, conducting preoperational testing of the facility and equipment, and training for fire protection and security. All the costs are expense-funded. The details of this cost category are shown below:

Cost Item	Millions of Constant 1985 Dollars
Operating procedure & training	$35.5
Preoperational testing	22.0
Fire protection and security training	4.5
Total Training and Testing	$62.0

Operation

Total operation cost through 2022, when the last of the stored spent fuel is retrieved and shipped to the repository, is estimated to amount to $1,915 million, including 20% contingency allowance. This total includes costs for procurement of the storage casks, capital additions and modifications, operating staff salary and benefits, canisters, other consumables such as drums and filters, and utilities including electricity and fuel oil. These are shown below:

(a) This is the "construction" cost estimate included in the design report (Ralph M. Parsons Company 1985) noted earlier in Section E.1.1.

Cost Item	Millions of Constant 1985 Dollars
Casks and capital additions	\$509.0
Staff	675.4
Canisters	414.7
Other consumables	135.7
Utilities	180.2
Total Operation	\$1915.0

According to the items included in the costing framework in Subsection E.1.1, total operating costs can also be disaggregated as follows:

Cost Item	Millions of Constant 1985 Dollars
R&H building	\$1026.4
CHTRU facility	1.0
Support facilities	284.2
Storage facilities	17.1
Environmental surveillance	17.8
Operations management and support	59.5
Capital modifications/additions	509.0
Total Operation	\$1915.0

Costs incurred during the operation phase are both capital- and operation expense-funded. A total of \$509 million will be capital-funded, including \$297 million for storage casks and \$212 million for capital additions or modifications.

Decommissioning

Decommissioning costs are assumed to be 12% of facility construction cost and 5% of the cost of all sealed storage casks produced. These assumptions are based on experience and engineering judgment (Engineering News Report 1984). Of the total cost incurred during the construction phase of \$646.4 million, \$90 million is for construction management and support, not directly related to physical facilities at the MRS site. Hence, these are excluded in computing the facilities-related decommissioning cost. Moreover, approximately \$23 million of the remaining \$558 million of construction costs is for excavation and other earth work and is not used in computing the decommissioning cost for capital facilities. Hence, the total construction cost used for computing decommissioning costs is only \$535 million. Total decommissioning cost is estimated to be $79.0 million and is expense-funded. Since the construction cost used for computing decommissioning cost includes 20% contingency allowance, the decommissioning cost can be viewed as containing the same 20% contingency allowance. The detailed breakout is shown below:

Cost Item	Millions of Constant 1985 Dollars
R&H building	$50.6
CHTRU facility	0.1
Support facilities	4.7
Storage facility (incl. casks)	17.3
Site improvements (incl. utilities)	6.4
Total Decommissioning	$79.1

Institutional Interactions

As discussed in Subsection E.1.5, the total costs for institutional interactions will include financial assistance to state and local entities, which is still under discussion. However, the cost of public information programs is estimated to be $2.1 million for the period 1986 through 1991. This cost category is expense-funded.

Program Management

Program management costs include those costs associated with system engineering and configuration management, institutional relations, project planning and control, subcontract management, management services, and quality assurance. Annual program management costs are estimated for three periods: 1) preoperation until the start of full-scale operation, 2) operation, and 3) postoperation. The latter period contains only quality assurance costs. During the operation years, all program management costs, including QA costs, are included in the cost estimate for operations. During the postoperational period, program management costs other than QA costs are included in the decommissioning costs. This cost category is expense-funded. The cost components are shown below:

Cost Item	Millions of Constant 1985 Dollars
System engineering & configuration management	$17.0
Institutional relations	3.7
Project planning and control	19.7
Subcontract management	6.5
Management service	10.1
Quality assurance	12.7
Total Program Management	$69.7

E.2.2 Total MRS Facility Life-Cycle Cost of the Preferred Site-Design Case

Table E.1 presents the preferred site-design case cost estimates for the MRS facility using the 12-inch-diameter current design storage canister as the basis for costing. Total life-cycle cost for the MRS facility is estimated to be $2902 million. Among the nine cost categories, operations accounts for the largest share, about 66%. Construction is second with 22%. Preconstruction activities of environmental evaluation, design, and regulatory compliance combined account for 4%. Training and testing accounts for 2%. Decommissioning and program management account for 3% and 2%, respectively. It should be noted that among the nine cost categories, contingency allowances of 20% were explicitly incorporated into the categories of design, construction, training and testing, operation, and decommissioning. The other four categories do not include such allowances.

Table E.2 presents the annual costs by cost category for the preferred site-design case. Annual expenditures are highest during the construction period and initial facility operation years, ranging from $91 million to $203 million per year. When the MRS facility is in steady-state operation, the annual cost is estimated to be about $71 million per year. The estimated staffing requirement for operation during this period is 601 people.

Disaggregation of Costs By Function

The MRS facility life-cycle cost estimates shown in Tables E.1 and E.2 can also be disaggregated by function of the MRS operation. The MRS performs functions such as spent fuel consolidation, storage, and related support functions. The spent fuel consolidation function is performed within the R&H building.

Viewed in this manner, the estimate of total facility cost can be disaggregated into the following components by function:

Function	Millions of Constant 1985 Dollars
R&H operation	$1715.1
Storage	392.3
Support	795.0
TOTAL	$2902.4

TABLE E.1. Life-Cycle Cost Estimate for the Preferred Site-Design Case (MRS Facility at the Clinch River, Tennessee, Site Using the Sealed Storage Cask)

Cost Element	Constant 1985 Dollars (Millions)	(%)
Environmental Evaluations	5.3	0.2
Design	97.2	3.3
Regulatory Compliance	25.7	0.9
Construction	646.4	22.3
Training and Testing	62.0	2.1
Operation	1915.0	66.0
Decommissioning	79.0	2.7
Institutional Interactions	2.1	0.1
Program Management	69.7	2.4
Total MRS Facility	2,902.4	100.0

TABLE E.2. Annual Cost Estimate for the MRS Facility, By Cost Category (millions of constant 1985 dollars)

Design: Sealed Storage Cask Site: Clinch River, Tennessee

Fiscal Year	Environmental Evaluations	Design	Regulatory Compliance	Construction	Training and Testing	Operation	Decom-missioning	Institutional Interaction	Program Management	Total Program
1986	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.1	1.9	2.8
1987	3.2	8.5	1.5	0.0	0.0	0.0	0.0	0.4	7.0	20.6
1988	1.2	24.2	1.5	0.0	0.0	0.0	0.0	0.4	8.2	35.5
1989	0.4	29.4	1.5	0.0	0.4	0.0	0.0	0.4	8.5	40.6
1990	0.3	23.7	1.5	1.5	0.7	0.0	0.0	0.4	6.7	34.8
1991	0.0	6.5	1.2	37.4	1.4	0.0	0.0	0.4	6.3	53.2
1992	0.0	4.5	0.8	142.5	2.6	0.0	0.0	0.0	6.6	157.0
1993	0.0	0.1	0.8	174.2	5.3	0.0	0.0	0.0	6.2	186.6
1994	0.0	0.0	0.8	174.2	12.1	9.0	0.0	0.0	6.5	202.6
1995	0.0	0.1	0.8	110.3	15.4	11.5	0.0	0.0	4.8	142.9
1996	0.0	0.0	0.4	6.3	24.1	62.2	0.0	0.0	2.2	95.2
1997	0.0	0.0	0.4	0.0	0.0	102.6	0.0	0.0	0.8	103.8
1998	0.0	0.0	0.4	0.0	0.0	135.7	0.0	0.0	0.0	136.1
1999	0.0	0.0	0.4	0.0	0.0	123.7	0.0	0.0	0.0	124.1
2000	0.0	0.0	0.4	0.0	0.0	135.7	0.0	0.0	0.0	136.1
2001	0.0	0.0	0.4	0.0	0.0	90.6	0.0	0.0	0.0	91.0
2002	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2003	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2004	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2005	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2006	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2007	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2008	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2009	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2010	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2011	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2012	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2013	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2014	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2015	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2016	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2017	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2018	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2019	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2020	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2021	0.0	0.0	0.4	0.0	0.0	24.6	1.4	0.0	0.0	26.4
2022	0.0	0.0	0.9	0.0	0.0	9.6	16.2	0.0	0.5	27.2
2023	0.0	0.0	0.9	0.0	0.0	0.0	19.1	0.0	1.0	21.0
2024	0.0	0.0	0.9	0.0	0.0	0.0	17.9	0.0	1.0	19.8
2025	0.0	0.0	0.9	0.0	0.0	0.0	12.4	0.0	1.0	14.3
2026	0.0	0.0	0.9	0.0	0.0	0.0	10.8	0.0	0.5	12.2
TOTAL	5.3	97.2	25.7	646.4	62.0	1915.0	79.0	2.1	69.7	2902.4

E.3 COST ESTIMATES FOR ALTERNATIVE CASES

In addition to the cost estimates for the preferred site-design case explained above, cost estimates are also developed for the five alternative cases. Alternative cases involving the sealed storage cask design at the alternative sites of Hartsville and Oak Ridge, Tennessee, are considered first. The cases involving the alternative storage design (field drywell) at the three alternative sites are then presented. All cost estimates are based on a 12-inch-diameter current design storage canister, which is not specific to the geologic medium of the first repository.

E.3.1 Sealed Storage Cask at Alternative Sites

Table E.3 presents the life-cycle cost estimates for an MRS facility using a sealed storage cask design for all three sites. The difference in cost for these two alternative cases from the preferred site-design case result from the

TABLE E.3. Life-Cycle Cost Estimates for the MRS Facility at the Preferred and Alternative Sites for the Sealed Storage Cask Design

Cost Categories	Millions of Constant 1985 Dollars		
	Clinch River	Hartsville	Oak Ridge
Environmental Evaluations[a]	$5.3	$5.3	$5.3
Design	97.2	97.2	97.2
Regulatory Compliance	25.7	25.7	25.7
Construction	646.4	653.4	635.2
Training and Testing	62.0	62.0	62.0
Operation	1915.0	1915.0	1915.0
Decommissioning	79.0	79.0	79.0
Institutional Interactions	2.1	2.1	2.1
Program Management	69.7	69.7	69.7
Total MRS Facility	$2902.4	$2909.4	$2891.2

(a) The $5.3 million cost is the best estimate at this time for the Clinch River site. Since more data are available for the Clinch River site than the other two sites, costs can be expected to be somewhat higher for the Hartsville and Oak Ridge sites. However, separate estimates have not been made for the other sites.

differences in the site preparation required during construction. The life-cycle cost for the Oak Ridge site is estimated to be about $11 million lower, and that for the Hartsville site is about $7 million higher, than the preferred site-design case.

E.3.2 Field Drywell at the Preferred and Alternative Sites

Table E.4 presents the cost estimates for the MRS facility using the field drywell design at the preferred (Clinch River) site and two alternative sites. The differences in costs, compared to the sealed storage cask design, occur mainly in the cost categories of construction and operation. There are also

TABLE E.4. Life-Cycle Cost Estimates for the MRS Facility with the Field Drywell Design, by Potential Site

	Millions of Constant 1985 Dollars		
Cost Categories	Clinch River	Hartsville	Oak Ridge
Environmental Evaluations[(a)]	$ 5.3	$ 5.3	$ 5.3
Design	97.2	97.2	97.2
Regulatory Compliance	25.7	25.7	25.7
Construction	741.4	717.8	726.9
Training and Testing	62.0	62.0	62.0
Operation	1718.0	1718.0	1718.0
Decommissioning	73.4	73.4	73.4
Institutional Interactions	2.1	2.1	2.1
Program Management	69.7	69.7	69.7
Total MRS Facility	$2794.8	$2771.2	$2780.3

(a) The $5.3 million cost is the best estimate at this time for the Clinch River site. Since more data are available for the Clinch River site than the other two sites, costs can be expected to be somewhat higher for the Hartsville and Oak Ridge sites. However, separate estimates have not been made for the other sites.

smaller differences in costs for decommissioning. There are no differences in the cost estimate for the other six cost categories.[a] Table E.5 presents the specific differences using the preferred Clinch River, Tennessee, site as an example. Total facility life-cycle cost for an MRS facility using the drywell concept is estimated to be $108 million, or about 4% less than the cost estimate for one using the sealed storage cask design. The field drywell design has higher construction costs, yet lower operation and decommissioning costs, than the sealed storage cask design.

TABLE E.5. Cost Differentials Due to Difference in Storage Design at the Clinch River Site

	Millions of Constant 1985 Dollars		
Cost Category	Sealed Storage Cask (SSC)	Field Drywell (FD)	Differences (SSC-FD)
Construction	$646.4	$741.4	-$95
Operation	1915.0	1718.0	197
Decommissioning	79.0	73.4	5.6
Subtotal	$2640.4	$2532.8	$107.6
All other costs	262.0	262.0	
Total Life Cycle	$2902.4	$2794.8	$107.6

E.4 COST SENSITIVITIES AND OTHER FACTORS

While the cost estimates presented above are based upon the best information presently available, actual technical, economic, and institutional factors might deviate from those incorporated into the assumptions used for deriving the cost estimates. The impact of some of these factors can be analyzed through sensitivity testing, while impacts of other factors can only be discussed qualitatively. The sensitivities of the life-cycle cost estimates to changes in the assumptions concerning the staffing requirements during operations, unit labor cost, and real escalation in labor cost are examined first. Other factors affecting cost estimates are then discussed qualitatively.

(a) Because the required size of the site for the MRS facility is different for the two designs, the acquisition costs, if any, are also likely to be different. However, the cost estimates presented do not include such cost items.

E.4.1 Sensitivity to Operations Staffing Requirements

The production operation of the MRS facility is based on 3000 MTU throughput per year. Actual storage conditions at the reactors may dictate either a higher or lower production rate. This could lead to some adjustments in the staffing requirements during operations. If the operation manpower requirement over the operating life of the facility is either 10% higher (or lower) than that of the preferred site-design case, total facility life-cycle cost would be 2.5%, or $73 million, higher (or lower) than the preferred site-design case (see Table E.14, Section E.6).

E.4.2 Sensitivity to Unit Labor Cost

The cost estimate for the preferred site-design case is based on the assumption that unit labor cost stays constant in real terms over the entire program period. The cost estimate would change if either the per person annual wage cost used were changed or if some real wage escalation were assumed. For example, if the unit labor cost for operations over the operating life of the facility is 20% higher (or lower) than that used for the preferred site-design case, the MRS life-cycle cost estimate will be 5%, or $145 million, higher (or lower). Similarly, if unit labor cost is assumed to be escalating at a 1% real rate during operation instead of the 0% real escalation in the preferred site-design case, then the life-cycle cost of the MRS facility can be expected to be 5.1% higher (see Table E.15, Section E.6).

E.4.3 Other Factors Affecting Cost Estimates

Other factors that could potentially affect the cost estimates for the preferred site-design case include the geological medium of the first repository, the timing of congressional approval of the MRS Program, and delays in construction for any reason. The following provides brief qualitative discussions on each of these items.

First, it is useful to note that, among the nine cost categories included in the preferred site-design case cost estimate, the five categories of design, construction, training and testing, operation, and decommissioning, which account for about 96% of total life-cycle costs, have explicitly incorporated a contingency allowance of about 20% to take care of normally unexpected occurrences in the required activities in each of the five elements (see Sections E.1 and E.2).

At this time, three potential geological media are under consideration for the first repository: basalt, salt, and tuff. The requirements for canistering consolidated waste materials at the MRS facility could differ according to the geological medium of the repository. If the waste disposal is to be in either a basalt or a salt repository, packaging the waste canisters into another container might be required. In contrast, the waste might be consolidated and placed into a single container for disposal in a tuff repository. The costs of canisters would differ, depending on the repository geological medium, as would the life-cycle cost estimates for the facility.

The designs for repository-specific canisters are expected to be larger than the current-design MRS canisters and these each can contain larger numbers of consolidated fuel per canister. Therefore, although the cost per repository-specific canister may be higher, total canister costs could be lower than that incorporated into the preferred site-design case using the current design canister, because of the reduced number of canisters needed. At this time, the current design (12-inch-diameter) canister has been used in the preferred site-design case. In this sense, the cost estimate can be viewed as conservative.

The preferred site-design case cost estimate assumed congressional approval for the construction of the MRS facility by July 1986. If approval is delayed, then there would be some added cost involved in carrying and maintaining the program in a ready status for activation until the time approval is granted. The project carrying costs would depend on the actual date of the congressional decision, but is not expected to be high. The major concern, however, is the potential impact the timing of the congressional decision would have on the schedule for deployment of the MRS facility. If the schedule is compressed and overtime is required for construction, then construction cost may be raised. Similarly, substantial delays in construction due to labor- and weather-related work stoppages beyond those covered by the contingency allowances would also add to costs.

E.5 FUNDING

Section 141(b)(2)(B) of the NWPA requires that a funding plan be developed to finance the deployment, operation, and decommissioning of an MRS facility and Section 302 of the NWPA authorizes use of the Nuclear Waste Fund for all MRS activities. Other provisions of the NWPA preclude using appropriated funds from the DOE's regular budget to fund the MRS facility.

This section describes analyses of alternative funding approaches, the rationale for selecting the proposed approach, and the proposed plan to fund the MRS Program. The impact on the total waste management system life-cycle cost is discussed and the annual and cumulative funding requirements for the MRS Program are provided.

E.5.1 Analysis of Alternative Funding Approaches

In this section, the possible alternative approaches for funding the MRS Program are first reduced to those successfully meeting the initial screening criteria. A second set of evaluation criteria are then explained and applied to those alternatives satisfying the initial screening criteria to select the proposed funding approach.

Description and Initial Screening of Alternative Approaches

[illegible] criteria were used for initial screening of potential approaches to fun[illegible] [illegible]e MRS Program. First, given the cost burden requirement of the NWPA, any potential funding approach not meeting such requirement need not be considered further. Thus, any approach to finance the MRS Program from the general revenues of the federal government through the regular DOE budget is excluded. Second, the MRS facility is intended to be an integral part of the federal waste mar[illegible]ment system--the "improved-performance system" of the May 1985 DOE (OCRWM) [illegible]on Plan. From this perspective, an approach that imposes a surcharge on [illegible] [illegible]ne generators and owners of spent fuel which passes through the MRS facility would be inconsistent with the integral nature of the MRS facility. The decision of which fuel will pass through the MRS facility rests on overall system considerations and not on the preferences of individual utilities. Hence, this approach is not considered further.

Given the above criteria considerations, there are only two potential alternative ap[illegible]hes to funding the MRS Program:

1. Waste Fund Approach: With this approach all MRS Program costs would be financed by the Nuclear Waste Fund, established under Section 302(c) of the NWPA to cover the cost of the federal waste management system. The current Nuclear Waste Fund fee is being assessed at 1-mill per kWh of electricity generated from all nuclear power plants. If a required annual review of the fee adequacy were to conclude that the 1-mill per kWh fee would not ensure full cost recovery, then an adjustment to the fee could be requested.

2. Overall Surcharge Approach: With this alternative a separate surcharge would be assessed on all generators and owners of HLW and SNF in order to set up a separate MRS fund to finance the MRS Program.

Evaluation Criteria

Four criteria were used to evaluate these two funding approaches:

1. Cost of Administration: To the extent that alternative approaches achieve the same overall objective, the ones that are easier and less costly to administer and implement would be preferred.

2. Flexibility in Response to Changing Situations: Due to potentially changing economic and operational situations, the charge for waste disposal may need to be adjusted. The approaches that are more flexible from a system standpoint would be preferable to those that are less flexible.

3. Regulatory Acceptance: Nuclear utilities are subject to state and federal regulation through approval of costs and ratesetting. Approaches that require setting up additional reserves for paying waste disposal fees in the future are more likely to run into difficulties in securing regulatory acceptance, particularly in determining the appropriate size of the reserve account.

4. Incentive for Cost-Effective Management of the System: Since the waste management system is complex, costly and has a long planning horizon, it is necessary to have some built-in mechanism which encourages efficient management so that the cost to ratepayers can be kept at the lowest possible level consistent with meeting the overall objective of the waste management system.

Discussion

With the Waste Fund approach, there would be no need, except for accounting purposes, to distinguish between funds used to finance MRS activities and funds used to finance other waste management system activities. With the overall surcharge approach, a separate MRS fund would need to be established and the surcharge amount would be determined separately from the waste fee to ensure that the separate MRS fund would be adequate to finance MRS activities. This additional step would tend to raise the cost of administering the total waste management system. Hence, from the perspective of cost and ease of administration, the Waste Fund approach is preferable to the overall surcharge approach.

Both the Waste Fund and overall surcharge approaches have about the same flexibility to respond to changing economic and waste management system situations. The 1-mill per kWh fee would probably gain wider regulatory acceptance more easily than the overall surcharge approach because it is clearly mandated by Congress in the NWPA, has been in practice since April 1983, and the 1-mill per kWh charge appears relatively fixed and easily understood. In contrast, to determine the amount of separate charge, precise cost estimates of the MRS facility and how the charge would be allocated among utilities would need to be determined. To the extent the cost estimates and utility charges may be contested in regulatory proceedings, there is more uncertainty in the overall surcharge approach concerning regulatory acceptance than the Waste Fund approach.

It could be argued that because the overall surcharge approach would cover only the MRS Program activities whereas the Waste Fund approach covers the overall waste management system, the overall surcharge approach might be more conducive to cost-effective management and control of the MRS activities than the Waste Fund approach. Nevertheless, it should be possible to closely monitor and control the cost of MRS activities under the Waste Fund approach and to achieve the same cost-effective management of the MRS activities as could be achieved under the overall surcharge approach.

The Waste Fund approach is consistent with both the philosophy and the provisions of the NWPA. Section 302(d) of the NWPA provides that expenditures can be made from the Waste Fund only for purposes of radioactive waste disposal activities under Title I and II of the NWPA, including the following (emphasis added):

> "(1) the identification, development, licensing, construction, operation, decommissioning, and post-decommissioning maintenance and monitoring of any repository, <u>monitored, retrievable storage facility</u> or test and evaluation facility constructed under this Act;
> (2) the conducting of nongeneric research, development, and demonstration activities under this Act;
> (3) the administrative cost of the radioactive waste disposal program;
> (4) any costs that may be incurred by the Secretary in connection with the transportation, treating, or packaging of spent nuclear fuel or high-level radioactive waste to be disposed of in a repository, to be stored in a <u>monitored, retrievable storage</u> site or to be used in a test and evaluation facility;
> (5) the costs associated with acquisition, design, modification, replacement, operation, and construction of facilities at a repository site, a <u>monitored, retrievable storage</u> site or a test and evaluation facility site and necessary or incident to such repository, <u>monitored retrievable storage</u> facility or test and evaluation facility; and
> (6) the provision of assistance to States, units of general local government, and Indian tribes under sections 116, 118, and 219."

This statutory language clearly envisions the use of the Waste Fund for MRS-related activities. Funding MRS directly through the Waste Fund rather than through a separate fund via the surcharge approach is more appropriate in that the MRS facility confers benefits directly and indirectly to all contributors to the Waste Fund through improvements in the waste management system, including better integration and performance, and provision of a cost-effective capability to accommodate potential repository schedule changes. Based upon the above considerations, the DOE is confident that financing the MRS Program through the Nuclear Waste Fund is fully justified under the provisions of the NWPA and recommends that the MRS Program be funded through the Waste Fund.

E.5.2 Funding Plan

Based upon the above considerations, the DOE's plan for funding the MRS Program is as follows:

1. The MRS Program will be financed through the Nuclear Waste Fund.

2. Although the federal waste management system is self-financing, the amount of money allowed to be spent from the Nuclear Waste Fund is governed through the federal budget process. The NWPA requires that a budget be submitted for the NWF and provides that appropriations be subject to triennial authorization. The Fund Management Plan (DOE 1984) has been developed for implementation. The budgeting and financial management of the MRS Program will be in accordance with the DOE Fund Management Plan.

3. Each year, the annual costs from the most recent update of the MRS facility cost estimates will be converted into a budget request and incorporated into the overall Nuclear Waste Fund budget request. This budget request will go through the federal budgeting process and would be subject to congressional authorization and appropriation.

4. Disbursement of authorized and appropriated funds for the MRS Program will be controlled and reported according to DOE Order 2200, "Financial Management of Civilian Nuclear Waste Activities."

5. The DOE will continue to conduct an annual review of the 1 mill per kWh fee for waste disposal to determine whether the revenues would be sufficient to finance the total costs of the federal waste management system, including the cost of the MRS facility. If it is determined that the fee is inadequate to assure full cost recovery, an adjustment to the 1-mill per kWh fee will be proposed.

E.5.3 Nuclear Waste Fund

This section briefly explains the revenue sources and temporary financing mechanisms of the Nuclear Waste Fund. The primary source of revenues to the Waste Fund is the fee collected from the owners and generators of HLW and SNF. A secondary source of revenue is the interest income derived from investing any positive balance of the Fund. In the event that there are revenue shortfalls, temporary financing mechanisms are available in the form of congressional appropriations and borrowings from the Treasury.

The DOE has interpreted that the NWPA authorizes collection of a fee of 1 mill per kWh on gross generation of electricity from nuclear power plants on or after April 6, 1983, and a one-time fee on SNF and HLW discharged by April 6, 1983, as well as in-core spent fuel or spent fuel planned to be reinserted into the core as of April 6, 1983 [NWPA, Section 302(a)(2) and (3)]. The NWPA also requires the DOE to annually review the adequacy of the fees collected in funding the waste management activities and to propose adjustment to the unit disposal fee to ensure that the Waste Fund will achieve full cost recovery.

For the fees on gross generation, payments by utilities will be based on actual generation that occurred during a quarter. According to the contractual arrangement, individual utilities must report quarterly on the amount they owe to the Waste Fund, and payments must be made within thirty days after the end of the quarter. Late payments would be assessed with interest charges (10 CFR 961). For long-term planning purposes, the DOE is relying on the Energy Information Administration's mid-growth forecast of electricity generation.

It is estimated that the one-time fee for all accumulated SNF and HLW, in-core spent fuel, or spent fuel planned to be reinserted into the core as of April 6, 1983, for all operating reactors totaled about $2.32 billion. Utilities have three payment options: 1) a single payment by June 30, 1985, 2) payments in 40 quarterly installments, and 3) payments at time of delivery of waste to the federal system. Whereas the 1985 single-payment option is interest free, the delayed-payment options would incur interest charges based on the U.S. Treasury bill rate from 1983 until payments are made (Engel 1985). The amount of single payment under Option 1 was previously assumed to be $770 million (Engel 1985, p. 4.4). As of July 1, 1985, the amount paid into the Waste Fund via the single-payment option was $1.4 billion, almost twice the previously assumed amount.

The President has authorized that defense high-level waste be disposed at the repository. Therefore, the federal government would be paying into the Waste Fund according to a fee schedule to be determined through a ratemaking process that is presently under way. This fee payment by the federal government would become a source of revenue to the Waste Fund.

During the early period of the waste management program, revenues to the Waste Fund could exceed the expenses. In that event, the temporary excess funds are to be invested, and the interest income realized will become a supplemental source for funding the waste management activities in later years [NWPA, Section 302(e)(3)].

Likewise, during the beginning years and prior to substantial payments by utilities, the current expenses could exceed the revenues. The NWPA authorizes congressional appropriations to fund the initial program start-up activities [NWPA, Section 302(c)(2) and (d)]. The Waste Fund can also borrow from the Treasury to meet cash flow requirements [NWPA, Section 302(e)(5)]. However, both the separate appropriations and borrowing from the Treasury will need to be repaid with interest [NWPA, Section 302(e)(6)].

E.5.4 Impact on Total System Life-Cycle Cost

One impact of including an MRS facility in the federal waste management system is that the total system life-cycle cost will be changed, based on current plans and schedules. From the federal waste system perspective, total system life-cycle cost is composed of four major components: development and evaluation (D&E), repositories, MRS, and transportation. As the federal waste management system is changed from one without an MRS facility to the improved-performance system with an integral MRS facility, the four cost components change as follows:

1) Although the new system cost estimates are not yet available, the D&E cost component is not expected to be significantly affected because most of the D&E costs associated with the MRS facility have been included in the MRS life-cycle cost estimate.

2) The costs of surface facilities at the first repository will be reduced because of the transfer of the R&H building and its spent fuel handling, consolidation, and associated support functions from the repository to the MRS facility.

3) The MRS cost component increases from zero to the facility life-cycle cost estimate.

4) The system transportation cost may also change because of the changes in routing and characteristics of spent fuel shipments.

The Development and Evaluation (D&E) cost component includes program costs that support, but are not directly attributable to, the program facility cost categories of design, construction, operation and decommissioning. Typical D&E cost components include:

- DOE program management costs associated with the facility or system components
- system engineering costs
- design verification costs
- environmental documentation costs
- regulatory compliance costs
- training and testing costs
- impact payments, grants, etc. to affected state/local agencies.

Another D&E cost category, in the case of MRS, would be the costs of preparing the proposal to Congress. This "sunk" cost, however, is not included either in the Program Plan or in the Need and Feasibility section of the EA; only estimated-forward (post-proposal) costs are considered in these reports.

The MRS life-cycle cost estimates reported herein contain estimates for cost components equivalent to six of the seven D&E categories itemized above (refer to Section E.1.1). No estimates were included, however, for permitting or NRC licensing of the MRS facility (the federal fee bases have not yet been promulgated) or for state grants and impact payments, which are subject to negotiation under the consultation and cooperation agreements specified in the NWPA.

Repository cost estimates used by the MRS/Repository Interface Task Force (DOE 1985b), and reflected herein in net system cost comparisons with and without MRS, also contained some undefined components of D&E costs. Transportation system cost estimates, however, did not contain such cost estimates. The Task Force adopted the assumption that the D&E costs were a relatively minor component of the total cost, and that changes in non-MRS D&E costs (for the repository and the transportation system) would tend to compensate when an MRS facility is added to the system. That assumption is inherent in the life-cycle cost comparisons used herein.

Estimated changes in the total federal waste management system life-cycle cost components with the inclusion of the MRS facility are shown in Table E.6. The net increase in total system cost ranges from about $1.4 to $2.0 billion in constant 1985 dollars. The MRS facility cost of about $2.9 billion is partially offset by reductions in surface facility costs at the first repository in the range of $1.0 to $1.4 billion. The change in transportation cost is estimated to be in the range of -$0.1 billion to +$0.1 billion.

TABLE E.6. Changes in Total System Life-Cycle Cost of the Waste Management System Due to Inclusion of the Integral MRS Facility[a] (billions of constant 1985 dollars)

Cost Components	Changes in Cost
Development and Evaluation	$0.0
First Repository	-1.4 to -1.0
MRS	+2.9
Transportation	-0.1 to +0.1
Net Change in System Cost	+$1.4 to +$2.0

(a) This analysis assumes all spent fuel, including that from western reactors, is sent to the MRS facility for consolidation and canistering. In the EA, the net change in total system life-cycle cost for the case assuming no western fuel is sent to the MRS facility also is in the range of +$1.4 to +$2.0 billion.

According to the 1985 Fee Adequacy Review (Engel 1985), total waste management system costs, excluding an MRS facility, ranged from $24.5 to $30.6 billion in constant 1985 dollars.[a] Therefore, the incremental costs amount to increases in the total system costs of between 5% to 8%, which is within the uncertainty range of current estimates of total system cost without an MRS facility. Based on results of the 1985 fee adequacy review, and the DOE's assessment of the projected growth of the U.S. nuclear economy, the NWF generated at the current 1-mill per kWh fee level would be adequate for funding the improved performance waste management system (including an integral MRS facility). Consistent with the MRS funding plan described above and with past practice, the annual review of fee adequacy for FY-1986 is currently being conducted, using updated waste management system cost estimates and revenue projections. If this review should indicate that the 1-mill per kWh fee would not generate sufficient revenue to assure full cost recovery for the authorized system, and in the future if Congress approves the improved-performance system, an adjustment to the fee would be submitted for congressional approval.

(a) An inflation rate of 3.8% was used to convert the cost estimates in constant 1984 dollars to constant 1985 dollars.

E.5.5 Funding and Spending Schedules

Table E.7 provides a summary of funding requirements for the preferred site-design case, separating the capital-funded from the operating expense-funded items. Total capital-funded items are estimated to be about $1200 million, including about $700 million for facility design and construction, about $210 million for facility improvements, and about $300 million for the production of the sealed storage casks. The majority ($1410 million) of the operating expense-funded items of $1690 million goes to facility operation. The other operating expense-funded items are preoperational support (about $100 million), decommissioning ($80 million), and other support (about $100 million). (Note that all cost estimates and budget authority cited in this discussion are in terms of constant 1985 dollars.)

It is useful to illustrate the relationship between the funding items shown in Table E.7 and the cost categories shown in Table E.1. Among the nine cost categories shown in Table E.1 (and explained in Sections E.1 and E.2), six categories are treated as totally operating expense-funded: Environmental Evaluations, Regulatory Compliance, Institutional Interactions, Program Management, Training and Testing, and Decommissioning. Except for the two cost categories of Training and Testing and Decommissioning, the other four of the six are grouped under the "Other Support" item in Table E.7.

The cost categories of Design, Construction, and Operation have both capital-funded and operating expense-funded components. For example, the total estimated cost for the Design phase, $97.2 million, is composed of $65 million capital-funded for the design and $32.2 million operating expense-funded. This is shown below:

	Millions of Constant 1985 Dollars		
Design Phase	Capital-Funded	Operating Expense-Funded	Total
Design	$65.0		$65.0
Design Verification		$17.0	17.0
Site Data		6.0	6.0
Operational Support		9.2	9.2
Total Design Phase	$65.0	$32.2	$97.2

TABLE E.7. Summary of Funding Requirements for the MRS Program for the Preferred Site-Design Case

Funding Items	Millions of Constant 1985 Dollars	
Capital-Funded		
Facility Construction		$701.4
Design-Construction		
Design Phase	$65.0	
Construction Phase	80.0	
Construction Contractors	556.4	
Capital Improvement		212.0
Casks		297.0
Total Capital-Funded		$1210.4
Operating Expense-Funded		
Preoperational Support		$ 104.2
Design Verification	$17.0	
Site Data	6.0	
Operational Support Cost During Design Phase	9.2	
Operational Support Cost During Construction Phase	10.0	
Training and Testing	62.0	
Facility Operation		1406.0
Staff	675.4	
Consumable	550.4	
Utilities	180.2	
Decommissioning		79.0
Other Support		102.8
Environmental Evaluation	5.3	
Regulatory Compliance	25.7	
Institutional Interactions	2.1	
Program Management	69.7	
Total Operating Expense-Funded		$1692.0
TOTAL MRS FACILITY		$2902.4

Similarly, the total Construction cost of $646.4 million is composed of $636.4 million capital-funded and $10.0 million operating expense-funded, as shown below:

Construction Phase	Millions of Constant 1985 Dollars Capital-Funded	Operating Expense-Funded	Total
Design-Construction Management	$80.0		$80.0
Construction Contractors	556.4		556.4
Operational Support		$10.0	10.0
Total Construction Phase	$636.4	$10.0	$646.4

As shown below, the total Operation cost of $1915.0 million includes capital-funded items of capital improvements and casks:

Operation Phase	Millions of Constant 1985 Dollars Capital-Funded	Operating Expense-Funded	Total
Facility Operation		$1406.0	$1406.0
Capital Improvements	$212.0		212.0
Casks	297.0		297.0
Total Operation Phase	$509.0	$1406.0	$1915.0

Table E.8 illustrates the annual and total funding requirements for the life-cycle of the MRS facility for the preferred site-design case. Table E.16 provides further details on the annual funding authority, indicating capital-funding or expense-funding. The funding authority required through 1996, when operation starts, is $998 million, including $701.4 million capital funds for the design and construction phases.

Annual funding requirements for the MRS Program will be heaviest during construction and initial operation years, 1991 through 2001. They will range from about $80 million to about $190 million. During the period 2002 through 2016 when the MRS facility is in steady-state operation, annual spending is estimated to be $71.4 million per year. The funding requirement for facility decommissioning is $79 million.

TABLE E.8. Spending and Funding Schedule for the Preferred Site-Design Case (millions of constant 1985 dollars)

Fiscal Year	Capital-Funded		Expense-Funded		Total Project	
	BA	BO	BA	BO	BA	BO
1986	0.0	0.0	7.4	2.8	7.4	2.8
1987	6.2	2.0	18.6	18.6	24.8	20.6
1988	19.0	17.0	17.8	18.5	36.8	35.5
1989	23.8	25.0	15.4	15.6	39.2	40.6
1990	24.4	20.0	15.1	14.8	39.5	34.8
1991	63.2	37.4	16.0	15.8	79.2	53.2
1992	148.6	140.7	15.8	16.3	164.4	157.0
1993	174.5	172.2	16.2	14.4	190.7	186.6
1994	166.0	181.2	21.7	21.4	187.7	202.6
1995	103.4	120.6	27.6	22.3	131.0	142.9
1996	52.1	51.9	45.3	43.3	97.4	95.2
1997	58.0	52.7	53.6	51.1	111.6	103.8
1998	71.1	74.1	62.0	62.0	133.1	136.1
1999	65.1	62.1	62.0	62.0	127.1	124.1
2000	62.8	74.1	62.0	62.0	124.8	136.1
2001	24.1	29.0	62.0	62.0	86.1	91.0
2002	9.4	9.4	62.0	62.0	71.4	71.4
2003	9.4	9.4	62.0	62.0	71.4	71.4
2004	9.4	9.4	62.0	62.0	71.4	71.4
2005	9.4	9.4	62.0	62.0	71.4	71.4
2006	9.4	9.4	62.0	62.0	71.4	71.4
2007	9.4	9.4	62.0	62.0	71.4	71.4
2008	9.4	9.4	62.0	62.0	71.4	71.4
2009	9.4	9.4	62.0	62.0	71.4	71.4
2010	9.4	9.4	62.0	62.0	71.4	71.4
2011	9.4	9.4	62.0	62.0	71.4	71.4
2012	9.4	9.4	62.0	62.0	71.4	71.4
2013	9.4	9.4	62.0	62.0	71.4	71.4
2014	9.4	9.4	62.0	62.0	71.4	71.4
2015	9.4	9.4	62.0	62.0	71.4	71.4
2016	9.4	9.4	62.0	62.0	71.4	71.4
2017	7.1	9.4	52.9	62.0	60.0	71.4
2018	0.0	0.0	25.4	25.4	25.4	25.4
2019	0.0	0.0	25.4	25.4	25.4	25.4
2020	0.0	0.0	25.6	25.4	25.6	25.4
2021	0.0	0.0	26.6	26.4	26.6	26.4
2022	0.0	0.0	25.6	27.2	25.6	27.2
2023	0.0	0.0	20.7	21.0	20.7	21.0
2024	0.0	0.0	18.4	19.8	18.4	19.8
2025	0.0	0.0	13.8	14.3	13.8	14.3
2026	0.0	0.0	9.1	12.2	9.1	12.2
Total MRS Facility	1210.4	1210.4	1692.0	1692.0	2902.4	2902.4

BA = Budget Authority.

BO = Budget Outlays.

E.6 DETAILED COST AND DATA TABLES

Tables E.9 through E.13 present the detailed annual cost estimates for the alternative site-design combinations. Table E.14 presents the sensitivity cases for changes in staffing requirements during operation. Table E.15 presents the sensitivity cases for changes in unit labor costs. Table E.16 provides additional details on the spending and funding schedules shown in Table E.8.

TABLE E.9. Annual Cost Estimate for the MRS Facility, By Cost Category (millions of constant 1985 dollars)

Design: Sealed Storage Cask Site: Hartsville, Tennessee

Fiscal Year	Environmental Evaluations	Design	Regulatory Compliance	Construction	Training and Testing	Operation	Decom-missioning	Institutional Interaction	Program Management	Total Program
1986	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.1	1.9	2.8
1987	3.2	8.5	1.5	0.0	0.0	0.0	0.0	0.4	7.0	20.6
1988	1.2	24.2	1.5	0.0	0.0	0.0	0.0	0.4	8.2	35.5
1989	0.4	29.4	1.5	0.0	0.4	0.0	0.0	0.4	8.5	40.6
1990	0.3	23.7	1.5	1.5	0.7	0.0	0.0	0.4	6.7	34.8
1991	0.0	6.5	1.2	37.7	1.4	0.0	0.0	0.4	6.3	53.5
1992	0.0	4.5	0.8	144.2	2.6	0.0	0.0	0.0	6.6	158.7
1993	0.0	0.1	0.8	176.1	5.3	0.0	0.0	0.0	6.2	188.5
1994	0.0	0.0	0.8	176.1	12.1	9.0	0.0	0.0	6.5	204.5
1995	0.0	0.1	0.8	111.5	15.4	11.5	0.0	0.0	4.8	144.1
1996	0.0	0.0	0.4	6.3	24.1	62.2	0.0	0.0	2.2	95.2
1997	0.0	0.0	0.4	0.0	0.0	102.6	0.0	0.0	0.8	103.8
1998	0.0	0.0	0.4	0.0	0.0	135.7	0.0	0.0	0.0	136.1
1999	0.0	0.0	0.4	0.0	0.0	123.7	0.0	0.0	0.0	124.1
2000	0.0	0.0	0.4	0.0	0.0	135.7	0.0	0.0	0.0	136.1
2001	0.0	0.0	0.4	0.0	0.0	90.6	0.0	0.0	0.0	91.0
2002	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2003	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2004	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2005	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2006	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2007	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2008	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2009	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2010	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2011	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2012	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2013	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2014	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2015	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2016	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2017	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2018	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2019	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2020	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2021	0.0	0.0	0.4	0.0	0.0	24.6	1.4	0.0	0.0	26.4
2022	0.0	0.0	0.9	0.0	0.0	9.6	16.2	0.0	0.5	27.2
2023	0.0	0.0	0.9	0.0	0.0	0.0	19.1	0.0	1.0	21.0
2024	0.0	0.0	0.9	0.0	0.0	0.0	17.9	0.0	1.0	19.8
2025	0.0	0.0	0.9	0.0	0.0	0.0	12.4	0.0	1.0	14.3
2026	0.0	0.0	0.9	0.0	0.0	0.0	10.8	0.0	0.5	12.2
TOTAL	5.3	97.2	25.7	653.4	62.0	1915.0	79.0	2.1	69.7	2909.4

TABLE E.10. Annual Cost Estimate for the MRS Facility, By Cost Category (millions of constant 1985 dollars)

Design: Sealed Storage Cask   Site: Oak Ridge, Tennessee

Fiscal Year	Environmental Evaluations	Design	Regulatory Compliance	Construction	Training and Testing	Operation	Decom-missioning	Institutional Interaction	Program Management	Total Program
1986	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.1	1.9	2.8
1987	3.2	8.5	1.5	0.0	0.0	0.0	0.0	0.4	7.0	20.6
1988	1.2	24.2	1.5	0.0	0.0	0.0	0.0	0.4	8.2	35.5
1989	0.4	29.4	1.5	0.0	0.4	0.0	0.0	0.4	8.5	40.6
1990	0.3	23.7	1.5	1.5	0.7	0.0	0.0	0.4	6.7	34.8
1991	0.0	6.5	1.2	36.9	1.4	0.0	0.0	0.4	6.3	52.7
1992	0.0	4.5	0.8	139.9	2.6	0.0	0.0	0.0	6.6	154.4
1993	0.0	0.1	0.8	171.1	5.3	0.0	0.0	0.0	6.2	183.5
1994	0.0	0.0	0.8	171.1	12.1	9.0	0.0	0.0	6.5	199.5
1995	0.0	0.1	0.8	108.4	15.4	11.5	0.0	0.0	4.8	141.0
1996	0.0	0.0	0.4	6.3	24.1	62.2	0.0	0.0	2.2	95.2
1997	0.0	0.0	0.4	0.0	0.0	102.6	0.0	0.0	0.8	103.8
1998	0.0	0.0	0.4	0.0	0.0	135.7	0.0	0.0	0.0	136.1
1999	0.0	0.0	0.4	0.0	0.0	123.7	0.0	0.0	0.0	124.1
2000	0.0	0.0	0.4	0.0	0.0	135.7	0.0	0.0	0.0	136.1
2001	0.0	0.0	0.4	0.0	0.0	90.6	0.0	0.0	0.0	91.0
2002	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2003	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2004	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2005	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2006	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2007	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2008	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2009	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2010	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2011	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2012	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2013	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2014	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2015	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2016	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2017	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2018	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2019	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2020	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2021	0.0	0.0	0.4	0.0	0.0	24.6	1.4	0.0	0.0	26.4
2022	0.0	0.0	0.9	0.0	0.0	9.6	16.2	0.0	0.5	27.2
2023	0.0	0.0	0.9	0.0	0.0	0.0	19.1	0.0	1.0	21.0
2024	0.0	0.0	0.9	0.0	0.0	0.0	17.9	0.0	1.0	19.8
2025	0.0	0.0	0.9	0.0	0.0	0.0	12.4	0.0	1.0	14.3
2026	0.0	0.0	0.9	0.0	0.0	0.0	10.8	0.0	0.5	12.2
TOTAL	5.3	97.2	25.7	635.2	62.0	1915.0	79.0	2.1	69.7	2891.2

TABLE E.11. Annual Cost Estimate for the MRS Facility, By Cost Category (millions of constant 1985 dollars)

Design: Field Drywells Site: Clinch River, Tennessee

Fiscal Year	Environmental Evaluations	Design	Regulatory Compliance	Construction	Training and Testing	Operation	Decom-missioning	Institutional Interaction	Program Management	Total Program
1986	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.1	1.9	2.8
1987	3.2	8.5	1.5	0.0	0.0	0.0	0.0	0.4	7.0	20.6
1988	1.2	24.2	1.5	0.0	0.0	0.0	0.0	0.4	8.2	35.5
1989	0.4	29.4	1.5	0.0	0.4	0.0	0.0	0.4	8.5	40.6
1990	0.3	23.7	1.5	1.5	0.7	0.0	0.0	0.4	6.7	34.8
1991	0.0	6.5	1.2	50.0	1.4	0.0	0.0	0.4	6.3	65.8
1992	0.0	4.5	0.8	159.5	2.6	0.0	0.0	0.0	6.6	174.0
1993	0.0	0.1	0.8	195.4	5.3	0.0	0.0	0.0	6.2	207.8
1994	0.0	0.0	0.8	195.4	12.1	0.0	0.0	0.0	6.5	214.8
1995	0.0	0.1	0.8	133.3	15.4	0.0	0.0	0.0	4.8	154.4
1996	0.0	0.0	0.4	6.3	24.1	16.1	0.0	0.0	2.2	49.1
1997	0.0	0.0	0.4	0.0	0.0	80.9	0.0	0.0	0.8	82.1
1998	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
1999	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
2000	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
2001	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2002	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2003	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2004	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2005	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2006	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2007	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2008	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2009	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2010	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2011	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2012	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2013	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2014	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2015	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2016	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2017	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2018	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2019	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2020	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2021	0.0	0.0	0.4	0.0	0.0	24.6	1.5	0.0	0.0	26.5
2022	0.0	0.0	0.9	0.0	0.0	9.6	14.9	0.0	0.5	25.9
2023	0.0	0.0	0.9	0.0	0.0	0.0	17.5	0.0	1.0	19.4
2024	0.0	0.0	0.9	0.0	0.0	0.0	16.4	0.0	1.0	18.3
2025	0.0	0.0	0.9	0.0	0.0	0.0	11.4	0.0	1.0	13.3
2026	0.0	0.0	0.9	0.0	0.0	0.0	9.9	0.0	0.5	11.3
TOTAL	5.3	97.2	25.7	741.4	62.0	1718.0	73.4	2.1	69.7	2794.8

TABLE E.12. Annual Cost Estimate for the MRS Facility, By Cost Category (millions of constant 1985 dollars)

Design: Field Drywells Site: Hartsville, Tennessee

Fiscal Year	Environmental Evaluations	Design	Regulatory Compliance	Construction	Training and Testing	Operation	Decom-missioning	Institutional Interaction	Program Management	Total Program
1986	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.1	1.9	2.8
1987	3.2	8.5	1.5	0.0	0.0	0.0	0.0	0.4	7.0	20.6
1988	1.2	24.2	1.5	0.0	0.0	0.0	0.0	0.4	8.2	35.5
1989	0.4	29.4	1.5	0.0	0.4	0.0	0.0	0.4	8.5	40.6
1990	0.3	23.7	1.5	1.5	0.7	0.0	0.0	0.4	6.7	34.8
1991	0.0	6.5	1.2	48.6	1.4	0.0	0.0	0.4	6.3	64.4
1992	0.0	4.5	0.8	154.3	2.6	0.0	0.0	0.0	6.6	168.8
1993	0.0	0.1	0.8	189.0	5.3	0.0	0.0	0.0	6.2	201.4
1994	0.0	0.0	0.8	189.0	12.1	0.0	0.0	0.0	6.5	208.4
1995	0.0	0.1	0.8	129.1	15.4	0.0	0.0	0.0	4.8	150.2
1996	0.0	0.0	0.4	6.3	24.1	16.1	0.0	0.0	2.2	49.1
1997	0.0	0.0	0.4	0.0	0.0	80.9	0.0	0.0	0.8	82.1
1998	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
1999	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
2000	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
2001	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2002	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2003	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2004	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2005	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2006	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2007	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2008	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2009	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2010	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2011	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2012	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2013	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2014	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2015	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2016	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2017	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2018	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2019	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2020	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2021	0.0	1.0	0.4	0.0	0.0	24.6	1.5	0.0	0.0	26.5
2022	0.0	0.0	0.9	0.0	0.0	9.6	14.9	0.0	0.5	25.9
2023	0.0	0.0	0.9	0.0	0.0	0.0	17.5	0.0	1.0	19.4
2024	0.0	0.0	0.9	0.0	0.0	0.0	16.4	0.0	1.0	18.3
2025	0.0	0.0	0.9	0.0	0.0	0.0	11.4	0.0	1.0	13.3
2026	0.0	0.0	0.9	0.0	0.0	0.0	9.9	0.0	0.5	11.3
TOTAL	5.3	97.2	25.7	717.8	62.0	1718.0	73.4	2.1	69.7	2771.2

TABLE E.13. Annual Cost Estimate for the MRS Facility, By Cost Category (millions of constant 1985 dollars)

Design: Field Drywells   Site: Oak Ridge, Tennessee

Fiscal Year	Environmental Evaluations	Design	Regulatory Compliance	Construction	Training and Testing	Operation	Decommissioning	Institutional Interaction	Program Management	Total Program
1986	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.1	1.9	2.8
1987	3.2	8.5	1.5	0.0	0.0	0.0	0.0	0.4	7.0	20.6
1988	1.2	24.2	1.5	0.0	0.0	0.0	0.0	0.4	8.2	35.5
1989	0.4	29.4	1.5	0.0	0.4	0.0	0.0	0.4	8.5	40.6
1990	0.3	23.7	1.5	1.5	0.7	0.0	0.0	0.4	6.7	34.8
1991	0.0	6.5	1.2	49.1	1.4	0.0	0.0	0.4	6.3	64.9
1992	0.0	4.5	0.8	156.3	2.6	0.0	0.0	0.0	6.6	170.8
1993	0.0	0.1	0.8	191.5	5.3	0.0	0.0	0.0	6.2	203.9
1994	0.0	0.0	0.8	191.5	12.1	0.0	0.0	0.0	6.5	210.9
1995	0.0	0.1	0.8	130.7	15.4	0.0	0.0	0.0	4.8	151.8
1996	0.0	0.0	0.4	6.3	24.1	16.1	0.0	0.0	2.2	49.1
1997	0.0	0.0	0.4	0.0	0.0	80.9	0.0	0.0	0.8	82.1
1998	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
1999	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
2000	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
2001	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2002	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2003	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2004	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2005	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2006	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2007	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2008	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2009	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2010	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2011	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2012	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2013	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2014	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2015	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2016	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2017	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2018	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2019	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2020	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2021	0.0	0.0	0.4	0.0	0.0	24.6	1.5	0.0	0.0	26.5
2022	0.0	0.0	0.9	0.0	0.0	9.6	14.9	0.0	0.5	25.9
2023	0.0	0.0	0.9	0.0	0.0	0.0	17.5	0.0	1.0	19.4
2024	0.0	0.0	0.9	0.0	0.0	0.0	16.4	0.0	1.0	18.3
2025	0.0	0.0	0.9	0.0	0.0	0.0	11.4	0.0	1.0	13.3
2026	0.0	0.0	0.9	0.0	0.0	0.0	9.9	0.0	0.5	11.3
TOTAL	5.3	97.2	25.7	726.9	62.0	1718.0	73.4	2.1	69.7	2780.3

TABLE E.14. Sensitivities of Preferred Site-Design Case Cost Estimate to Changes in Staffing Requirements During Facility Operation (millions of constant 1985 dollars)

Design: Sealed Storage Casks Site: Clinch River, Tennessee

Fiscal Year	(1) Total MRS Program	(2) Labor Cost During Operation	(3) Change in Labor Cost due to 10% Change in Staffing Requirements (SR)	(4) Total MRS Program Costs With the Changes In SR: 10% Higher	(5) Total MRS Program Costs With the Changes In SR: 10% Lower	(6) Deviations From Column (1): 10% Higher	(7) Deviations From Column (1): 10% Lower
1986	2.8	0.0	0.0	2.8	2.8	0.0	0.0
1987	20.6	0.0	0.0	20.6	20.6	0.0	0.0
1988	35.5	0.0	0.0	35.5	35.5	0.0	0.0
1989	40.6	0.4	0.0	40.6	40.6	0.1	-0.1
1990	34.8	0.7	0.1	34.9	34.7	0.2	-0.2
1991	53.2	1.4	0.1	53.3	53.1	0.3	-0.3
1992	157.0	2.6	0.3	157.3	156.7	0.2	-0.2
1993	186.6	4.9	0.5	187.1	186.1	0.3	-0.3
1994	193.6	8.5	0.9	194.5	192.8	0.4	-0.4
1995	151.9	11.8	1.2	153.1	150.7	0.8	-0.8
1996	95.2	27.5	2.8	98.0	92.5	2.9	-2.9
1997	103.8	23.2	2.3	106.1	101.5	2.2	-2.2
1998	136.1	28.3	2.8	138.9	133.3	2.1	-2.1
1999	124.1	28.3	2.8	126.9	121.3	2.3	-2.3
2000	136.1	28.3	2.8	138.9	133.3	2.1	-2.1
2001	91.0	28.3	2.8	93.8	88.2	3.1	-3.1
2002	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2003	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2004	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2005	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2006	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2007	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2008	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2009	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2010	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2011	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2012	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2013	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2014	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2015	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2016	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2017	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2018	25.4	18.3	1.8	27.2	23.6	7.2	-7.2
2019	25.4	18.3	1.8	27.2	23.6	7.2	-7.2
2020	25.4	18.3	1.8	27.2	23.6	7.2	-7.2
2021	26.4	18.3	1.8	28.2	24.6	6.9	-6.9
2022	27.2	6.0	0.6	27.8	26.6	2.2	-2.2
2023	21.0	0.0	0.0	21.0	21.0	0.0	0.0
2024	19.8	0.0	0.0	19.8	19.8	0.0	0.0
2025	14.3	0.0	0.0	14.3	14.3	0.0	0.0
2026	12.2	0.0	0.0	12.2	12.2	0.0	0.0
TOTAL	2902.4	726.2	72.6	2975.0	2829.8	2.5	-2.5

Sources and Notes: Col. (1): from Table F.2; Col. (2): derived from R. M. Parsons 1985; Col. (3): (0.1) x Col. (2); Col. (4): Col. (1) + Col. (3); Col. (5): Col. (1) - Col. (3); Col. (6): [Col. (4)/Col. (1) - 1.0] x 100%; Col. (7): [Col. (5)/Col. (1) - 1.0] x 100%.

TABLE E.15. Sensitivities of Preferred Case Cost Estimate to Changes in Unit Wage Cost During Facility Operation (millions of constant 1985 dollars)

Design: Sealed Storage Cask   Site: Clinch River, Tennessee

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
					Total MRS Cost With Changes			% Deviations from Column (2)		
Fiscal Year	Adjustment Factor for 1% Escalation	Total MRS Program	Labor Cost During Operation	Changes in Labor Cost With 20% Change in Unit Labor Cost	Labor Cost 20% Higher	Labor Cost 20% Lower	1% Real Escalation	Labor Cost 20% Higher	Labor Cost 20% Lower	1% Real Escalation
1986	0.000	2.8	0.0	0.0	2.8	2.8	2.8	0.0	0.0	0.0
1987	0.000	20.6	0.0	0.0	20.0	20.6	20.6	0.0	0.0	0.0
1988	0.000	35.5	0.0	0.0	35.5	35.5	35.5	0.0	0.0	0.0
1989	1.000	40.6	0.4	0.1	40.7	40.5	40.6	0.2	-0.2	0.0
1990	1.010	34.8	0.7	0.1	34.9	34.7	34.8	0.4	-0.4	0.0
1991	1.020	53.2	1.4	0.3	53.5	52.9	53.2	0.5	-0.5	0.1
1992	1.030	157.0	2.6	0.5	157.5	156.6	157.1	0.3	-0.3	0.1
1993	1.041	186.6	4.9	1.0	187.6	185.6	186.8	0.5	-0.5	0.1
1994	1.051	193.6	8.5	1.7	195.3	191.9	194.0	0.9	-0.9	0.2
1995	1.062	151.9	11.8	2.4	154.3	149.5	152.6	1.6	-1.6	0.5
1996	1.072	95.2	27.5	5.5	100.7	89.7	97.2	5.8	-5.8	2.1
1997	1.083	103.8	23.2	4.6	108.4	99.2	105.7	4.5	-4.5	1.9
1998	1.094	136.1	28.3	5.7	141.8	130.4	138.8	4.2	-4.2	1.9
1999	1.105	124.1	28.3	5.7	129.8	118.4	127.1	4.6	-4.6	2.4
2000	1.116	136.1	28.3	5.7	141.8	130.4	139.4	4.2	-4.2	2.4
2001	1.127	91.0	28.3	5.7	96.7	85.3	94.6	6.2	-6.2	3.9
2002	1.138	71.4	28.3	5.7	77.1	65.7	75.3	7.9	-7.9	5.5
2003	1.150	71.4	28.3	5.7	77.1	65.7	75.6	7.9	-7.9	5.9
2004	1.161	71.4	28.3	5.7	77.1	65.7	75.0	7.9	-7.9	6.4
2005	1.173	71.4	28.3	5.7	77.1	65.7	76.3	7.9	-7.9	6.8
2006	1.184	71.4	28.3	5.7	77.1	65.7	76.6	7.9	-7.9	7.3
2007	1.196	71.4	28.3	5.7	77.1	65.7	76.9	7.9	-7.9	7.8
2008	1.208	71.4	28.3	5.7	77.1	65.7	77.3	7.9	-7.9	8.2
2009	1.220	71.4	28.3	5.7	77.1	65.7	77.6	7.9	-7.9	8.7
2010	1.232	71.4	28.3	5.7	77.1	65.7	78.0	7.9	-7.9	9.2
2011	1.245	71.4	28.3	5.7	77.1	65.7	78.3	7.9	-7.9	9.7
2012	1.257	71.4	28.3	5.7	77.1	65.7	78.7	7.9	-7.9	10.2
2013	1.270	71.4	28.3	5.7	77.1	65.7	79.0	7.9	-7.9	10.7
2014	1.282	71.4	28.3	5.7	77.1	65.7	79.4	7.9	-7.9	11.2
2015	1.295	71.4	28.3	5.7	77.1	65.7	79.8	7.9	-7.9	12.7
2016	1.308	71.4	28.3	5.7	77.1	65.7	80.1	7.9	-7.9	12.2
2017	1.321	71.4	28.3	5.7	77.1	65.7	80.5	7.9	-7.9	12.7
2018	1.335	25.4	18.3	3.7	29.1	21.7	31.5	14.4	-14.4	24.1
2019	1.348	25.4	18.3	3.7	29.1	21.7	31.8	14.4	-14.4	25.1
2020	1.361	25.4	18.3	3.7	29.1	21.7	32.0	14.4	-14.4	26.0
2021	1.375	26.4	18.3	3.7	30.1	22.7	33.3	13.9	-13.9	26.0
2022	1.389	27.2	6.0	1.2	28.4	26.0	29.5	4.4	-4.4	8.6
2023	1.403	21.0	0.0	0.0	21.0	21.0	21.0	0.0	0.0	0.0
2024	1.417	19.8	0.0	0.0	19.8	19.8	19.8	0.0	0.0	0.0
2025	1.431	14.3	0.0	0.0	14.3	14.3	14.3	0.0	0.0	0.0
2026	1.445	12.2	0.0	0.0	12.2	12.2	12.2	0.0	0.0	0.0
TOTAL		2902.4	726.2	145.2	3047.6	2757.2	3051.6	5.0	-5.0	5.1

Sources and Notes: Col. (1): $(1.01)^{t-1989}$ where t is year from 1989 on. For 1987 through 1988, the adjustment factor is assigned 1.0. Col. (2): from Table F.2; Col. (3): Derived from R. M. Parsons, 1985; Col. (4): (0.2) x Col. (3); (Col. (5): Col. (2) + Col. (4); Col. (6): Col. (2) - Col. (4); Col. (7): Col. (2) + [Col. (1) - 1.0] x Col. (3). Col. (8): [Col. (5)/Col. (2) - 1.0] x 100; Col. (9): [Col. (6)/Col. (2) - 1.0] x 100; Col. (10): [Col. (7)/Col. (2) - 1.0] x 100.

TABLE E.16. Detailed Spending and Funding Schedules (millions of constant 1985 dollars)

Fiscal Year	Capital-Funded: Facility Construction BA	BO	Capital-Funded: Facility Modification BA	BO	Capital-Funded: Casks BA	BO	Operating Expense-Funded: Preoperation Support[a] BA	BO	Operating Expense-Funded: Facility Operation BA	BO	Operating Expense-Funded: Decommissioning BA	BO	Operating Expense-Funded: Other Project Support[b] BA	BO	Total Project BA	BO
1986	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.2	0.0	0.0	0.0	0.0	5.6	2.6	7.4	2.8
1987	6.2	2.0	0.0	0.0	0.0	0.0	6.7	6.5	0.0	0.0	0.0	0.0	11.9	12.1	24.8	20.6
1988	19.0	17.0	0.0	0.0	0.0	0.0	6.6	7.2	0.0	0.0	0.0	0.0	11.2	11.3	36.8	35.5
1989	23.8	25.0	0.0	0.0	0.0	0.0	5.1	4.8	0.0	0.0	0.0	0.0	10.3	10.8	39.2	40.6
1990	24.4	20.0	0.0	0.0	0.0	0.0	6.4	5.9	0.0	0.0	0.0	0.0	8.7	8.9	39.5	34.8
1991	63.2	37.4	0.0	0.0	0.0	0.0	8.2	7.9	0.0	0.0	0.0	0.0	7.8	7.9	79.2	53.2
1992	148.6	140.7	0.0	0.0	0.0	0.0	8.5	8.9	0.0	0.0	0.0	0.0	7.3	7.4	164.4	157.0
1993	172.2	172.2	0.0	0.0	2.3	0.0	9.1	7.4	0.0	0.0	0.0	0.0	7.1	7.0	190.7	186.6
1994	156.4	172.2	0.0	0.0	9.6	9.5	14.8	14.1	0.0	0.0	0.0	0.0	6.9	7.3	187.7	202.6
1995	83.3	109.1	0.0	0.0	20.1	11.0	22.7	16.7	2.0	0.0	0.0	0.0	4.9	5.6	131.0	142.9
1996	4.2	5.8	0.0	0.0	47.8	46.1	14.3	24.6	28.7	16.1	0.0	0.0	2.3	2.6	97.4	95.2
1997	0.0	0.0	5.3	0.0	52.7	52.7	0.0	0.0	52.3	49.9	0.0	0.0	0.8	1.2	111.6	103.8
1998	0.0	0.0	18.4	21.4	52.7	52.7	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	133.1	136.1
1999	0.0	0.0	12.4	9.4	52.7	52.7	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	127.1	124.1
2000	0.0	0.0	18.4	21.4	44.4	52.7	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	124.8	136.1
2001	0.0	0.0	9.4	9.4	14.7	19.6	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	86.1	91.0
2002	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2003	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2004	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2005	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2006	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2007	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2008	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2009	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2010	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2011	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2012	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2013	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2014	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2015	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2016	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2017	0.0	0.0	7.1	9.4	0.0	0.0	0.0	0.0	47.8	61.6	0.1	0.0	0.4	0.4	60.0	71.4
2018	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.6	24.6	0.4	0.4	0.4	0.4	25.4	25.4
2019	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.6	24.6	0.4	0.4	0.4	0.4	25.4	25.4
2020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.6	24.6	0.6	0.4	0.4	0.4	25.6	25.4
2021	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.8	24.6	5.1	1.4	0.7	0.4	26.6	26.4
2022	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	9.6	17.0	16.2	1.5	1.4	25.6	27.2
2023	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.8	19.1	1.9	1.9	20.7	21.0
2024	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.5	17.9	1.9	1.9	18.4	19.8
2025	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0	12.4	1.8	1.9	13.8	14.3
2026	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.1	10.8	1.0	1.4	9.1	12.2
TOTAL	701.4	701.4	212.0	212.0	297.0	297.0	104.2	104.2	1406.0	1406.0	79.0	79.0	102.8	102.8	2902.4	2902.4

(a) Preoperation support includes costs of design verification, collection of design-related site data, operation contractor support to design ($9.2M) and construction ($10M), and training and testing ($62M).
(b) Other project support includes costs for four categories: Environmental Evaluations, Regulatory Compliance, Institutional Interactions, and Program Management.
BA = Budget authority; BO = Budget outlays.

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DOE/RW-0035
Volume 3 of 3 Volumes

Nuclear Waste Policy Act

Monitored Retrievable Storage Submission to Congress

Volume 3

Monitored Retrievable Storage
Program Plan

PREFACE

On January 7, 1983, President Reagan signed the Nuclear Waste Policy Act (NWPA) of 1982, which establishes the federal policy for disposal of commercial spent nuclear fuel and high-level radioactive waste. The NWPA instructs the Secretary of Energy to start accepting spent fuel and high-level waste for disposal in a deep geologic repository by January 1998. The NWPA also states that storage of high-level radioactive waste or spent fuel in a monitored retrievable storage (MRS) facility is an option for providing safe and reliable management of such waste or spent fuel.

Section 141 of the NWPA instructs the Secretary of Energy to prepare a proposal for construction of one or more MRS facilities. The NWPA states that the proposal to Congress shall include the establishment of a federal program for the siting, development, construction, and operation of such facilities; a plan for funding the construction and operation of such facilities; a plan for integrating the facilities with other storage and disposal facilities authorized in the NWPA; and site-specific designs and cost estimates. The proposal is to be accompanied by an environmental assessment.

In response to these requirements, the Office of Civilian Radioactive Waste Management in the Department of Energy (DOE) has prepared this submission to Congress. The submission consists of three volumes, described below. The required site-specific designs and cost estimates are incorporated by reference.

The first volume, The MRS Proposal, describes the DOE's proposal to construct and operate an MRS facility at the Clinch River Site in Roane County, Tennessee. The proposed MRS facility would be an integral part of the federal waste management system and would perform most of the waste-preparation functions before emplacement in a repository.

The second volume, The Environmental Assessment, is divided into two parts. Part 1 examines the need for and feasibility of constructing an MRS facility as an integral component of the waste management system. Part 2 includes descriptions of two facility design concepts at each of three candidate sites, and a detailed assessment and comparison of the environmental impacts associated with each of the six site-design combinations.

The third volume, The Program Plan, describes the activities, costs and schedules for establishing a federal program to site, develop, construct, and operate an MRS facility, if approved by Congress. It includes plans for funding the construction and operation of an MRS facility and for integrating the facility with other waste management facilities authorized in the NWPA.

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TABLE

1.0 INTRODUCTION

This Program Plan has been prepared in response to the requirements of Section 141 of the Nuclear Waste Policy Act (NWPA) of 1982. It describes the Department of Energy's (DOE) proposed program for developing, constructing, and operating a monitored retrievable storage (MRS) facility. The MRS facility, if approved by Congress, will be an integral part of the federal waste management system and will perform the necessary waste preparation functions for spent fuel prior to its emplacement in a repository.[a]

This document presents the current DOE program objectives and the strategy for implementing the proposed program for the integral MRS facility. If the MRS proposal is approved by Congress, DOE will periodically review the need to revise or update this Program Plan. Any needed revisions to the Program Plan will be made available to the Congress, the State of Tennessee, affected Indian tribes, local governments, other federal agencies, and the public.

The NWPA requires that the proposal for constructing an MRS facility include:

1. the establishment of a federal program for the siting, development, construction, and operation of MRS facilities [Section 141(b)(2)(A)]

2. a plan for funding the construction and operation of MRS facilities [Section 141(b)(2)(B)]

3. site-specific designs, specifications, and cost estimates for the first such facility [Section 141(b)(2)(C)]

4. a plan for integrating MRS facilities with other storage and disposal facilities authorized by the NWPA [Section 141(b)(2)(D)].

This plan includes the information required in Items 1, 2, and 4, and a summary of the cost estimates required in Item 3. Detailed site-specific designs, specifications, and cost estimates for an MRS facility are provided in the DOE's Conceptual Design Report (Ralph M. Parsons Company 1985).

Chapter 2.0 of this Program Plan provides an overview of the proposed MRS Program. It describes the functions of an MRS facility and includes a discussion of schedules, costs, and management approaches for implementing the Program. Chapter 3.0 identifies the elements which will comprise the MRS

(a) Present and future verb tenses are used for ease in describing this Program Plan and do not imply that an MRS facility will be approved or built.

program and provides further details on proposed program activities and schedules. Chapter 4.0 contains schedule information on the integration of the MRS Program with other DOE programs and with other waste management facilities authorized by the NWPA. Chapter 5.0 describes the funding plan proposed for MRS facility development, construction, operation, and decommissioning. The source of funding and funding needs are both discussed. Detailed information to support the Program Plan is provided in the appendices.

2.0 PROGRAM OVERVIEW

This chapter provides an overview of the MRS Program by presenting and discussing the proposed functions and site for the MRS facility, a proposed schedule for key program activities, the estimated costs of the program, and the proposed DOE management approach and responsibilities for implementing the program, if the MRS proposal is approved by Congress.

2.1 MRS FACILITY FUNCTIONS

The MRS facility will be an integral part of the federal waste management system. Its primary functions will be to receive spent fuel assemblies from commercial nuclear power plants, consolidate them (i.e., disassemble them to reduce their volume), package them in sealed canisters, and ship them to the repository for disposal. It will also provide temporary storage for up to 15,000 MTU (metric tons uranium) of the canistered spent fuel, if required. It will receive, consolidate, and package between 2500 and 3000 MTU of spent fuel annually. The facility will be licensed by the Nuclear Regulatory Commission (NRC). Figure 2.1 depicts the operation of the MRS facility.

2.2 PROPOSED MRS SITE

The proposal to Congress for the MRS facility recommends that the facility be constructed at the Clinch River site in Tennessee. The Clinch River site, located 25 miles west of Knoxville, is adjacent to the DOE's Oak Ridge reservation and lies within the Roane County portion of the city of Oak Ridge. The site covers only a portion of the site area for the canceled Clinch River Breeder Reactor project.

2.3 PROGRAM SCHEDULE

The deployment schedule,[a] shown in Figure 2.2, presents major events that must occur prior to operation of the MRS facility. The proposed MRS facility will be operational approximately 10 years after the date of congressional approval. Initial operation will be at a reduced capacity. Operation

(a) To correlate program activities with specific dates, it was necessary to assume a starting date for the program. The starting date will depend on the date of congressional approval of the MRS proposal but was assumed to be July 1986.

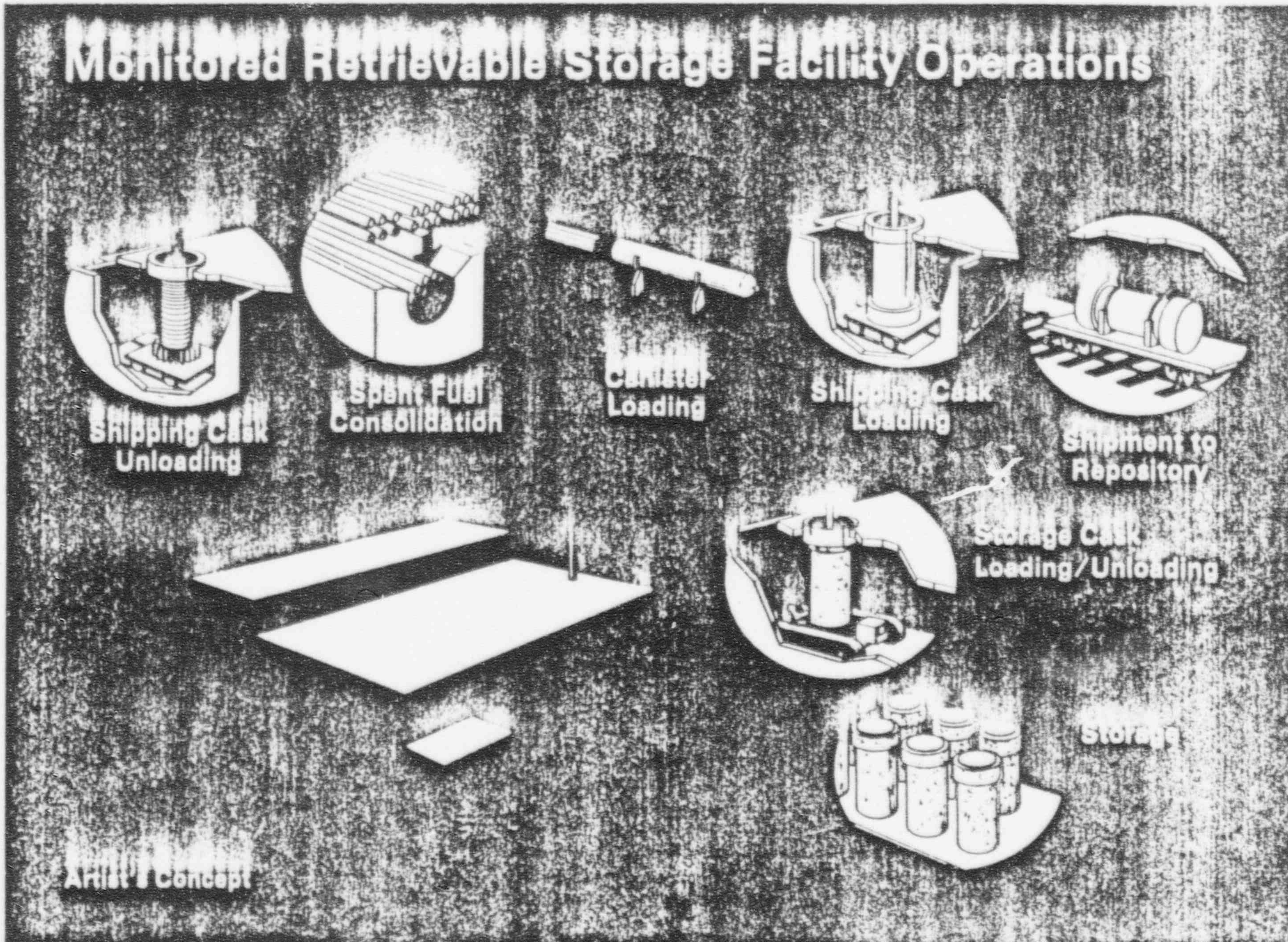

FIGURE 2.1. Monitored Retrievable Storage Facility Operations

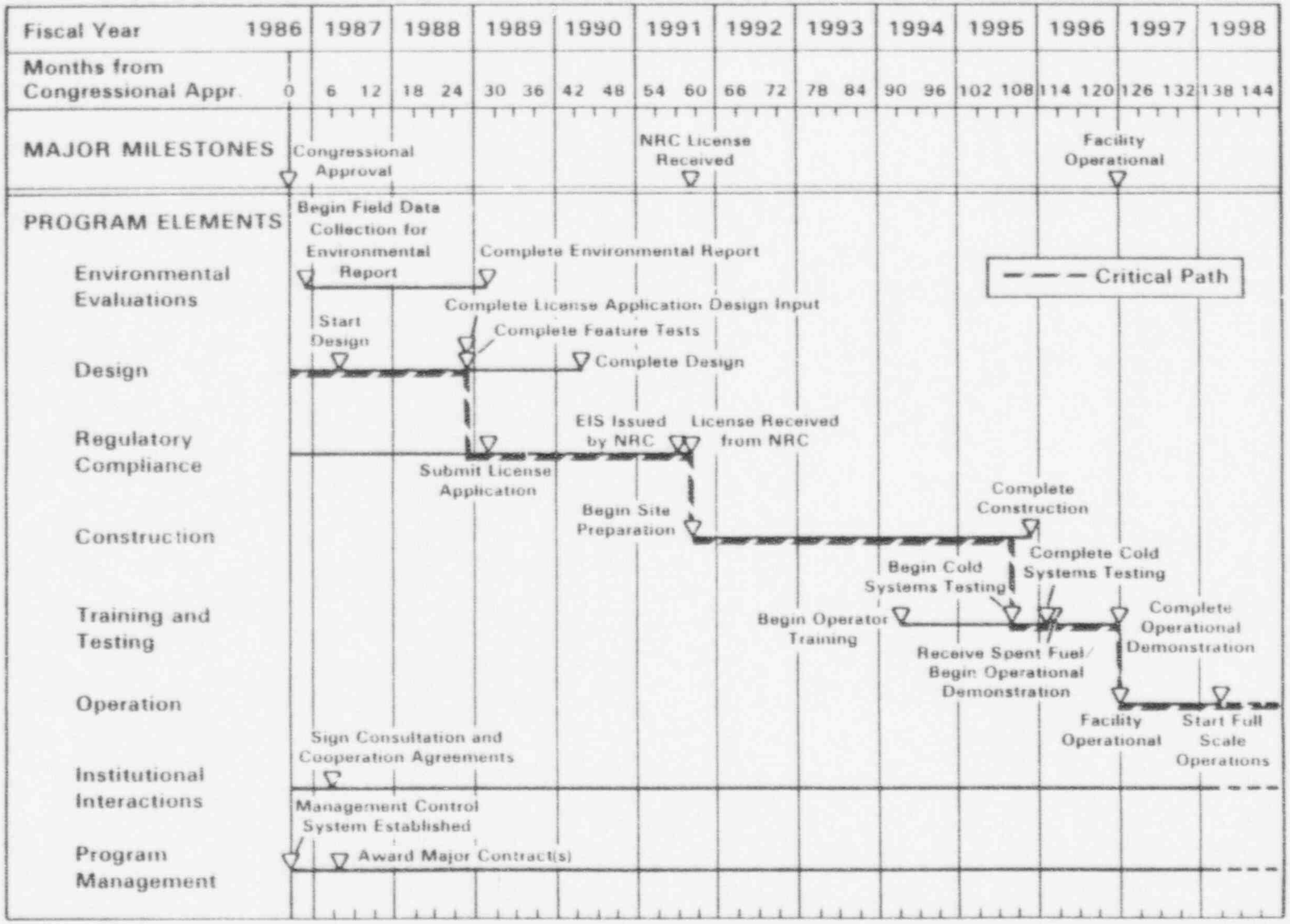

FIGURE 2.2. MRS Deployment Schedule

at full capacity will be achieved about 15 months after initial operation. The MRS facility will service the first repository and will operate for approximately 26 years. Decommissioning of the facility will be completed approximately 4 years after operations cease.

Figure 2.2, the MRS deployment schedule, identifies key milestones and the critical path to operation of the MRS facility. The following discussion describes the activities that correspond with the milestones on the deployment schedule.

Early activities in the Environmental Evaluations and Design elements support the preparation of a license application to the NRC for construction and operation of the MRS facility. In order to submit a license application, the DOE must have sufficient information on facility design and expected performance and on the potential environmental effects of the facility so that the NRC can make a judgment on whether to grant a license. The license application does not require a complete definitive design of the entire facility, only those portions that affect safety or environmental impact. Design of other portions of the facility (e.g., the administration buildings) will continue after the license application is submitted.

Two other elements that will be initiated immediately upon receipt of congressional approval of the MRS proposal are the Institutional Interactions element and the Program Management element. An initial activity in the Institutional Interactions element will be the establishment of binding Consultation and Cooperation Agreements with the State of Tennessee. These agreements will specify the processes and procedures for interactions between the State of Tennessee and the DOE relative to MRS facility development. The Program Management element will adapt state-of-the-art management control systems to support sound and efficient management of the program.

As shown on the Regulatory Compliance line of the deployment schedule, 30 months are allowed for the NRC review, issuance of the Environmental Impact Statement (EIS), and the granting of a license. Following receipt of the license from the NRC, the approximately 4-year construction effort for the facility will begin. After construction is completed there will be approximately 1 year of testing and demonstration before the facility becomes operational.

2.4 ESTIMATED COSTS

The costs for implementing the MRS Program were estimated using information developed as a part of the conceptual design effort (Ralph M. Parsons Company 1985) which also supports the MRS submission to Congress. Analysis of other program activities necessary to deploy and operate the MRS facility provided supplemental information that was used in the cost estimate.

The cost estimate is based on development of an MRS facility that uses the sealed storage cask design and is located at the Clinch River site in Tennessee. The facility functions and schedule used in the cost estimate were briefly described in Sections 2.1 and 2.2.

The cost of the program from the time of congressional approval until the facility becomes operational will be approximately $970 million. From this total, approximately $700 million of capital funds will be used for facility design and construction. The annual operating costs of the facility, which will employ about 600 workers, will be approximately $70 million. The costs are higher during the initial years of operation when the sealed storage casks must be procured and lower in the later years when the MRS facility stops receiving spent fuel and is only shipping spent fuel canisters to the repository. The cost of decommissioning the facility following completion of operations will be approximately $80 million.

All costs are in constant 1985 dollars. The estimates do not include costs for financial assistance to state and local governments.

It should be noted that inclusion of an integral MRS facility in the waste management system will reduce the costs of other components of the system (e.g., the repository). These cost reductions are discussed in Chapter 5 and Appendix E of this Program Plan and in Volume 2 of this submission to Congress, Environmental Assessment for a Monitored Retrievable Storage Facility.

2.5 MANAGEMENT APPROACH AND RESPONSIBILITIES

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

The OCRWM's operations are 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, the 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. This section describes the organizational structure of the OCRWM and the approach and responsibilities for implementating the MRS Program, if approved by Congress.

As shown in Figure 2.3, the OCRWM is organized by staff responsibility and functional responsibility. The Office of Policy and Outreach provides staff support. The three major functional components are 1) the Office of Resource Management, 2) the Office of Geologic Repositories, and 3) the Office of Storage and Transportation Systems.

The Director of the OCRWM interacts regularly with the Secretary of Energy in establishing overall policy and ensuring that the activities of OCRWM

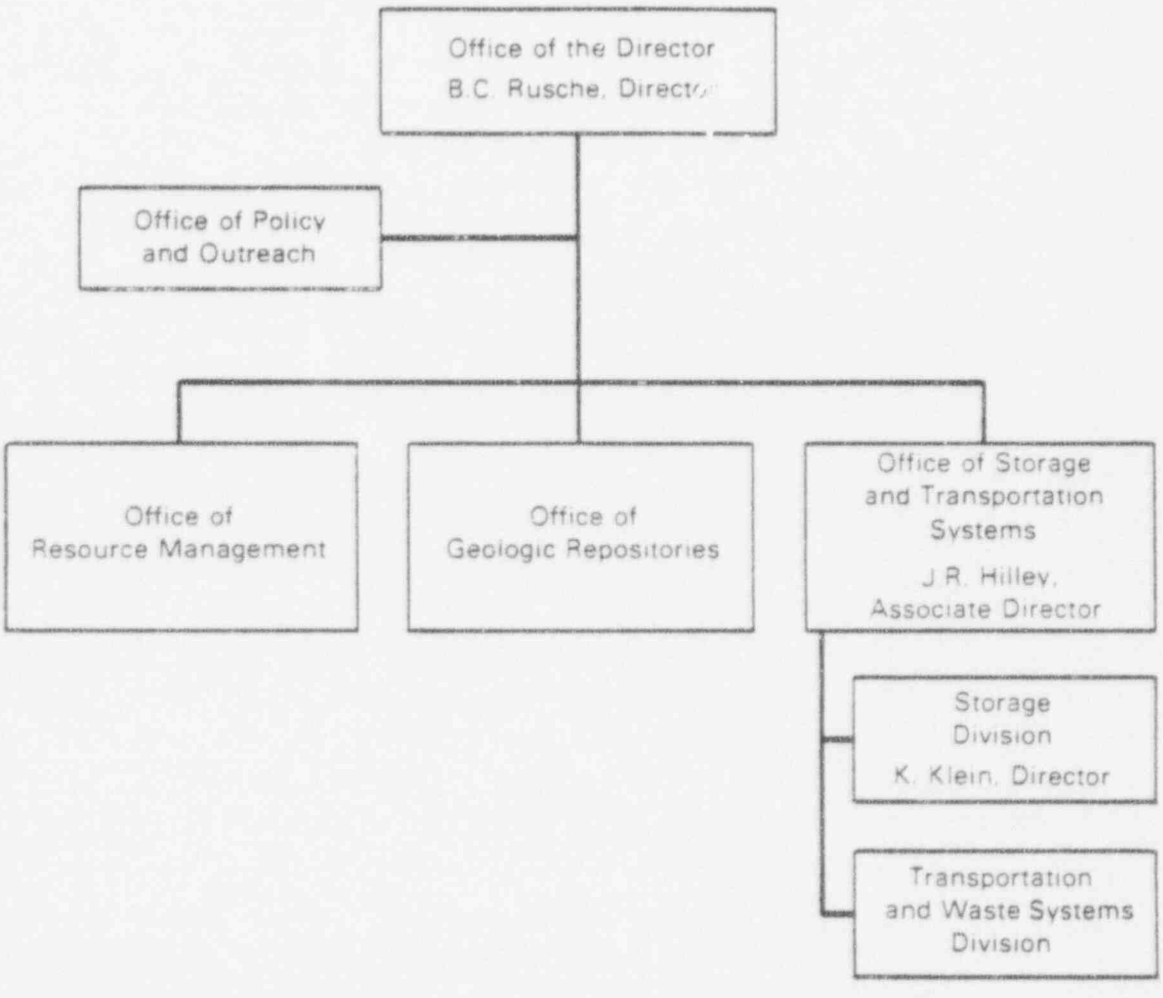

FIGURE 2.3. The Office of Civilian Radioactive Waste Management

components are properly focused, paced, and integrated. His associate directors and their staff guide the project offices in implementing major program decisions.

The Office of Policy 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 associate director for Resource Management and his staff administer the Nuclear Waste Fund and the Interim Storage Fund. This responsibility 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.

The associate director for Geologic Repositories and his staff have primary responsibility to site, design, construct, operate, close, and decommission geologic repositories for spent nuclear fuel and high-level waste.

The associate director for Storage and Transportation Systems and his staff implement all storage and transportation activities. The Office is responsible for developing: 1) a systems integration approach that coordinates all activities for the entire federal waste management system; 2) R&D to support increased at-reactor storage and 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; 3) an MRS facility, if approved by Congress; and 4) a transportation system that will meet the requirements of the waste management system.

The Storage Division of the Office of Storage and Transportation Systems has developed the Monitored Retrievable Storage submission to Congress and will be responsible for policy and direction of the MRS Program, if the MRS proposal is approved by Congress.

The responsibility for implementation of this Program Plan will be assigned to the Oak Ridge Operations Office. An MRS Project Office will be established within the Operations Office.

3.0 DEPLOYMENT PLAN

This chapter describes the activities and schedule for implementing the MRS Program. The activities and schedules are discussed in terms of program elements. These elements were developed by analysis and grouping of the many and diverse activities that are required to develop, operate and decommission an MRS facility. The following elements make up the MRS Program:

- Environmental Evaluations
- Design
- Regulatory Compliance
- Construction
- Training and Testing
- Operation
- Decommissioning
- Institutional Interactions
- Program Management.

The chapter is organized by program element in the same order as listed above. For each element, the objective and scope are stated, and the status at the time of proposal submittal is provided as background information. Planned activities and schedules within each element and the interfaces with other activities and program elements are described. Anticipated interactions with other government organizations, regulatory agencies, state and local governments, and the public are included. A master schedule, which combines the individual program element schedules, is given in Section 3.10.

3.1 ENVIRONMENTAL EVALUATIONS

The objective of the Environmental Evaluations element is to evaluate the environmental effects of proposed MRS Program activities and to provide guidance to other program elements on monitoring for and control of these effects. Work in this element includes collection of any additional environmental data determined to be needed on the Clinch River site and surroundings, evaluation of impacts on the environment, monitoring and guidance of other program elements whose activities could potentially affect the environment, and preparation of all environmental documentation related to the development, operation, and decommissioning of an MRS facility.

3.1.1 Background

The NWPA directs the Secretary of Energy to prepare an Environmental Assessment (EA) on at least five alternative combinations of proposed sites and facility designs. The EA analyzes the relative advantages and disadvantages among the site-design combinations. It is based on a conceptual design for a facility that is an integral component of the federal waste management system, with a design capability to receive, prepare, and ship up to 3600 metric tons of uranium (MTU) per year.[a]

The EA is only one of several documents that consider the environmental impacts of constructing and operating an MRS facility. Documentation ranges from the consideration of environmental factors during the site screening process (DOE 1985a) to the future preparation of an Environmental Report. The NRC will prepare and issue an Environmental Impact Statement to support their licensing action for the MRS facility.

Other documents related to environmental evaluations for the MRS facility include the following:

- Environmental Assessment on 10 CFR 72 Proposed Revisions (NRC 1984)
- Reference-Site Environmental Document (Silviera 1985)
- Site Screening and Evaluation Report (Golder Associates 1985)
- Regulatory Assessment Document (Ralph M. Parsons Company, Vol. II 1985).

3.1.2 Planned Activities

Discussions will be held with the NRC to confirm the scope of environmental data needed to support the license application. In addition, discussions with state and local officials will assist DOE in scoping the issues that need more detailed evaluation. Based on these discussions, any additional field data needed to estimate the environmental impacts will be identified. These data will be collected by a contractor for use in the preparation of an Environmental Report that will accompany the license application to the NRC. Other activities will be to monitor and guide other program elements such as design, construction, and decommissioning, whose activities could potentially

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(a) Within this program plan, the MRS receipt, preparation and shipment of spent fuel is referred to as throughput. The design throughput for the MRS facility operating 4 shifts, 7 days a week, is 3600 MTU per year of spent fuel. The planned throughput of 2500 to 3000 MTU per year can be achieved with a 3-shift, 5 day-per-week operation. The larger throughput was analyzed in the EA to assure that the maximum potential impacts were considered.

affect the environment. The key document produced will be the Environmental Report which is discussed in more detail below.

Environmental Report

The schedule of activities to support the Environmental Report is shown in Figure 3.1. Upon congressional approval to proceed with deployment of an MRS facility, verification of environmental characteristics of the site and surroundings will begin by identifying specific characterization needs. Detailed environmental data was collected for the Clinch River site to support the Environmental Report for the Clinch River Breeder Reactor Plant (PMC 1975 and Amendments through 1982). Much of this data is applicable to the Environmental Report for an MRS facility at the Clinch River site. An early activity will be detailed evaluation of this existing data to determine the additional data needs. These needs may include the collection of baseline environmental data about meteorology, air quality, geologic and hydrologic characteristics and use; surface-water quality; and natural background radiation. Other types of site and regional data that may need to be updated include ecological conditions and socioeconomic characteristics.

The NRC requires that an Environmental Report be submitted with the license application for the MRS facility. In accordance with NRC requirements,

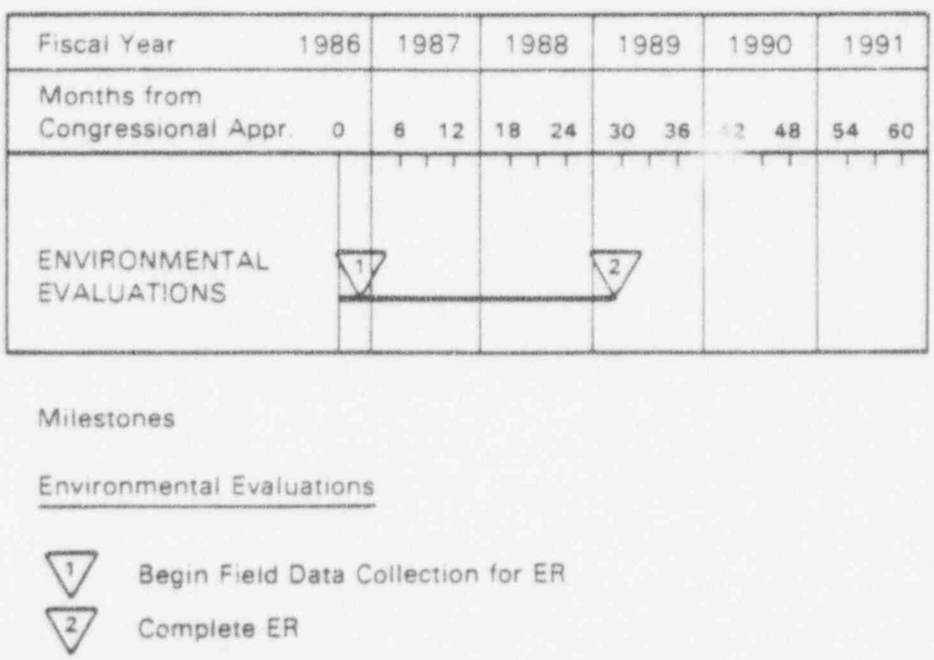


FIGURE 3.1. Schedule for Environmental Evaluations

the Environmental Report will discuss the potential environmental impacts (and mitigation of those impacts) resulting from construction and operation of an MRS facility at the Clinch River site. The Environmental Report will also discuss alternative designs, consistent with the requirements of the NWPA and with any additional requirements that Congress may impose as conditions for approving the MRS proposal.

Field data collection at the site will begin after obtaining any permits that may be required. This activity will result in an updated collection of environmental information obtained through both environmental monitoring and verification of available site data. This updated site data, together with design information related to construction, operation and decommissioning, will be used to prepare the Environmental Report.

3.2 DESIGN

With the MRS facility conceptual design (Ralph M. Parsons Company 1985) as a starting point, the objectives of the Design element are 1) to develop an MRS facility definitive (detailed) design that emphasizes safety, cost effectiveness, operability, and reliability; and 2) to verify performance of the design for key MRS systems. Work in this element includes collecting site engineering data; performing design optimization studies; identifying quality requirements for procurement and construction; developing technical specifications; identifying limiting operating conditions; and preparing design documents required for licensing, equipment procurement, installation, and acceptance, and for facility construction and acceptance. Tests and demonstrations will be performed to verify performance of key systems and the results will be factored into the final design.

3.2.1 Background

In order to select a storage concept for MRS, eight dry storage concepts[(a)] employing passive cooling of spent fuel were identified and design studies were performed for each using a common set of design requirements. These concepts were then evaluated and compared in terms of a set of criteria that included safety, environmental and socioeconomic impacts, siting, cost, technological maturity, and facility flexibility.

(a) The Monitored Retrievable Storage Proposal Research and Development Report (DOE 1983a), which was required by the NWPA and submitted to Congress in June 1983, concluded that all of these storage concepts were sufficiently mature to allow development of an MRS proposal without additional research and development.

Based on these evaluations, two storage concepts were selected (DOE 1984a). The sealed storage cask (SSC) concept was selected as the primary storage concept. Its design is simple, economical, and sufficiently flexible to accommodate all proposed waste forms and packages in any incremental quantity required, and it is relatively independent of site characteristics. In addition, the accumulated experience with cask storage provides assurance of safe, reliable operations and accurate cost estimates. The field drywell was selected as the alternative storage concept for similar reasons; however, the drywell is more dependent on site characteristics and requires more land area than the sealed storage cask for equivalent amounts of storage.

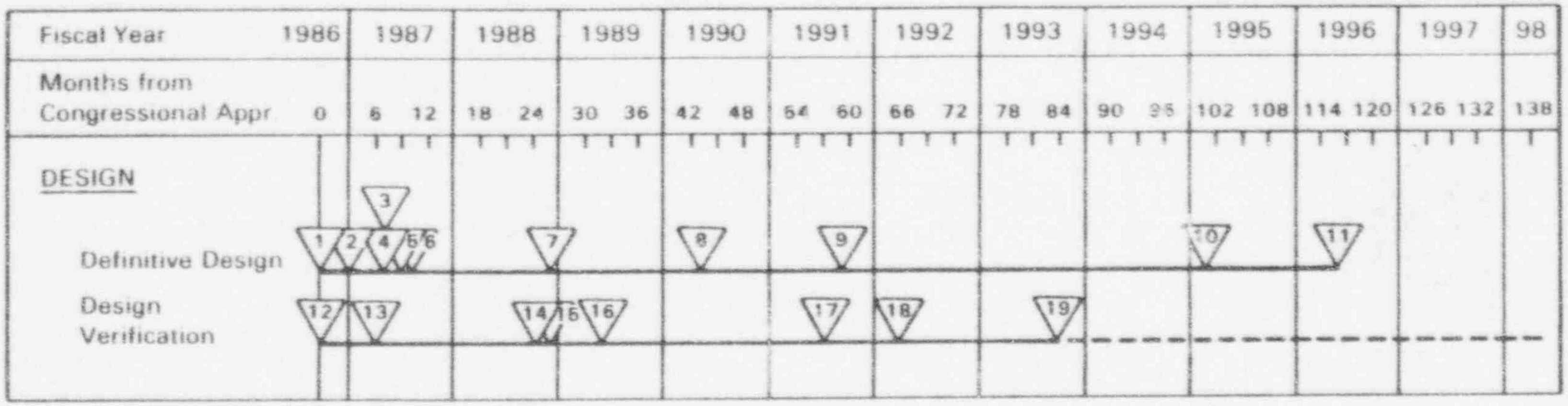
Conceptual designs were developed for both storage concepts located at three different sites. These conceptual designs are for facilities that receive, unload, disassemble and consolidate, canister, and temporarily store or directly ship spent fuel to a geologic repository.

The conceptual designs are documented in the MRS Facility Conceptual Design Report (Ralph M. Parsons Company 1985). The conceptual design was performed under stringent quality assurance requirements consistent with the ANSI/ASME Standard NQA-1 (ASME 1983). The Conceptual Design Report describes the design features and operations of the facility; documents how expected licensing requirements were incorporated in the design; and includes the conceptual drawings, design calculations, cost estimates, and design studies performed to date. Also identified in the Conceptual Design Report are areas that require further design study. These and additional studies that may be identified during review of the present conceptual design will be performed during the definitive design.

The conceptual design encompasses a number of technologies that must be interfaced to provide a facility that will safely, reliably and efficiently receive, handle, disassemble, package, temporarily store and ship commercial spent nuclear fuel. Although each of the principal subsystems or "features" of the MRS design is derived from a mature technology, they have not been demonstrated as combined systems under the operating conditions or at the production rates required for the MRS facility. Therefore, there is a need for limited design verification testing that includes tests of individual features of the MRS design as well as prototype MRS systems demonstrations.

3.2.2 Planned Activities

Activities for the Design element are discussed in terms of those required for preparation of the definitive design and those required for verification of the design. The schedule for these activities is shown in Figure 3.2. The scope and schedule of work has been developed to provide timely input to



Milestones

Definitive Design

1. Begin Site Data Confirmation
2. Canister Configuration Interface Baselined
3. Start Design
4. Transportation Cask Interface Baselined
5. Decision on Waste Reduction Concepts
6. Complete Site Data Collection
7. Complete License Application Design Input
8. Complete Design
9. Begin Field Inspection
10. Begin As Built Drawings
11. Complete As Built Drawings

Design Verification

12. Begin Test Plan Development
13. Begin Feature Tests
14. Start SSC Testing
15. Complete Feature Tests
16. Complete SSC Performance Testing
17. Begin Prototype Consolidation Equipment Tests
18. Complete Prototype Consolidation Equipment Tests
19. Complete 5 Year SSC Tests

FIGURE 3.2. Schedule for Design

support the license application to the NRC, and to provide the drawings and specifications necessary for construction of an MRS facility.

Definitive Design

Detailed identification and confirmation of site data required for the design will be initiated immediately following congressional approval. Collection of site data (such as soil and rock characteristics needed to design building foundations) will start after obtaining any required site investigation permits.

The initial design activity will be a review of the conceptual design to identify any outstanding needs. There were a few instances in the conceptual design activity where a particular process or design feature was selected because it was a demonstrably safe and feasible method of meeting the design requirements. In the definitive design, additional studies will be undertaken to determine if other approaches or design features also meet the safety and feasibility requirements, but are preferable because they offer lower cost or higher reliability. One area that has been identified for evaluation is the methodology for volume reduction of the spent fuel hardware that remains after the fuel rods are removed and consolidated. Additional studies and a decision on the volume reduction concept are planned early in the definitive design.

The MRS Program will coordinate with the other DOE waste management programs to establish design interfaces for system components common to these programs (e.g., the canister and the transportation cask). These interfaces will be put under baseline control, so that no changes will be made in features that affect another program without full review and analysis of impacts by all programs involved. As designs become further advanced the design baseline will become more complete and specific. The MRS facility design will have sufficient flexiblity to accommodate any uncertainties in the interfaces.

Other early design work will include optimization and tradeoff studies for the purpose of identifying and evaluating approaches which would lead to reduction of radiological exposure (including application of the ALARA principle to occupational and public exposure), reduction of costs, or improvements in operability and reliability. Quality standards for structures, systems, and components important to safety as defined by 10 CFR 72 will be designated to ensure that safety and reliability goals are met. To meet the requirements of applicable NRC regulations and DOE orders, technical specifications will be developed and limiting conditions for operations will be identified. Sufficient design information will be available to support submission of the license application to the NRC prior to completion of the definitive design.

Documents needed for construction of the MRS facility, including detailed drawings and procurement, construction, and installation specifications for the facilities and equipment, will continue to be developed after submittal of the license application. As part of the remaining design, a systems description document will be completed. The systems description document will describe in detail the specific process systems and equipment used in the MRS facility and their methods of operation and maintenance. The document will become the basis for the operations and maintenance manuals. Once the construction documents are completed, the detailed acceptance test plan for the facility will be prepared. The total time required for definitive design is 3 years.

The final activities performed in the design consist of field engineering inspection to verify that construction is in accordance with the design drawings and specifications, processing and approving design changes made during construction, and preparing as-built drawings.

Design Verification

Several types of tests are planned for design verification; these tests are described more fully in Appendix C and Section 3.5 of this Program Plan:

- Feature Tests - tests performed to verify conceptual design choices for individual components, equipment, processes, and materials.
- Systems Development Tests - tests to assist in the design of the disassembly and consolidation equipment.
- Prototype demonstrations - tests to verify operability of major systems.
- Preoperational Tests - tests performed on MRS systems installed in the facility before receipt of spent fuel (described in Section 3.5, Training and Testing).

Feature Tests. Feature tests are planned for components or subsystems of the disassembly, packaging and storage systems. Equipment components for which feature tests are currently planned include:

- Robotics - tests of equipment for automated remote operations, such as cask handling, sampling, and unbolting.
- Canisters - tests to verify the integrity of canisters during storage or after an accidental drop.

- Welding - tests of equipment selected to weld canisters and cask liners.

- Volume Reduction - tests of equipment to shred, melt, or incinerate contaminated materials.

Wherever possible the feature tests will be done "cold" (i.e., without use of radioactive materials). Verification of "hot" performance (i.e., with radioactive materials) will be achieved in subsequent system demonstrations. Preparation of test plans will be initiated upon congressional approval and feature tests will start shortly thereafter.

<u>System Development Tests</u>. The spent fuel disassembly and consolidation system is a mechanical system that must operate remotely. Although spent-fuel rods have been pulled from assemblies in large quantities and some few assemblies have been consolidated, this MRS system must operate on a production basis in a hot cell. Development tests already included in tne DOE's Prototypical Consolidation Development Project will be performed concurrently with design of this system to assure its operability and reliability. The current schedule for these tests (see Chapter 4.0 and Appendix C) calls for completion of most tests in time to provide confirmation of designs to be submitted with the MRS license application.

<u>Prototype Demonstrations</u>. Prototype demonstrations are planned for the sealed storage cask and the spent fuel consolidation/packaging systems. The sealed storage cask demonstration will consist of two phases. The first phase will be a short-term verification of the cask thermal, shielding, and structural performance. The thermal and shielding tests will be done with a cask containing consolidated spent fuel. The structural performance tests will include drop and impact tests. The second phase involves long-term tests to monitor the thermal and shielding performance with periodic inspections to measure any material or performance degradation.

A spent fuel disassembly and consolidation demonstration is planned to demonstrate the capability of achieving the operability and reliability goals. All key subsystems will be tested, including fuel disassembly and packaging, radioactive scale collection, volume reduction of hardware, canister decontamination, and associated handling apparatufM The scope and extent of any hot tests that may be needed will be determined from the results of cold tests.

3.3 REGULATORY COMPLIANCE

The objective of the Regulatory Compliance element is to obtain 1) applicable permits from the State of Tennessee, local governing bodies, and the Environmental Protection Agency (EPA); and 2) a license from the NRC to receive, prepare, and store spent nuclear fuel. This element identifies permitting and licensing requirements, ensures that the applications and supporting information for the required permits and licenses are filed with the EPA, state and local agencies, and the NRC at the earliest feasible time and ensures that appropriate regulations and agency standards applicable to the MRS facility are met.

3.3.1 Background

The MRS Program must comply with the requirements of the National Environmental Policy Act (NEPA), the regulations of the EPA and the NRC, and many specific federal, state, and local statutes, regulations, and standards. In addition, the DOE has developed standards for DOE-owned nuclear facilities that are applicable to the MRS facility. The DOE and other federal requirements are enumerated in Volume 2, Appendix C of this submission to Congress, Environmental Assessment for a Monitored Retrievable Storage Facility. The DOE will also comply with the applicable statutes and requirements of the State of Tennessee and the local governmental entities.

The DOE is committed to provide a safe and environmentally acceptable facility. The independent reviews and inspections specified in the regulatory requirements will provide additional assurance that public health and safety, environmental values, and socioeconomic impacts are adequately addressed during design, construction, and operation of the MRS facility. The permitting and licensing processes described below provide for review and approval by the agencies involved and for involvement of the public and other interested parties at various points in the processes.

The NWPA requires that the MRS facility, if approved by Congress, be licensed by the NRC. The NRC has indicated that they intend to use 10 CFR 72 as the basis for licensing the MRS facility (NRC 1984). The purpose of the licensing requirements is to protect the health and safety of the public and the environment. The licensing process used by the NRC provides for information dissemination to the public through NRC public document rooms and for review and comment on the NRC draft Environmental Impact Statement by federal agencies, affected state and local governments, and other interested parties. In addition, the regulations provide for public hearings, as needed, before a license is issued.

Since the NRC requirements pertain to all activities from site characterization through design, construction, operation, and decommissioning, the DOE has consulted with the NRC, as directed by the NWPA, during preparation of the conceptual designs and the proposal. In addition, the NRC observed and provided comments on a DOE design review and a quality assurance audit of the design process.

As a part of the conceptual design, a Regulatory Assessment Document was prepared to document, to a degree commensurate with this stage of the design process, the design features provided to ensure compliance with each requirement in 10 CFR 72. The Regulatory Assessment Document, Volume II of the Conceptual Design Report (Ralph M. Parsons Company 1985), references a preliminary evaluation of off-normal events and the design features that will provide for safe operation in spite of malfunctions or operational errors. The radiological impacts of postulated accidents are documented in Volume 2 of this submission to Congress, Environmental Assessment of a Monitored Retrievable Storage Facility. The conclusions drawn from these studies are that the facility design will provide the requisite level of safety, and the radiological impacts on the public will be well below EPA and NRC regulatory limits.

The reasons for these conclusions are:

- The radioactivity content and heat release of the five- (or more) year-old spent fuel to be handled at the MRS facility are much lower than that of freshly discharged fuel handled at reactors.

- The release of significant quantities of radioactive material can result only from an energetic driving force such as high temperatures or pressures which will not be present in an MRS facility.

- The multiple barriers used to prevent release of radioactivity are metallic containers, reinforced concrete, and highly efficient ventilation filters which are carefully engineered and tested and which have been routinely used for this purpose for more than 40 years.

- The facility is designed to limit any dispersal from 1) very unlikely events such as major earthquakes and 2) events which must be anticipated, such as dropping a spent fuel assembly.

The activities planned for regulatory compliance are summarized below. A more detailed description of the plans for licensing the MRS facility with the NRC is contained in Appendix D.

3.3.2 Planned Activities

The schedule for the Regulatory Compliance element is shown in Figure 3.3. After approval of the MRS proposal by Congress, the DOE will arrange meetings with the EPA, the NRC, and the State of Tennessee and local governments to discuss the plans for the facility and to obtain guidance on the requirements to be met and the permits or licenses to be obtained. A regulatory compliance plan will be prepared that will identify the times at which applications for various permits and licenses are needed, the data that must be provided in the applications, and the agencies that will issue the permits and licenses. The schedule of activities to obtain the necessary data and to make applications will be included in the plan. This plan will be the primary mechanism for providing guidance on regulatory matters to other program elements and for monitoring progress toward compliance.

State and Local Governments

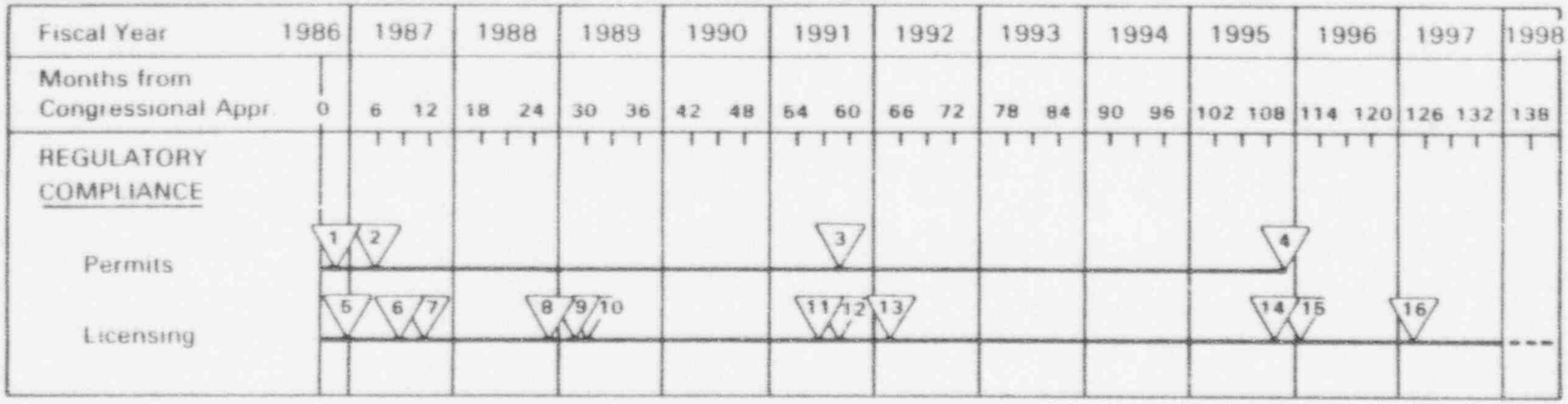
State and local governmental requirements to which the MRS facility must conform include land-use and zoning laws; air, water, noise, and solid waste pollution control laws; hazardous waste disposal laws; transportation laws and ordinances, including carrier statutes and vehicle permit laws; state and local occupational and public health and safety laws; state environmental review statutes; and specific statutes pertaining to preservation of environmental values.

Specific permits and requirements will be identified early so that they can be factored into plans for site and regional data collection, for facility design, and for supporting utilities and the local infrastructure. Meetings with state and local officials in the early stages of the program will establish lines of communications that will promote mutual understanding of needs and requirements.

The Environmental Protection Agency

The EPA is responsible for protection of the general environment and has issued regulations for control of offsite releases of radioactivity, emissions of pollutants to the air or water, and disposal of solid wastes.

The environmental standards for the uranium fuel cycle and management of spent nuclear fuel and high-level wastes are contained in 40 CFR 190 and 191. These EPA standards are implemented by the NRC through their regulations, specifically 10 CFR 72, and through issuance of a license for the MRS facility.



Milestones

Permits

1. Receive Site Investigation Permits
2. Complete Regulatory Compliance Plan
3. Receive Site Utilization Permits
4. Complete Permitting

Licensing

5. Establish Procedural Agreement with NRC
6. Begin Preparation of SAR
7. Submit First Topical Reports to NRC
8. Complete Safety Assessment and SAR
9. Submit License Application
10. LA Docketed
11. EIS Issued by NRC
12. License Received from NRC
13. Submit First Semiannual SAR Update
14. Submit Final Semiannual SAR Update and Final Technical Specifications
15. Submit Preoperational Test Criteria and Test Results to NRC
16. Submit First Annual SAR Update to NRC

FIGURE 3.3. Schedule for Regulatory Compliance

The EPA has responsibility for implementing the Clean Air Act, the Clean Water Act, and the Resource Conservation and Recovery Act. Since the EPA delegates its regulatory authority to their regional offices and in some cases to individual states, coordination with these offices will be required. A listing of the related federal statutes and regulations is given in Volume 2, Appendix C of this submission to Congress, Environmental Assessment for a Monitored Retrievable Storage Facility.

Interactions with the NRC

To ensure that the MRS facility is deployed on a planned schedule, it is necessary that the DOE and the NRC reach agreement on the activities related to licensing that will be required of each agency. As soon as possible after congressional approval, the DOE will seek to enter into a Procedural Agreement with the NRC on plans and actions that will foster cooperation on planning of licensing activities including NEPA, and establish an open information exchange between the DOE and the NRC. The existing Procedural Agreement between the DOE and the NRC for the conduct of the geologic repository program serves as a precedent for agreements on the MRS Program.

One objective of the Procedural Agreement is to provide for meetings, prior to submitting a license application, at which appropriate management and technical personnel of both agencies could discuss plans, review progress, and facilitate the resolution of problems. The meetings will be open to the public. Another objective is to obtain agreement that NRC staff will review and comment on Topical Reports submitted to the NRC. The purpose of these reports will be to receive an NRC staff evaluation before completion of design and submittal of the license application, that the technical plans and analytic techniques are adequate to meet the requirements foreseen by the NRC.

Based upon interactions with the NRC, the EPA, and the State of Tennessee, the Regulatory Compliance element will develop guidance for the site investigation studies and definitive design. This guidance will be included in the Regulatory Compliance Plan, and used as input to update the bases for definitive design and to prepare a systems studies plan that specifies the optimization and design trade-off studies to be performed during the design.

Preparation of the NRC License Application

It will take about two and one-half years to develop all of the information required for the NRC License Application. Part 72 of 10 CFR requires that the application contain a Safety Analysis Report (SAR), an Environmental Report, and a number of plans for operations. The design and safety studies will be carefully planned and scheduled so that the SAR contains a safety assessment of the final design of all structures, systems, and components important to safety. The Regulatory Compliance element will ensure that the information required is available for preparation of the SAR at about the midpoint in the design process. The license application will be submitted about 4 months later.

The MRS Program schedule assumes that the NRC review process will take 30 months from application to issuance of a license. Although a longer review period may be required in the event of serious contentions which require extensive hearings and appeals, a shorter period may be sufficient in the absence of unresolved issues. The DOE believes that the scheduled 30 months is reasonable in view of the proposed pre-licensing interactions with the NRC.

NRC Requirements During Construction and Testing

After receipt of a license, the DOE will proceed with site preparation and construction. During this period, the major NRC requirements that will need to be addressed involve inspection and the assurance that quality standards specified in the design are met for purchased materials and equipment, and for major construction and installation and that the conditions of the license are met. The NRC also requires that an updated SAR be submitted semiannually throughout the period.

The final semiannual SAR update must be delivered to the NRC no later than 3 months before spent fuel is to be received at the MRS facility. The final semiannual SAR update will be followed by a report to the NRC containing the acceptance criteria and test results of the preoperational tests. This report must be submitted at least 1 month before the intended date for receipt of spent fuel.

After receipt of spent fuel, the preoperational tests will be continued in one cell at a time to test each component and system required in normal operation. The throughput rate of the facility will be judiciously increased during the hot demonstration period as more experience is gained in the use of the operating procedures and in the operating characteristics of the processes and equipment. All operations with spent fuel will be in accordance with the Technical Specifications approved by the NRC. In addition, the SAR will be updated on an annual basis in accordance with NRC requirements throughout the operational phase.

3.4 CONSTRUCTION

The objective of this element is to construct a licensed MRS facility from the drawings and specifications prepared by the Design element. Work to be undertaken in the Construction element includes procurement of equipment; selection of contractors; improvements to the site; and construction of the Receiving and Handling (R&H) building, the storage facility, and the support buildings.

3.4.1 Background

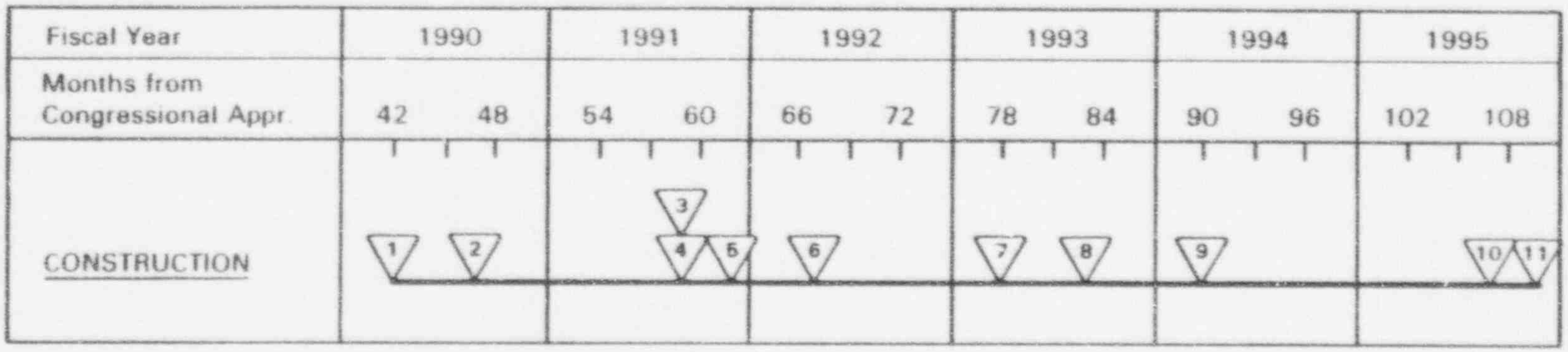
The conceptual design completed for the MRS proposal includes drawings, outline specifications for construction, cost estimates, and a construction schedule. Evaluation of the information developed in the conceptual design process leads to the conclusion that the facility can be successfully constructed at any of the candidate sites. The construction schedule and plans described below are based on the information developed in the conceptual design.

3.4.2 Planned Activities

The schedule for the Construction element is shown in Figure 3.4. Construction field work is not scheduled to start until the NRC issues a license for the MRS facility. Prior to receiving the license, procurement activities will be initiated for specialized equipment that require long lead times to obtain, particularly the R&H building equipment. This will ensure that material and equipment are available to support field work.

Construction will begin immediately upon receipt of the license from the NRC. The first step will be field work to improve the site so construction of the R&H building, the storage facility, and the support buildings can commence. Improvements to the site include clearing the land, constructing roads and railroads onsite and offsite, grading, installing drainage, installing fences, and landscaping. Fabrication of special equipment to be installed in the R&H building will also be initiated at this time.

Construction of the R&H building, the storage facility, and the support buildings will follow site improvement activities. Design work to date shows that the R&H building is on the critical path to completion of construction. Therefore, R&H building construction will begin as soon as the needed site improvements are completed. Actions to procure consolidation equipment will also be initiated at that time.



Milestones

1. Prepare Long Lead Item Bid Package
2. Solicit Bids for R&H Building Equipment
3. Begin Site Preparation
4. Begin R&H Building Equipment Fabrication
5. Begin Concrete Pours
6. Begin Consolidation Equipment Procurement
7. Complete Site Mockup Facility
8. Begin R&H Building Equipment Installation
9. Complete Consolidation Equipment Installation in Mockup Facility
10. Complete Equipment and Controls Installation
11. Complete Construction

FIGURE 3.4. Schedule for Construction

Construction of the storage facility and the support buildings will be coordinated with construction of the R&H building. Included with the storage facility construction are the concrete cask support pads to be used with the sealed storage casks. The site services building will be constructed early since it will contain a mockup area of the R&H building hot cell. Prototype equipment will be installed in the mockup area for equipment testing and staff training in a nonradioactive environment.

Construction is estimated to be completed in about 50 months. The R&H building is on the critical path. This schedule is based on 2 shifts per day and 40 hours per week for each shift involved in constructing the R&H building. The schedule assumes no major work interruptions caused by bad weather or labor disputes. Construction of the other support buildings and storage areas is scheduled to be completed within the time-frame required for the R&H building.

The equipment and structures of the MRS facility are designed to be constructed using standard materials and normal construction practices. There will be no specialty items used in construction of the facility. There are many construction contractors with the experience and capabilities required to build the MRS facility. The quality requirements identified during the design period will be implemented by the construction contractors. Inspections will be planned and performed to conform with the QA plan and procedures. Quality assurance requirements will meet or exceed ANSI/ASME Standard NQA-1.

3.5 TRAINING AND TESTING

The objective of the Training and Testing element is to provide a trained staff and a tested facility that can function together to meet the MRS operating goals. Work to be undertaken in this element includes reviewing the design for operability and maintainability, preparing operations and maintenance manuals and procedures, monitoring construction, performing construction acceptance tests, preparing training manuals, and conducting preoperational systems tests.

3.5.1 Background

The Mission Plan for the OCRWM Program proposed that an MRS facility receive 2200 MTU of spent nuclear fuel prior to 1998 (DOE 1985b). To accomplish this mission, it will be necessary to have a trained and experienced operating staff and an operating facility ready for routine spent-fuel receiving and handling operations by late 1996. All handling, processing, and storage equipment must also have been tested and operated successfully using actual spent fuel by that time.

3.5.2 Planned Activities

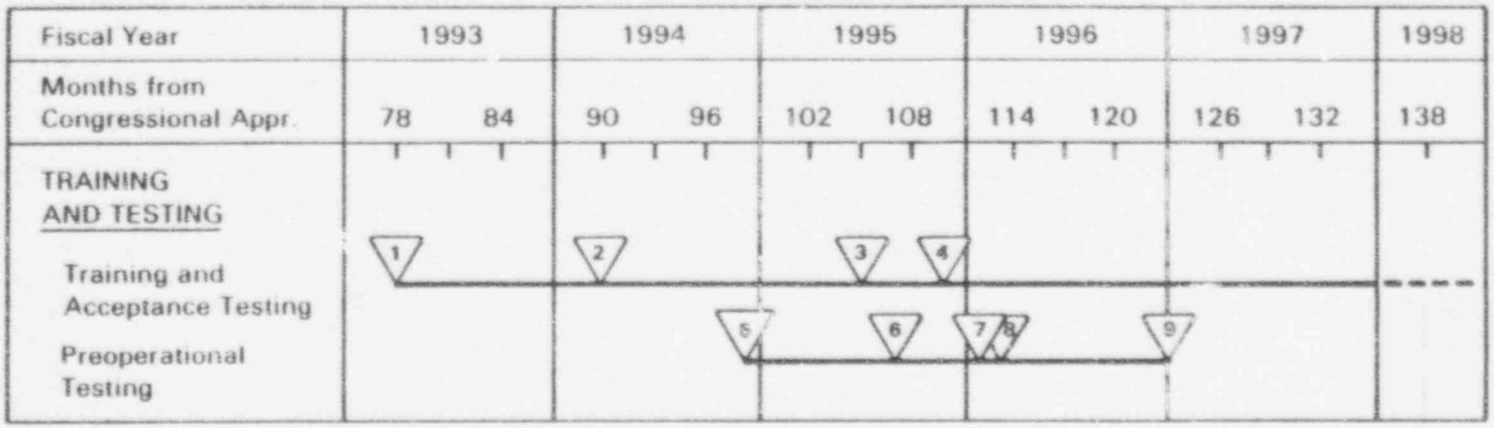
The schedule for the Training and Testing element is shown in Figure 3.5. Activities in this element are designed to ensure that the MRS facility and operations staff can safely perform their intended functions at the required throughput rates and in a manner that is consistent with product quality requirements. The training and testing plans will be part of the NRC license application and will be reviewed by the NRC.

Experienced operating and maintenance personnel will review the design for operability and maintainability. They will then prepare the training documents, operating and maintenance manuals, and operational test procedures. A number of these people, after becoming familiar with operation of the various systems and components, will be assigned to train additional operating and maintenance staff who will perform the preoperational tests. Others will be assigned to follow construction of the various MRS buildings and systems, to witness acceptance testing of these buildings and systems, and to become familiar with their functions, features, and installations.

To allow early testing of fuel-handling equipment and systems and training of the operators, the design of this equipment will be scheduled to permit early procurement. Construction of the mockup area in the site services building will be completed and the mockup fuel handling equipment installed early in the construction sequence to support the onsite training and testing program.

The first stage of training and testing related to the fuel handling operations will take place in the mockup area of the site services building. This area will be equipped with a full complement of cask and fuel handling equipment upon which operators and maintenance staff will be trained in remote handling and remote maintenance procedures. Using this mockup will allow remote handling operations to be tested at full [illegible]e in a nonradioactive environment. These prototypic tests will also permit modifications to be made to either the equipment or the operating procedures.

A team of operating personnel who have been trained in the mockup area will be qualified to perform the same tests and operations on a full complement of equipment installed in one of the hot cells. The first tests and demonstrations in the hot cells will not use spent fuel assemblies. If any problems with operating or maintaining the equipment are observed, the deficiencies will be corrected and the tests rerun until reliable operation is demonstrated. These cold tests and demonstrations will be performed in succession in each of the remaining cells until each functions reliably. In addition, the operation



Milestones

Training and Acceptance Testing

1. Begin Preparation of Training Documentation
2. Begin Operator Training
3. Begin Construction Acceptance Tests
4. Complete Construction Acceptance Tests

Preoperational Testing

5. Begin Preparation of Systems Test Plan
6. Begin Cold Systems Testing
7. Complete Cold Systems Testing
8. Receive Spent Fuel/Begin Operational Demonstration
9. Complete Operational Demonstration

FIGURE 3.5. Schedule for Training and Testing

of the radwaste and other systems and utilities will be tested. The test acceptance criteria and test results will be submitted to the NRC for review at least 30 days prior to planned receipt of irradiated fuel.

After operation of the equipment in a cell has been successfully demonstrated using dummy (nonradioactive) spent fuel, hot tests and demonstrations will be performed using spent fuel, again demonstrating successful operation in one cell at a time. All systems will be demonstrated to be operational. Operating procedures and manuals will be revised, as required, throughout testing and demonstration.

After the operating personnel are trained and qualified in the mockup area for hot operations in the R&H building, the throughput rate of the facility will be prudently increased. As the operating personnel become more familiar with operation and maintenance of the receiving and handling equipment and with load-out procedures to the storage facility, the processing times will be reduced and the throughput will be increased to rates that conform to full-scale routine operations.

3.6 OPERATION

The objective of the Operation element is to safely operate and maintain the MRS facility. The MRS facility operations consist of all activities associated with spent-fuel receipt, consolidation and canistering, temporary storage, and shipment to a repository.

3.6.1 Background

As part of the conceptual design activities, the operations and maintenance characteristics of the MRS facility were analyzed. The analyses included evaluations of operating and maintenance activities, equipment reliability and maintainability, operating staff size and skills, materials and equipment needed during operation (e.g., canisters, casks), and operating costs. These analyses, which were independently reviewed by persons with experience in the design, construction and operation of nuclear facilities, formed a large part of the basis for the planned activities identified for this element.

3.6.2 Planned Activities

The schedule for operation of the MRS facility is shown in Figure 3.6. The facility will become operational following completion of hot systems testing in October 1996. The facility receipt rate will be gradually increased over a 15-month period to reach the planned throughput rate of 2500 to 3000 MTU per year (full-scale operation) in January 1998.

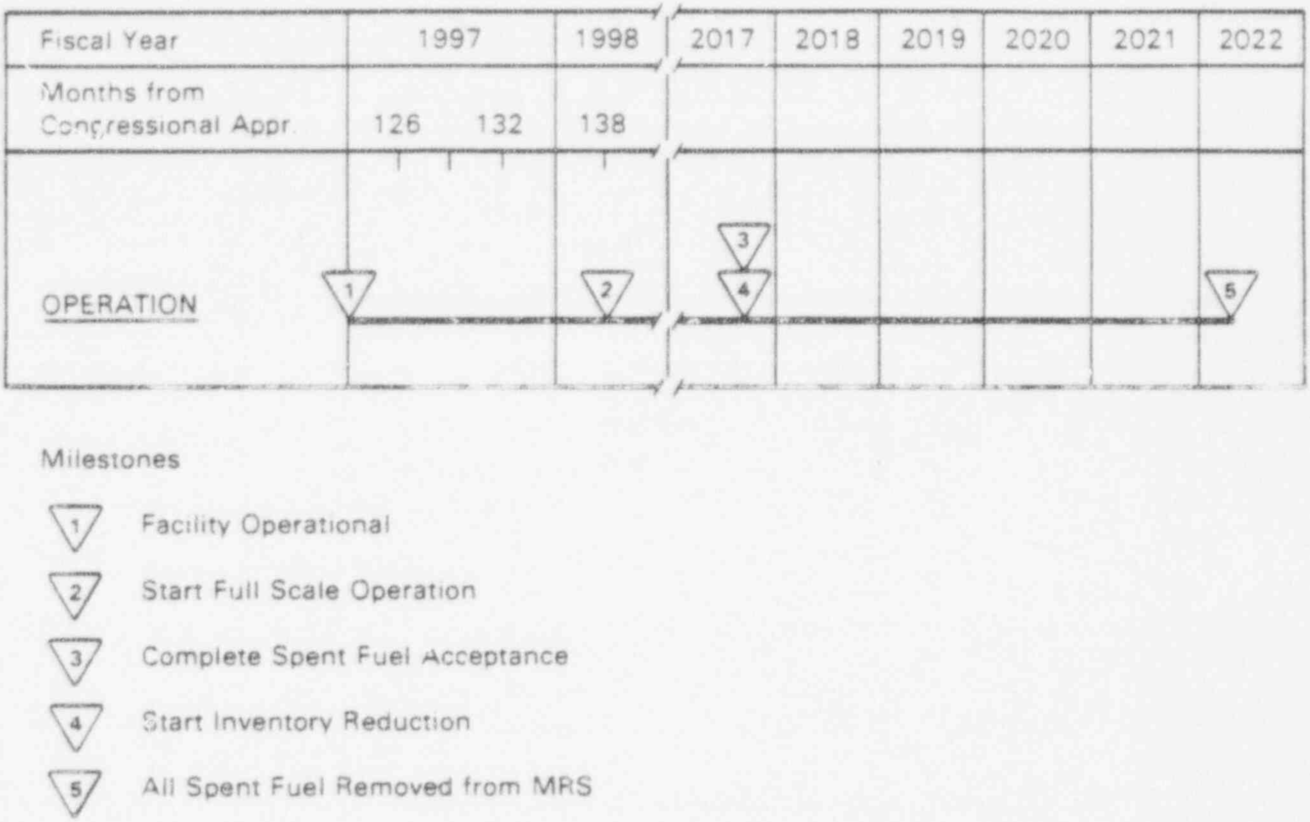


FIGURE 3.6. Schedule for Operation

Spent fuel shipments to the repository will commence in January 1998 and will gradually increase to the planned rate of 2500 to 3000 MTU per year in 2003. Full-scale operation will continue until 2017 when spent fuel acceptance will cease and inventory reduction will begin. Facility operations will cease when all waste stored at the MRS facility has been removed in 2022.

Shipments of spent fuel arriving at the MRS facility will enter the site through an inspection gatehouse. Following inspection, the shipment will be transported to the receiving and shipping area of the R&H building. Here the cask handling crew will remove the impact limiters, personnel barriers, tie-downs, etc. from the cask and vehicle. The cask will then be lifted from the rail car or truck trailer and placed upright onto a cask transfer cart. The rail car/trailer will then be surveyed for radioactive contamination and decontaminated if necessary.

The transfer cart and cask are moved into the cask unloading room and mated to a shielded process cell loading port. A shadow shield is closed around the top of the cask, personnel leave the room, and a shielding door is closed, thereby shielding the cask unloading operation from the rest of the building. The remotely operated in-cell crane then removes the cell loading port shield plug and the cover of the shipping cask. The fuel assemblies are then remotely removed from the cask, identified, inventoried, and placed in an in-process lag storage vault. After all fuel has been removed from the shipping cask, the cask interior is checked for contamination, and cleaned if necessary. The cask lid is then returned to the cask and the cell access port is closed. The cask is surveyed for contamination and decontaminated if necessary before being placed on the rail car or truck trailer for shipment.

In the shielded process cells, spent fuel assemblies are remotely removed from the in-process lag storage vault, identified, and disassembled. The disassembly operation consists of cutting off the end fittings and pulling the spent fuel rods from the spent fuel assembly. The fuel rods are then consolidated into a tight bundle and placed in a canister. The fuel assembly hardware is shredded and placed in sealed drums for interim storage onsite in sealed storage casks.

The canister of consolidated fuel is then filled with an inert gas. The end cap is then welded on and the canister decontaminated, leak tested and ultrasonically tested for weld integrity. The canisters of consolidated fuel are then moved either to an adjoining lag storage vault for temporary retention, to a cask discharge port for loading into a sealed storage cask for onsite interim storage, or to a cell discharge port and loaded directly into a shipping cask for shipment to the repository. The disassembly, consolidation, welding and testing operations, and handling of fuel assembly hardware are performed remotely using cranes, robots, and master-slave manipulators. Viewing windows and closed-circuit television are used to observe operations and for visual inspection.

Decontamination and maintenance of in-cell equipment will be performed remotely either in the process cells or in the maintenance cell. Contact maintenance will be permitted in those instances when equipment can be successfully decontaminated to an acceptable level.

Radioactive wastes generated during operation of the MRS facility will fall into two general classifications: 1) high-activity wastes (HAW) requiring remote handling and shielded storage, and 2) low-level wastes (LLW) and contact handled TRU wastes (CHTRU) permitting contact handling and nonshielded storage. Wastes requiring shielded storage will be packaged in sealed drums or canisters and stored in sealed storage casks similar to those used to store spent fuel, until they can be retrieved and shipped offsite for disposal. Low-level wastes and CHTRU wastes that do not require shielded storage will be stored in a covered, compartmentalized vault until shipment. All liquid radioactive wastes resulting from decontamination or other onsite operations, will be concentrated, solidified in a concrete matrix, and packaged in sealed drums. No radioactive liquid effluents will be discharged from the MRS facility.

To ensure that all spent fuel and waste packages are properly constructed, tested, identified, documented, and inventoried, a dedicated staff of operations inspectors, quality control inspectors, and quality assurance personnel will observe R&H building operations and ensure that operating procedures adequately provide for quality.

A staff of health physicists will be assigned to the R&H building to monitor operations in radiation zones, perform radiation surveys, direct decontamination operations and prescribe special procedures and attire to be used when performing work in radiation or contamination zones.

Storage facility operations consist of transporting empty concrete storage casks from the cask manufacturing plant (not a part of the MRS facility) to the R&H building, welding the outer lid on the cask after loading it with fuel or waste, transporting the cask to the storage facility, and placing it on a storage pad. As appropriate, casks will be connected to a monitoring system with remote displays in the R&H building control room. The monitoring system will monitor the cask liner temperature. In addition, gas samples and pressure readings will be taken periodically from representative casks to verify continued integrity of the canisters of consolidated fuel. Removal of the canisters from the concrete storage casks for loading into a shipping cask prior to transport to the repository will be the reverse of the above operations. Air samples for radiation monitoring will be taken both inside and at the perimeter of the storage facility to detect any unexpected release of airborne radioactive materials.

To support the storage operation, a sealed storage cask manufacturer will be required to fabricate, cure, age, inspect and deliver up to a maximum of about 30 casks per month to the MRS facility over a period of about 8 years. It is likely that the manufacturer will construct a fabrication plant adjacent to or at least near the MRS facility. It is estimated that a work force of about 115 people will be required to perform these activities during this time period in order to provide storage casks for 15,000 MTU of spent fuel and associated waste.

The three major parts of the MRS facility are the receiving and handling (R&H) building, the support facilities, and the storage facilities. A total plant operating staff of about 600 employees will be required when the plant is operating at the planned throughput rate. About half of the operating staff will work in the R&H building. Their work assignments will be in the following areas: hot cell operations; cask and material handling operations; maintenance and plant operations; nuclear material accountability; quality assurance, quality control and inspection; health and safety; laboratory and sampling; general support and administration.

The other half of the operating staff will work in the various support facilities. Their work assignments will be in the following areas: maintenance and shops; safeguards and security; fire protection; quality assurance; quality control; health and safety; laboratory and sampling; training; facilities operations, transportation and general support; and plant management, administration, and support. An operating staff of about 5 people will be assigned to the storage facilities for emplacement and retrieval operations.

During routine operation at the design throughput rate the MRS facility will be operated continuously on a 24 hour-per-day/5 days-per-week schedule. The facility will be in a standby mode 2 days per week. However, the MRS facility design includes sufficient flexibility to allow the facility to adapt to reasonable mission changes and/or operational perturbations. For example, the four disassembly/consolidation stations permit routine operation at the design throughput rate on a 3 shifts-per-day/5 days-per-week operating schedule. If need be, a cell can be taken out of production for an extended period to permit equipment modifications, or it may be set up to accommodate a special batch of fuel while the other three cells, operating on a 7-day week, can keep up the throughput until the fourth cell becomes available for routine operation again.

3.7 DECOMMISSIONING

The objective of the Decommissioning element is to release the site for unrestricted use after MRS operations are completed by decommissioning (and decontaminating as necessary) all facilities and equipment.[a] Work involved in this element includes decommissioning the sealed storage casks, the storage area, the R&H building, the protected area, the radwaste treatment facility, the analytical laboratory, the support facilities, and the limited access area for the MRS facility, as well as disposal of the residual radioactive materials.

(a) The present plan for decommissioning the MRS facility assumes a starting point when the facility is no longer needed to accept spent fuel from utilities for packaging and shipment to the first repository. This plan may change depending on whether the MRS facility is used to service another approved repository or if the facility is put on a standby basis for possible involvement in waste retrieval operations as required under Section 122 of the NWPA.

3.7.1 Background

The Criteria for Decommissioning, 10 CFR 72.76, state that an MRS facility shall be designed for decommissioning. In consideration of this, the conceptual design for the MRS facility includes provisions to:

- facilitate decontamination of structures and equipment
- minimize the quantity of radioactive wastes and radioactively contaminated equipment
- facilitate the removal of radioactive wastes and radioactively contaminated materials at the time the facility is being permanently decommissioned.

To identify how the decontaminating and decommissioning could be accomplished, a decommissioning plan for the conceptually designed MRS facility was prepared. The decommissioning plan describes practices and procedures for decontaminating the site and facilities and for the disposal of residual radioactive materials. The proposed decontamination practices and procedures are designed to ensure that the decommissioning activity and the decommissioned facility will not jeopardize the safety of the public.

3.7.2 Planned Activities

The schedule for decommissioning the MRS facility is shown in Figure 3.7. All buildings and internal components will be decommissioned after all spent fuel and waste packages have been removed. However, complete removal of all structures, particularly the R&H building, is not planned. The R&H building will be designed to facilitate the entire decontamination and decommissioning efforts. Those facilities and equipment that cannot be decontaminated will be packaged and shipped to a final disposal site. Following thorough decontamination of the R&H building and disposal of items that cannot be decontaminated, permanent decommissioning will be accomplished by disposal of the major equipment that is not contaminated.

The decommissioning effort is divided into phases. The phases overlap to provide continuity of the decommissioning work. The first phase consists of decontaminating and decommissioning the sealed storage casks and those portions of the R&H building that are not needed for the load-out operations (e.g., the disassembly cells). As the waste is removed from the sealed storage casks for shipment to the repository, the casks will be decontaminated and decommissioned. Since the spent fuel and waste are placed in sealed canisters before being emplaced in the sealed storage casks, it is expected that little or no decontamination of the casks will be required. The radioactive waste treatment

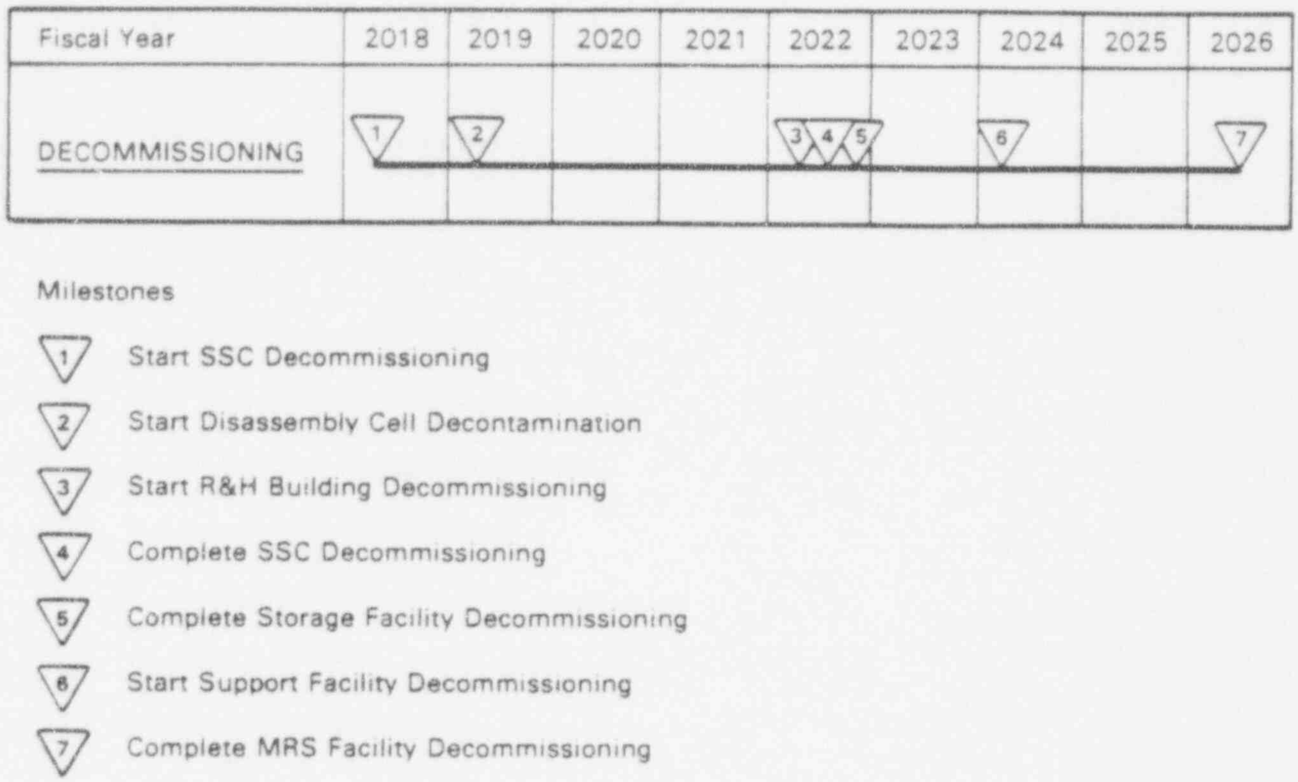


FIGURE 3.7. Schedule for Decommissioning

facility and analytical laboratory within the R&H building will be kept in service to support this decommissioning effort. This phase is expected to take 4 years to complete.

The next phase consists of decommissioning the remainder of the R&H building including the radwaste treatment facility and the analytical laboratory. This phase is not expected to start until all spent fuel has been removed from the MRS facility. Also included in this phase will be the decommissioning of the remainder of the protected area. This phase is expected to require approximately 4 years beyond completion of the first phase.

The final phase consists of decommissioning the support facilities and the limited access area for the MRS facility. Since radioactive materials will be excluded from this area of the MRS facility during the life of the facility, the decommissioning effort for this area is expected to consist of simply dismantling and removing these facilities and restoring the site.

Disposal of the decontamination and decommissioning wastes will be consistent with the requirements for disposal and the disposal methods in existence at the time decommissioning begins. The details for decommissioning activities will be described in the decommissioning plan to be submitted to the NRC as a part of the license application.

3.8 INSTITUTIONAL INTERACTIONS

The objectives of the Institutional Interactions element are: 1) to ensure timely and full information exchange and appropriate participation between and among the DOE, the public, the state, and local officials relative to the further development and operation of the MRS facility; and 2) to ensure that state and local governments receive fair and reasonable financial assistance for the effects of construction and operation of the MRS facility, as described in the MRS proposal to Congress.

3.8.1 Background

Information exchange on the MRS Program between the DOE, the State of Tennessee and local officials, and the public began in the spring of 1985. At that time a grant was given to the State of Tennessee (which subsequently shared it with potentially impacted local governments) to study the DOE basis for, and proposed actions in, the MRS Proposal to Congress. The intent of this grant was to allow the DOE to benefit from comments from the state and to enable the state to provide a studied judgment on the MRS Proposal to Congress.

The DOE has shared information with state and local officials and has participated in a number of public meetings and meetings of task forces established by state and local governments to study the MRS Proposal. In return, the state and local governments have provided the DOE with information that was considered in development of the proposal. Documentation for the MRS Proposal was provided to the State of Tennessee for early review before it was submitted to Congress.

3.8.2 Planned Activities

The activities in the Institutional Interactions element are of such importance that they have been thoroughly described in the MRS proposal to Congress. They include initiating and establishing Consultation and Cooperation (C&C) Agreements with the State of Tennessee as required by the NWPA; establishing an effective working relationship with state and local governments; providing mechanisms to assure the public that safety and environmental quality will be protected during the operation of the facility and transportation of spent fuel; and providing appropriate and reasonable assistance to affected government units.

Immediately following congressional approval of the MRS Proposal, the DOE will initiate interactions with the State of Tennessee directed toward establishing formal C&C Agreements for MRS activities. These agreements are expected to be signed within six months after approval of the proposal, as shown in Figure 3.8. It is anticipated that the local governments will work with the state to determine the nature and extent of their involvement in these agreements.

A public information program will be established to provide information on the MRS facility. This public information program will not be limited to the State of Tennessee, but will also address the national public information needs of the improved-performance waste management system, which includes the MRS facility. The MRS public information activities will be part of the coordinated OCRWM public information plan.

For specific details of the proposed interactions, the MRS Proposal to Congress should be reviewed.

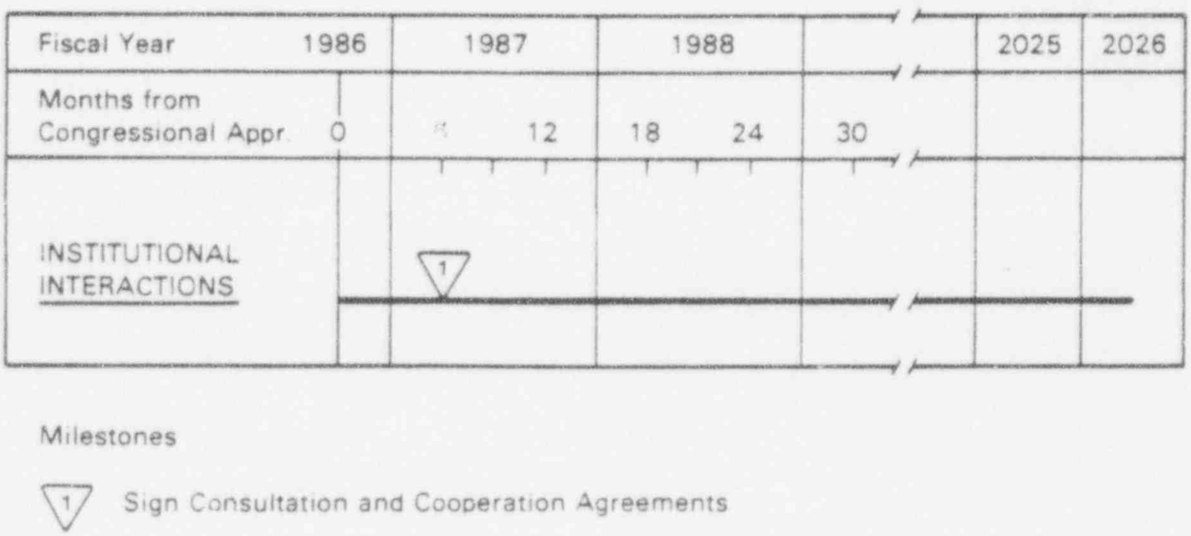


FIGURE 3.8. Schedule for Institutional Interactions

3.9 PROGRAM MANAGEMENT

The objective of the Program Management element is to manage the MRS Program in such a manner that program objectives are met within safety, quality, cost, and schedule goals. The work involves organizing, staffing, monitoring, controlling, and reporting all program activities.

3.9.1 Background

The DOE has established a project management system for programs that have a special significance in terms of national importance, exceed a specific dollar value (normally facilities with acquisition costs of $200 million or more), and are identified by DOE upper management as requiring special attention in project planning and control. Such projects are designated as Major Systems Acquisitions. The MRS Program has been designated as a Major Systems Acquisition and thus will be managed in accordance with the requirements of the DOE Project Management System (DOE 1983b). The DOE project management system was developed primarily for the management of projects that are executed by the DOE Operations Offices, and is therefore well suited to the management and control of the MRS Program.

3.9.2 Planned Activities

A schedule of planned activities for the Program Management element is shown in Figure 3.9. An MRS Project Office within the Oak Ridge Operations Office will be established and staffed upon congressional approval of the MRS proposal. Initial activities of the MRS Project Office will include finalization of the acquisition strategy for contracts involving design, construction, and operation of the facility. Maximum utilization of the private sector will be assured through competitive procurements for contractor-supplied goods and services, where possible.

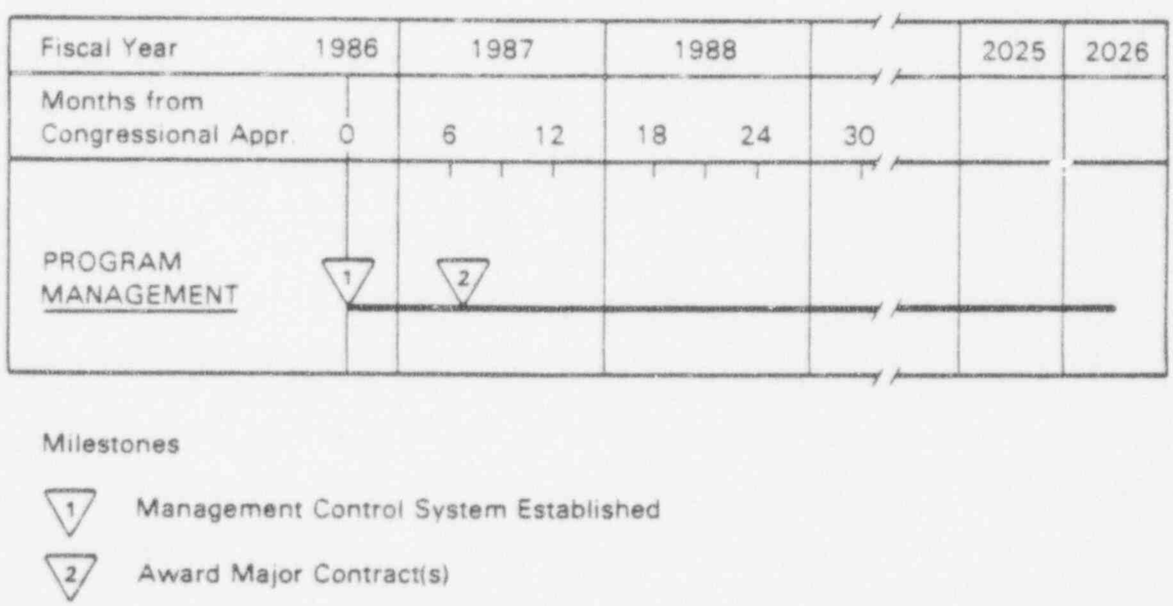


FIGURE 3.9. Schedule for Program Management

A DOE management structure was established and staffed for development of the MRS proposal. This structure will require expansion and additional staffing for implementation of the MRS program if it is approved by Congress. The principal addition will be the creation and staffing of the MRS Project Office in Oak Ridge, Tennessee. These staffing additions will not result in a significant increase in the overall management resources required for OCRWM activities and will not deplete the management resources for the other OCRWM programs (e.g., repository program).

The principal contractor manpower needs are for design, construction and facility operation. Nuclear related experience will be necessary. Designers (about 250) will be needed primarily for the period from FY 1987 through FY 1990. The maximum manpower required for construction is about 700 workers. Construction will extend over about a 4-year period ending in FY 1995. For operation of the MRS facility a staff of about 600 individuals will be required. These manpower requirements are modest and there are many firms qualified to perform these functions. A significant pool of qualified workers already exists in the area of the proposed MRS site.

A project management system will be developed and implemented that meets the requirements of the DOE Project Management System for major system acquisitions (DOE 1983b). Supporting management procedures will be developed and implemented for control, monitoring, and reporting progress of program activities.

A Quality Assurance Program consistent with the applicable QA criteria of DOE Order 5700.6A (Quality Assurance), the NRC's 10 CFR 50, and ANSI/ASME Standard NQA-1 will be established and implemented. All quality-related activities of the program will be planned, scheduled and documented to provide objective evidence of procedural adequacy and compliance. Quality overview will be provided by the OCRWM headquarters Quality Assurance Manager. To ensure that the proper degree of attention and authority are provided to QA in all MRS Program activities, the Quality Assurance Manager will report directly to the MRS Program Manager and will not be given any competing assignments. A clear line of responsibility and authority for QA throughout the program will be established and maintained.

The OCRWM has developed an overall Systems Engineering Management Plan for all of its activities. A System Engineering and Configuration Management activity will be established to implement the OCRWM Systems Engineering Management Plan and to expand and extend it to the MRS Program. This activity is responsible for developing and maintaining the MRS Program technical baseline documentation. These baselines will initially consist of the Systems Requirements Document, the System Design Description, and a System Studies Plan. The MRS Program technical interfaces with the transportation program and the repository program will be documented and subjected to change control procedures to ensure that proper, up-to-date design information is available to all system participants.

A Program Planning and Control activity will be established to maintain program schedules, measure and analyze performance, and provide budget and schedule forecasting. This activity will support the Systems Engineering and Configuration Management function in analyzing schedule compatibility with the transportation system and the repository programs.

3.10 MASTER SCHEDULE

This section describes the MRS Program master schedule, and discusses the critical path. The schedules discussed in Sections 3.1 through 3.9 were taken from the program master schedule shown in Figure 3.10. They showed the program milestones by program element. The program elements are all interdependent, so that information developed in one element is needed to complete milestones in other elements. The program master schedule, Figure 3.10, shows major constraints as vertical dashed lines. The milestones at arrowheads cannot be completed until after the connected milestones are complete. The figure also shows the critical path to facility operation. For activities on the critical path, extensions of the time for their completion potentially delays facility operation day-for-day.

For these activities, extra effort was expended to verify the reasonableness of the time estimates. The construction schedule is based upon a detailed analysis by the architect-engineer of the many parallel and sequential activities that would occur during construction. The licensing schedule and its uncertainties were discussed with the NRC staff. The NRC staff agrees that 30 months is a reasonable planning base, recognizing that only their review schedule, and not the schedule for public hearings, is under their control. The MRS facility, as designed, does not require research in unproven areas of technology. Thus, the DOE has confidence in the schedule.

Sections 3.1 through 3.9 provide detailed discussions of the milestones for the individual elements. Discussion here will concentrate on the critical path and the constraints which led to identification of the critical path. Following congressional approval, the critical path intially goes through the Design element. The two critical early activities are 1) confirmation and collection of site data for design and 2) award of major contract(s). While

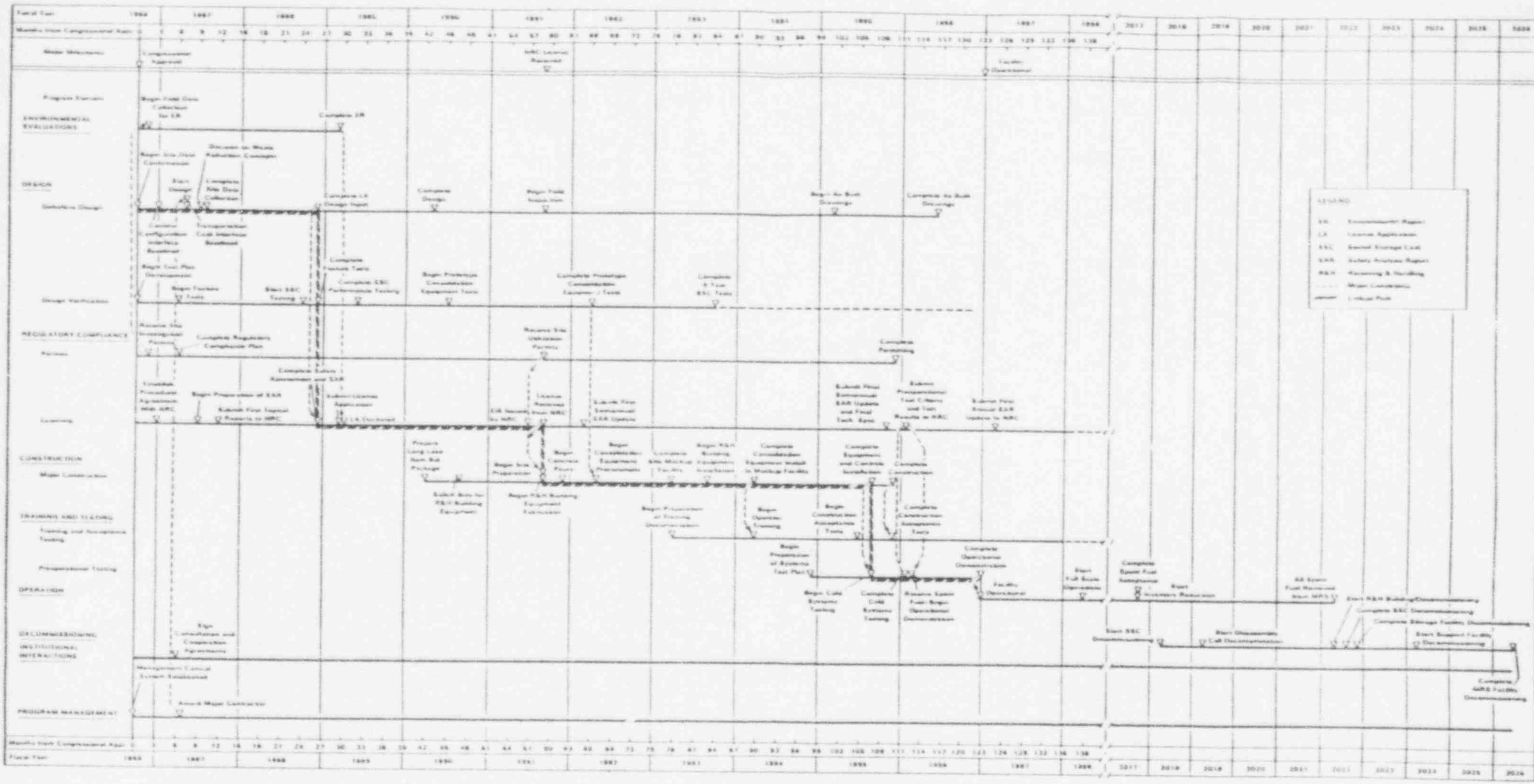


FIGURE 3.10. MRS Program Master Schedule

extensive site data is on hand and needs only to be verified, additional geotechnical data will need to be collected for the foundation designs and for the Safety Analysis Report to the NRC. Site investigation permits might be required to collect the additional environmental, geologic, and hydrologic data. Data collection is scheduled to take approximately ten months. The ten-month period is considered to be a reasonable amount of time to obtain this standard design information because extensive data already exists from excavation and design for the canceled Clinch River Breeder Reactor.

Procurement of the major contractor(s) is scheduled to be initiated immediately upon congressional approval of the MRS proposal. Procurement is on an expedited schedule. The initiation of design activities is not dependent upon having complete site data, so that design and data collection can proceed simultaneously for several months.

It is planned that sufficient information will be available by the midpoint in the design to complete the design input to the license application. The key inputs are safety assessments of the site and the MRS facility. These assessments are required to complete the Environmental Report and the Safety Analysis Report. These reports are the most time-consuming of the efforts required to prepare the license application. The NRC review of the license application and the potential hearings held by the licensing board then become the critical path activities. They are expected to take about 30 months, during which time the remainder of the design work will have been completed. Extensive coordination and consultation between the NRC and DOE staffs, which was begun during the preparation of the MRS proposal, is expected to limit the number of environmental and safety issues which will arise during the license review.

The DOE will not initiate construction of the MRS facility until a license is received from the NRC. After receipt of the license, site preparation and construction can begin. Construction of the R&H building becomes the critical path because of its size and the need to sequentially pour concrete for one floor of the R&H building at a time and then cure and remove the shoring of the upper floors before installation of services in the lower floors. The completion of the building constrains the installation of the handling, disassembly, and consolidation equipment in the R&H building.

The procurement and demonstration of reliability of the disassembly and consolidation equipment is important to achieving the schedule. However, it is not on the critical path because it appears that sufficient time exists from the completion of design (which constrains procurement of all long-lead-time items) to installation of the equipment in the R&H building.

Operator training cannot take place in the mockup training facility until the equipment is installed. However, there is sufficient time for training, so that construction remains on the critical path until the major equipment, services, and controls are completely installed in one of the R&H building receiving and handling cells. At this point the operators will have been trained on prototype equipment in the training facility and will be ready for a complete systems check on the first receiving and handling cell. The preoperational systems tests then remain on the critical path through the completion of the operational demonstration. During this testing and demonstration period, construction of other facilities will proceed, and each building or system will be accepted from the construction contractor as it is completed.

Operational testing and demonstration is scheduled to take 16 months. Demonstration activities include both cold and hot testing: a series of cold systems test; operations using spent fuel to test the waste treatment systems, shielding, and remote operations; and the ramp-up to significant processing rates. The facility is scheduled to be operational 123 months after congressional approval (in October 1996, if approval is received in July 1986). The ramp-up to full-scale operations is scheduled to take about 15 more months, until January 1998.

4.0 INTEGRATION PLAN

This chapter discusses the interfaces and integration of the MRS Program with the schedules of other OCRWM programs and with other storage and disposal facilities authorized in the NWPA.

The analysis of the integration of the MRS schedule for compatibility with the schedules of the other DOE waste management programs, e.g., the reference schedule for the first repository (DOE 1985b) and the transportation program schedule (DOE 1985c), is based on congressional approval of the MRS proposal by July 1986. Both technical and administrative interfaces were considered. The schedules of the other programs were reviewed to determine their compatibility and constraints. In some instances, integration of the MRS facility into the waste management system will require additional or changed activities in the other programs. For example, additional early definition and configuration control of technical interfaces involving waste forms and shipping casks will be required.

To ensure the required and continued functional integration of the waste management programs, the DOE is preparing a Systems Engineering Management Plan. This plan will implement a systems engineering approach to the integration of the repository program, the transportation program, and the MRS Program. The plan includes preparation of documents and management procedures to describe the waste management systems in terms of its component facilities; the allocation of functional requirements of the system to its components; establishment of technical baselines, including interface requirements, and change control procedures for each component; and provision for management assessments and reviews. In addition, the current OCRWM management system provides a disciplined cost and schedule control capability that ensures effective program management. The following discussion of interfaces and schedule integration is based on the integrated waste management schedule presented in Figure 4.1.

The Idaho National Engineering Laboratory is conducting a Prototypical Consolidation Demonstration Project which will demonstrate rod consolidation, canister welding, and non-fuel bearing component volume reduction techniques. Although this project was initiated to support the design of the surface facilities at the first repository, its results will be used for the MRS facility, if approved by Congress.

The Prototypical Consolidation Demonstration Project will provide confirmation of MRS design concepts and identify potential problem areas requiring resolution. The MRS facility design will be completed shortly after the completion of the demonstration project.

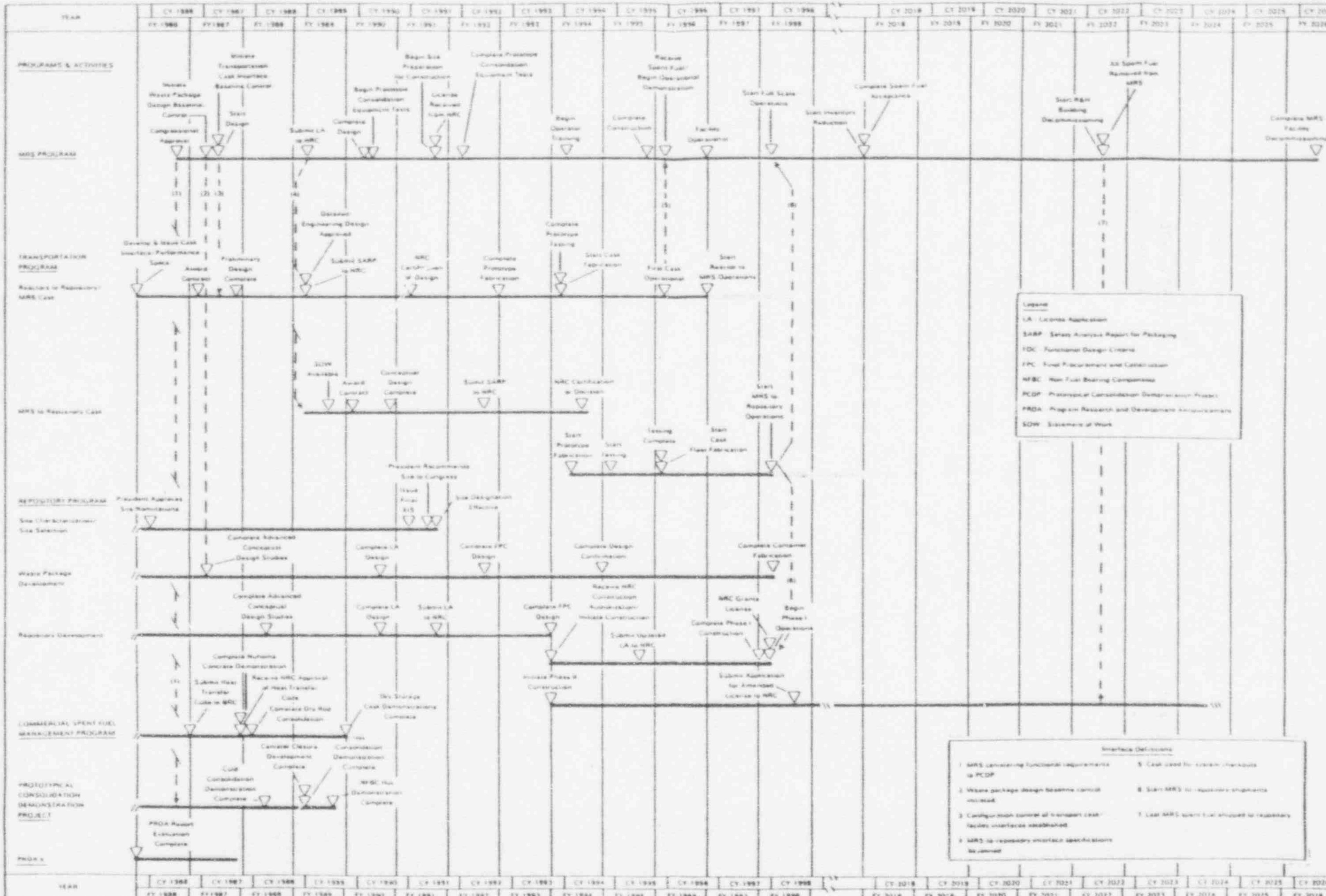


FIGURE 4.1. OCRWM Integrated Schedule

The transportation system schedule for the design of shipping casks is compatible with the MRS design data needs for cask interface and handling information. However, joint control with the transportation program of cask interface configurations must be established at the start of MRS design.

The schedule for the advanced conceptual designs for the repository will not be affected by the integration of an MRS facility into the system. However, the surface facility design requirements will be simplified because the MRS facility will do much of the spent fuel packaging currently included in the repository program plans. The site for the repository will not be selected until 1991. Currently, each repository program is considering a different configuration of waste canister and disposal container. The MRS design will be sufficiently flexible to accept whichever physical configuration is required for the selected geologic medium. An OCRWM Waste Package Coordination Group is currently studying the possible design of a common canister. An agreement between the MRS Program and the repository program on an envelope of possible waste canister designs will be reached by December 1986 to meet MRS and repository design requirements.

The DOE's Commercial Spent Fuel Management Program is developing spent fuel storage and consolidation information. The particular areas of interest to the MRS Program are:

- The NUHOMS[(a)] dry storage demonstration (in conjunction with Carolina Power and Light Co.) in concrete modules. This program was started in March 1984 and will be completed in September 1987. The program will demonstrate dry storage of PWR spent fuel assemblies in metal casks inside concrete modules. Confirmation of heat transfer, shielding design, and dry storage will be obtained.

- The Dry Rod Consolidation Demonstration (in conjunction with Virginia Power Co.). This program was started in June 1985 and will be completed in February 1988. The program will demonstrate dry consolidation of about 100 PWR spent fuel assemblies at INEL, followed by dry storage in two metal casks. The stored fuel rods in canisters will be used to validate and qualify heat transfer codes for application to dry storage of consolidated spent fuel rods.

The MRS Program will monitor these programs for compatibility with MRS designs.

(a) Nuclear Horizontal Modular Storage (NUHOMS) is a concrete storage module housing a double-sealed metal cask containing up to seven intact PWR assemblies.

In early 1984, the DOE issued a broad Program Research and Development Announcement aimed at identifying and researching various concepts that would enhance the overall performance of the waste management system. The majority of the concepts being evaluated under the Program Research and Development Announcement address various hardware developments that could be applied on a system-wide basis to enhance system efficiency and reduce system costs. These concepts include the use of various spent fuel canister shapes and configurations, the system-wide usage of extra large shipping casks, the evaluation of a mobile fuel rod consolidation system for at-reactor consolidation, and the feasibility of metallic cask systems for storage, transportation and disposal purposes. The preliminary results from these studies indicate that system benefits can potentially be accrued from the implementation of some of these concepts. The final results of the studies are not due until early 1986. When the studies are completed and their findings fully evaluated, those features having sufficient merit will be considered for further development and possible application in the waste management system.

The transportation program schedule for providing the first operational reactor-to-MRS facility shipping cask is compatible with the MRS Program schedule. The MRS Program will work with the transportation program to ensure that the transportation system cask fleet procurement schedule meets the waste management system shipping needs.

The shipment of spent fuel from the MRS facility to the repository is dependent upon the existence of the large rail casks suitable for dedicated trains. The date by which the transportation program will be ready to initiate such shipments (see Figure 4.1) is also compatible with the MRS Program schedule. MRS facility spent-fuel shipment rate requirements will be coordinated with the transportation program upon approval of the MRS proposal by Congress.

The MRS facility operation will conclude with shipment of the last stored spent fuel to the repository in the year 2022. The MRS facility will then be decommissioned.

In summary, the schedule for the waste management system with an MRS facility as an integral component of the system has been thoroughly analyzed and the MRS schedule integrated with those of the other system components. The DOE has also established management systems and procedures for controlling the interfaces in the development and operation of an improved performance waste management system.

5.0 FUNDING PLAN

The NWPA requires that the MRS proposal shall include "...a plan for the funding of the construction and operation of such facilities, which plan shall 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." The NWPA also establishes "...a separate fund, to be known as the Nuclear Waste Fund"..."for purposes of...the identification, development, licensing, construction, operation...of any...monitored retrievable storage facility constructed under this Act."

The DOE has considered different approaches to fund the MRS Program including the imposition of special charges on owners and generators of high-level waste and spent fuel in lieu of using funds from the Nuclear Waste Fund. Based on the analyses and supporting information presented in Appendix E of this Program Plan, the DOE is recommending that the MRS Program be financed through the Nuclear Waste Fund. With this approach, all generators and owners of high-level waste and spent fuel will pay for the MRS facility through the fee of 1.0 mill per kilowatt hour of electricity generated as specified in Section 302(a)(2) and (3) of the NWPA.

The proposed approach of financing the MRS facility through the Nuclear Waste Fund is administratively simple and conforms with the philosophy and provisions of the NWPA. Furthermore, the MRS facility confers benefits directly or indirectly to all contributors to the Nuclear Waste Fund through improvements in waste management system development, deployment, integration and performance, and through provision of a cost-effective capability to accommodate potential repository schedule changes (Volume 2, of this submission to Congress, Environmental Assessment for a Monitored Retrievable Storage Facility, Part 1, "Need for and Feasibility of Monitored Retrievable Storage").

The plan for funding the MRS Program is as follows:

1. The MRS Program will be financed through the Nuclear Waste Fund.

2. Although the federal waste management system is self-financing, the amount of money allowed to be spent from the Nuclear Waste Fund is governed by the federal budget process. The NWPA requires that a budget be submitted for the Nuclear Waste Fund and that appropriations be subject to triennial authorization. A Fund Management Plan (DOE 1984b) has been developed for implementation. The budgeting and financial management of the MRS Program will be in accordance with the DOE Fund Management Plan.

3. Each year, the annual costs from the most recent update of the MRS Program cost estimates will be converted into a budget request and incorporated into the overall Nuclear Waste Fund budget request. This budget request will go through the federal budgeting process and be subject to congressional authorization and appropriation.

4. Disbursement of authorized and appropriated funds for the MRS Program will be controlled and reported according to DOE Order 2200, "Financial Management of Civilian Nuclear Waste Activities" (DOE 1984c).

5. The DOE will continue to conduct an annual review of the 1-mill per kWh fee for waste disposal to determine whether the revenues will be sufficient to finance the total system costs of the federal waste management system, including the cost of the MRS facility. If it is determined that the fee is inadequate to assure full cost recovery, an adjustment to the 1-mill per kWh fee will be proposed.

The life-cycle cost of deploying, operating, and decommissioning an MRS facility employing the sealed storage cask design at the Clinch River site in Tennessee is estimated to be \$2.9 billion.[a] However, this life-cycle cost includes the cost for the necessary preparation and packaging of spent fuel prior to emplacement in a repository. With the transfer of this function from the repository to the MRS facility, the reduction in the cost of spent fuel preparation and packaging facilities and operations at the repository is estimated to range from \$1.0 to \$1.4 billion. In addition, the change in the cost of spent fuel transportation with the proposed MRS facility in the federal waste management system is estimated to range from -\$0.1 to +\$0.1 billion. Thus, the net increase in federal waste management system life-cycle cost with the proposed MRS facility in the system is estimated to be in the range of \$1.4 billion to \$2.0 billion.

According to the 1985 fee adequacy review (Engel 1985), total waste management systems costs, excluding an MRS facility, range from \$24.5 to \$30.6 billion in constant 1985 dollars. (An inflation rate of 3.8% was used to convert the cost estimates in the 1985 fee adequacy review from constant 1984 dollars to constant 1985 dollars.) Therefore, the increase in the total system cost is between 5% and 8%, which is within the uncertainty of current estimates of total system cost without the MRS facility. Appendix E, Section E.5.4, discusses total system cost changes more fully.

Based on results of the 1985 fee adequacy review, and the DOE's assessment of the projected growth of the U.S. nuclear economy, the Nuclear Waste

(a) All costs and funding requirements presented in this chapter are quoted in 1985 dollars.

Fund generated by the current 1-mill per kWh fee will be adequate for funding the improved-performance waste management system (including an integral MRS facility). Consistent with the funding plan described above and with past practice, the annual review of fee adequacy for FY-1986 is currently being conducted, using updated waste management system cost estimates and revenue projections. If this review should indicate that the 1-mill per kWh fee does not generate sufficient revenue to achieve full-cost recovery for the improved performance system and if the improved performance system is approved by Congress, an adjustment to the fee will be submitted for congressional approval.

Table 5.1 presents the annual funding schedules for the proposed MRS Program. The funding authority required through 1996, when operation starts, is about $1 billion, including about $700 million in capital funds for facility design and construction. The annual funding requirement will be heaviest during the construction and initial operation years of 1991 through 2001, ranging from about $80 million in 1991 to about $190 million in 1993. When the MRS facility is in steady-state operation, the annual funding requirement is estimated to be about $70 million per year. The funding requirement for facility decommissioning is about $80 million.

Cost data for the six site-design combinations, and the methods and assumptions used for cost and funding evaluations are discussed in Appendix E.

TABLE 5.1. Estimated Annual Funding Authority Required for the MRS Program[a]

Stage or Item	Fiscal Year	Millions of 1985 Dollars[b]
Congressional approval	1986	7
	1987	25
	1988	37
	1989	39
	1990	40
Construction begins	1991	79
	1992	164
	1993	191
Training begins	1994	188
Construction complete	1995	131
Operation starts	1996	97
	1997	112
Full-scale operation	1998	133
	1999	127
	2000	125
	2001	86
	2002	72
	2003	71
	2004	72
	2005	71
	.	.[c]
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	2015	71
	2016	72
	2017	60
Start decommissioning	2018	25
	2019	25
	2020	26
	2021	27
All spent fuel removed	2022	26
	2023	21
	2024	18
	2025	14
Complete facility decommissioning	2026	9
TOTAL MRS FACILITY		2900

(a) Source: Appendix E.

(b) Rounded.

(c) Identical pattern (72, 71, ...) for intervening years.

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7.0 GLOSSARY

ALARA - as low as reasonably achievable.

ANSI - American National Standards Institute.

ANSI NQA-1 - American National Standards Institute Quality Assurance Requirements for Nuclear Facilities.

ASME - American Society of Mechanical Engineers.

canister - The first material envelope surrounding a waste form (e.g., spent fuel rods) to provide containment for handling and storage purposes.

CFR - Code of Federal Regulations.

consolidation - The disassembly and packaging (reconfiguration into a close-packed array) of spent fuel rods to achieve volume reduction, thereby reducing the space required for storage, transportation, or disposal.

container - A metal barrier placed around a waste canister prior to disposal to meet the requirements of 10 CFR 60. The container provides the second level of containment.

containment - The sealed isolation (complete retention) of radioactive waste within a designated boundary or vessel in a manner that prevents its release to or contact with the surrounding environment.

decommissioning - The removal from service (at the end of its useful life) of an MRS facility and its related components in accordance with regulatory requirements and environmental policies.

decontamination - The removal of radioactive material from an MRS facility, its surrounding soils, and its equipment by washing, chemical action, mechanical cleaning, or other techniques.

disposal package - The primary container that holds, and is in contact with, solidified high-level radioactive waste, spent nuclear fuel, or other radioactive materials, and any overpacks that are emplaced at a repository.

DOE - U.S. Department of Energy.

DOE-OCRWM - Office of Civilian Radioactive Waste Management, U.S. Department of Energy.

dry storage - Storage of spent nuclear fuel or high-level waste surrounded by one or more gases (e.g., air, argon, helium) and no use of cooling liquids (e.g., water).

EA - Environmental Assessment.

EIS - Environmental Impact Statement.

ER - Environmental Report.

field drywell - An individual, stationary, inground, metal-lined cavity for storing one or more canisters or drums containing high-level waste or spent nuclear fuel. Shielding is provided by the surrounding earth and a shield plug. Heat dissipation is by conduction through the plug and earth to the atmosphere and also by thermal radiation.

high-level waste (HLW) - High-level radioactive waste. The highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in the first processing cycle in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations. Also, any other radioactive material that requires permanent isolation, as determined by the U.S. Nuclear Regulatory Commission.

integral MRS concept - The concept whereby an MRS facility would receive, process, package, store, and ship to the repositories all spent fuel and certain other wastes requiring permanent disposal, and thus serve as an "integral" part of the federal waste management system. In this role, sufficient storage would be provided to accommodate disruptions in operations.

MRS - monitored retrievable storage.

MRS facility operations - All functions at an MRS site leading to and involving the handling and/or storing of radioactive waste and spent fuel in the facility, including receiving, onsite transport, handling, packaging, consolidating, canistering, emplacement, retrieval, and load-out for equipment to a repository.

MRS support facilities - All permanent facilities constructed to support the operation of the MRS receiving and handling building, including structures, utility lines, roads, railroads, and similar facilities, but excluding the storage facility.

MTU - metric tons of uranium.

NRC - U.S. Nuclear Regulatory Commission.

NWPA - Nuclear Waste Policy Act of 1982.

package - The act of preparing spent nuclear fuel for storage, shipment, and/or final disposal. Includes disasembly and consolidation of the spent fuel, placement of the consolidated spent fuel in canisters, and placement of canisters into disposal containers.

R&D - research and development.

receiving and handling (R&H) building - The primary operating building of an MRS facility. The R&H building is designed to physically contain and control all radioactive material being handled or generated by process operations and includes space and equipment for all spent fuel operations (e.g., receiving, disassembly, packaging) and all HLW and RHTRU operations (e.g., canister receiving, handling, and shipping).

repository - A facility consisting primarily of mined cavities in a deep geological medium and associated support facilities for the permanent disposal of spent nuclear fuel and high-level waste.

site evaluation - Activities undertaken to establish the environmental, meteorological, socioeconomic, and geologic conditions and the ranges of the parameters of a site relevant to the location of an MRS facility, including borings, surface excavations, and in-situ testing needed to evaluate the suitabili · of a site.

spent nuclear fuel - Irradiated nuclear reactor fuel that has reached the end of its useful life.

storage - The retention of radioactive waste in a retrievable manner that requires surveillance and institutional control.

throughput - The average rate at which an MRS facility can receive, inspect, consolidate, and package spent fuel.

APPENDIX A

OPERATIONAL CHARACTERISTICS OF THE IMPROVED-PERFORMANCE SYSTEM

APPENDIX A

OPERATIONAL CHARACTERISTICS OF THE IMPROVED-PERFORMANCE SYSTEM

The Mission Plan for the Civilian Radioactive Waste Management Program (DOE 1985a) discusses two alternative federal waste management systems for spent nuclear fuel and high-level radioactive waste. In the first, the "authorized system," the primary federal facilities are two repositories, the first of which has been authorized by Congress, and a federally managed waste-transportation system. The second system, the "improved-performance system," contains in addition an integral MRS facility such as the DOE is proposing to construct. This appendix describes the operational characteristics of the improved-performance system, with emphasis on the MRS facility's role in that system.

The basic facilities and materials flows involved in the improved-performance system are shown in Figure A.1. The components involved in operating this system are:

- The nation's commercial power reactors, owned and operated by U.S. utilities.
- Two geologic repositories: the first, authorized by Congress, is scheduled to begin operation at a western or southern site in 1998; the second is not as yet authorized but is assumed to start up at an as yet unselected site in the year 2006.
- An MRS facility, which the DOE proposes to be located at the Clinch River Breeder Reactor site near Oak Ridge, Tennessee.
- A federally managed transportation system, utilizing commercial carriers, for shipments of spent fuel and high-level waste.

Based on evaluations of draft environmental assessments for several candidate geologic repository sites, three locations have been proposed by the DOE for recommendation for site characterization: 1) Yucca Mountain, Nevada, which features tuff as the geologic medium; 2) Hanford, Washington, with basalt; 3) and the Deaf Smith site in Western Texas, with salt. These three sites were considered in the analyses of the improved-performance system. The second repository was not considered in the analyses. However, the effect of spent fuel acceptance at the second repository on the age of the spent fuel received was considered in the analysis in Section A.5.

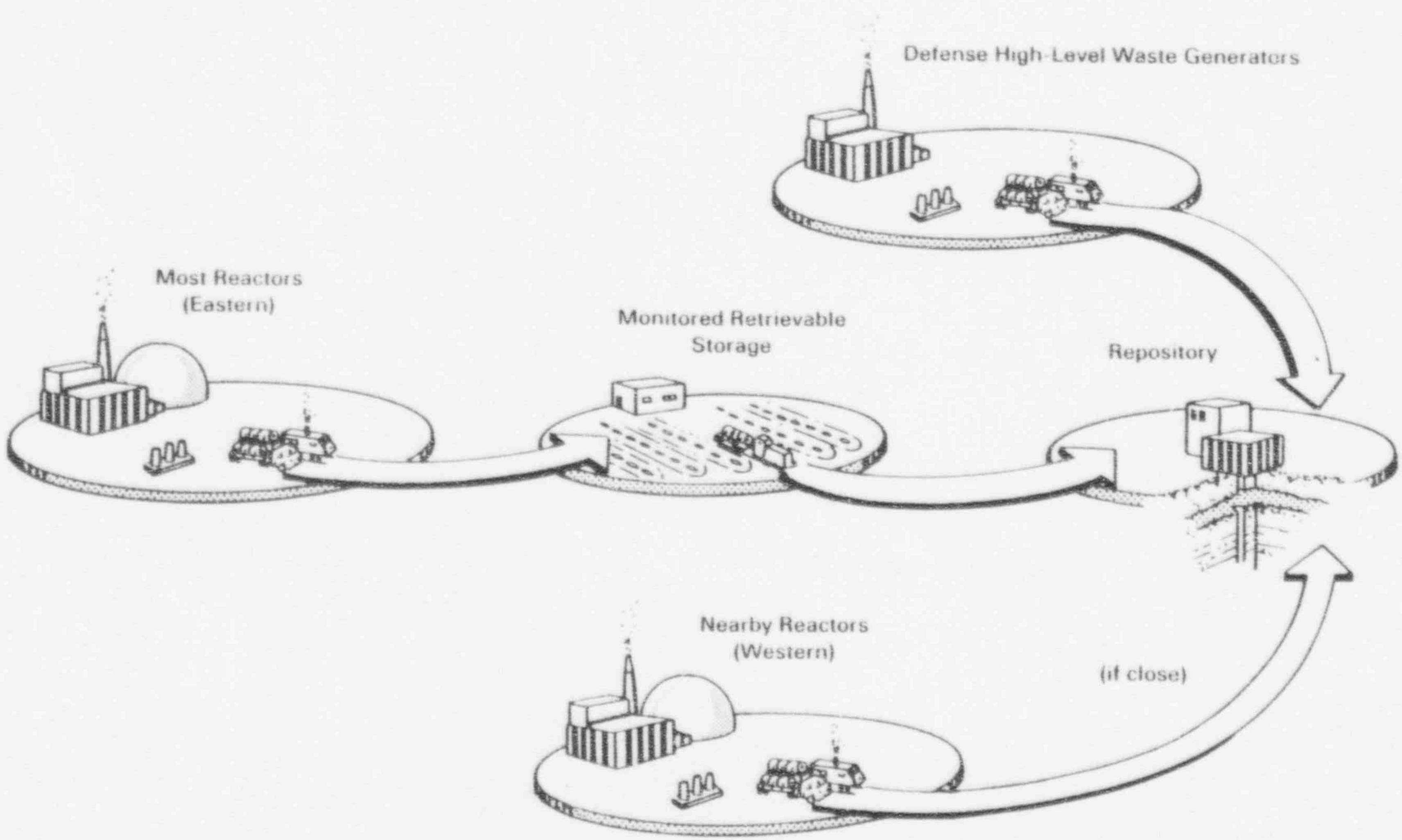

FIGURE A.1. Improved-Performance System

As proposed, the MRS facility would be capable of receiving spent fuel from reactors, disassembling the fuel assemblies, consolidating the fuel rods and encasing them in canisters, and shipping the canisters to a repository for final packaging (i.e., the addition of an overpack, which is the repository-specific barrier to radionuclides) and disposal. Current planning assumes the use of the MRS facility only in conjunction with the first repository; discussions in this appendix follow that assumption. Alternatively, depending on the location and geologic conditions of the second repository, it may prove advantageous for the MRS facility to serve the second repository as well.

The current plan, shown in Figure A.1, is to ship spent fuel from reactors near the repository (in the case of a western repository, reactors in Arizona, California, Oregon and Washington) directly to the first repository. An alternative scenario considered was to ship all spent fuel destined for the first repository to the MRS facility for consolidating and sealing in canisters.

Defense wastes and other high-level wastes will be shipped directly to the repository.

A.1 RECEIPT RATES, SHIPPING RATES, AND INVENTORIES

Under the current assumptions, 62,000 metric tons of uranium (MTU) in the form of spent fuel would be accepted for disposal by the first of the two repositories.[a] If western fuel were to be shipped directly to the repository, the MRS facility would receive and process about 53,000 MTU of spent fuel; the remainder of the first-repository inventory of spent fuel, about 9,000 MTU, would be shipped directly to the repository.

Current assumptions are that only spent fuel will be received and handled at the MRS facility. The facility is designed, however, to handle both spent fuel and high-level waste. If desired it can accept, after vitrification in steel canisters, the high-level waste currently in storage at West Valley. This waste, from the reprocessing of 228 MTU of spent fuel prior to 1972 (DOE 1985b), is scheduled to be vitrified during 1988-1989; it is estimated that about 300 waste canisters, 24 inches in diameter, will be produced.

Projected system flows and inventories of spent fuel are shown in Table A.1 assuming western fuel goes directly to the first repository, and in Table A.2 assuming the MRS facility accepts all fuel for the first repository. The following discussions are based primarily on the information in Table A.1.

(a) The repository will also receive additional defense high-level waste.

TABLE A.1. Projected System Flows and Inventories with Western Spent Fuel Shipped Directly to the First Repository (in MTU)

Year	MRS Receipt Rate	Shipments: MRS to First Repository	MRS Inventory	First Repository Receipts From Western Reactors	Total First Repository Receipts	First Repository Inventory
1995	0	0	0	0	0	0
1996	400	0	400	0	0	0
1997	1,800	0	2,200	0	0	0
1998	2,500	350	4,350	50	400	400
1999	2,500	350	6,500	50	400	800
2000	2,500	325	8,675	75	400	1,200
2001	2,500	825	10,350	75	900	2,100
2002	2,500	1,700	11,150	100	1,800	3,900
2003	2,500	2,800	10,850	200	3,000	6,900
2004	2,500	2,650	10,700	350	3,000	9,900
2005	2,500	2,550	10,650	450	3,000	12,900
2006	2,500	2,550	10,600	450	3,000	15,900
2007	2,500	2,550	10,550	450	3,000	18,900
2008	2,500	2,550	10,500	450	3,000	21,900
2009	2,500	2,550	10,450	450	3,000	24,900
2010	2,500	2,550	10,400	450	3,000	27,900
2011	2,500	2,550	10,350	450	3,000	30,900
2012	2,500	2,550	10,300	450	3,000	33,900
2013	2,500	2,550	10,250	450	3,000	36,900
2014	2,500	2,550	10,200	450	3,000	39,900
2015	2,500	2,550	10,150	450	3,000	42,900
2016	2,500	2,550	10,100	450	3,000	45,900
2017	2,500	2,550	10,050	450	3,000	48,900
2018	800	2,550	8,300	450	3,000	51,900
2019	0	2,550	5,750	450	3,000	54,900
2020	0	2,550	3,200	450	3,000	57,900
2021	0	2,550	650	450	3,000	60,900
2022	0	650	0	450	1,100	62,000
2023	0	0	0	0	0	62,000
2024	0	0	0	0	0	62,000
2025	0	0	0	0	0	62,000

TABLE A.2. Projected System Flows and Inventories with All Spent Fuel Shipped Directly to the MRS Facility (in MTU)

Year	MRS Receipt Rate	Shipments: MRS to First Repository	MRS Inventory	First Repository Inventory
1995	0	0	0	0
1996	400	0	400	0
1997	1,800	0	2,200	0
1998	3,000	400	4,800	400
1999	3,000	400	7,400	800
2000	3,000	400	10,000	1,200
2001	3,000	900	12,100	2,100
2002	3,000	1,800	13,300	3,900
2003	3,000	3,000	13,300	6,900
2004	3,000	3,000	13,300	9,900
2005	3,000	3,000	13,300	12,900
2006	3,000	3,000	13,300	15,900
2007	3,000	3,000	13,300	18,900
2008	3,000	3,000	13,300	21,900
2009	3,000	3,000	13,300	24,900
2010	3,000	3,000	13,300	27,900
2011	3,000	3,000	13,300	30,900
2012	3,000	3,000	13,300	33,900
2013	3,000	3,000	13,300	36,900
2014	3,000	3,000	13,300	39,900
2015	3,000	3,000	13,300	42,900
2016	3,000	3,000	13,300	45,900
2017	2,800	3,000	13,100	48,900
2018	0	3,000	10,100	51,900
2019	0	3,000	7,100	54,900
2020	0	3,000	4,100	57,900
2021	0	3,000	1,100	60,900
2022	0	1,100	0	62,000
2023	0	0	0	62,000
2024	0	0	0	62,000
2025	0	0	0	62,000

The rate of acceptance of spent fuel at the MRS facility can only be projected at this time. The DOE/utility spent-fuel disposal contract (10 CFR 961 1985) calls for acceptance schedules to be specified beginning in the year 1991. Based on current projections of spent-fuel-generation rates and of increases in need for at-reactor storage, it is currently estimated that 3000 MTU/year of spent fuel would be accepted for storage or disposal during and after 1998. The acceptance rate at the MRS facility is assumed, after the initial ramp-up, to be 2500 MTU/yr spent fuel, whereas 450 MTU/yr, and 9000 MTU total, are assumed to be shipped directly to the first repository from western reactors. Shipments from the MRS facility to the repository, once the repository is operating at full scale, would be at a rate of 2550 MTU/year, depleting the amount stored by 50 MTU/yr and maintaining a repository receipt rate of 3000 MTU/year.

Alternatively, all spent fuel could be shipped through the MRS facility, at a rate of 3000 MTU per year, as shown in Table A.2.

The MRS facility is currently envisioned to become operational in October 1996, following a 10-month period of operational demonstrations using spent fuel. The projected amount of fuel received in 1996, including that received both during the demonstration period and the initial 3 months of operation, is 400 MTU. In 1997 the acceptance of spent fuel would increase to 1800 MTU, and in 1998 the amount for full-scale operation (2500 MTU) would be received. In its current state of conceptual design, the MRS facility is capable of receiving (and concurrently shipping to the repository) 3600 MTU per year. Before definitive design, the MRS design capacity will be finalized, after consideration of the economics of facility capital cost and various modes of facility operation.

The MRS facility is planned to have a storage capability of 15,000 MTU, including storage of fuel in sealed storage casks and a lag storage vault in the receiving and handling building. The lag storage capacity is intended as a buffer for decoupling fuel-acceptance activities from shipment to the repository for disposal. It would compensate for operational mismatches or for short-term disruptions in the system without resort to retrieval from the sealed storage casks. The cask storage capability is expected to be used primarily to permit fuel acceptance before and during the startup period of the first repository. As discussed later, the cask storage system would also permit "tailoring" of the heat generation rates of fuel shipped to the repository, by aging fuel in the storage casks, to provide canisters with a more uniform heat output for disposal in the repository.

A.2 TRANSPORTATION CHARACTERISTICS WITH MRS

The transportation link for shipping spent fuel from the utility reactors to the MRS facility, and from the MRS facility to the repository, is planned as a system of NRC-certified shipping casks transported by commercial truck and rail carriers. The mode of shipment from the reactors will be governed primarily by the capabilities of each reactor; currently some 40 reactors either have no rail capability or have some degree of restriction on rail capability. Recently completed reactors have full rail capability; presumably, all reactors to be built in the future will also have this capability. Thus, shipments from the reactors are assumed to be a mixture of truck and rail; current estimates are that about 70% (by weight) of the fuel will be shipped by rail. The use of marshaling yards or transloading of shipping casks could increase the rail shipments.

It is planned that shipments of canistered spent fuel from the MRS facility to the repository will be by dedicated train, in groups of five or more large casks (100- to 150-ton weight).

A.3 TIME REQUIREMENTS FOR TRANSPORTATION AND MRS OPERATIONS

The time required to ship spent fuel from the utility reactors to the MRS facility, and from the MRS facility to the repository, plays an important role in determining the size of the cask fleet required for system transportation. The cask turnaround times (loading or unloading and associated idle time) at the MRS or repository are also important. The time required to handle the received fuel and prepare it for reshipment affects the lag storage size requirements and the basic throughput capability of the MRS facility.

Transport times for shipments between reactors and the MRS facility vary considerably with differing distances and routes, but are estimated to average 1 to 2 days for truck shipments and 9 to 10 days by rail. From the MRS facility to the repository, by dedicated train, transport times will vary from 2 to 10 days, depending on the location of the repository. Return trips in each case would require equivalent times. In addition, turnaround times at each facility (the time from receipt of a cask until it is returned to the carrier) average 1.5 days for truck casks and 2.5 days for rail casks at reactors; equivalent times are assumed at the MRS facility. For shipment from the MRS facility to the repository, turnaround times of 4.5 days for a five-cask dedicated train at each facility are projected.

Based on the above assumptions, it is estimated that a total fleet would consist of about 15 to 20 truck casks and 20 to 25 rail casks for shipments from the utility reactors, and 30 to 40 100-ton rail casks (or 10 to 15 150-ton casks) for shipments from the MRS facility to the repository. The ranges in numbers of casks servicing the reactors reflect uncertainties in priority allocations of fuel shipments in a given year; thus the fleet would tend to the high side of that range. For the MRS-to-repository casks, the ranges depend on the shipping times to the repository location.

A.4 PLANNED OPERATIONAL MODE FOR MRS

The MRS facility is intended to receive spent fuel from utility reactors at rates to be determined by the final DOE/Utilities contract (10 CFR 961), to consolidate and canister the fuel, and to reship the canistered fuel to the first repository for final packaging and disposal. The excess fuel accepted in the early years of MRS facility operation, before full operation of the repository, would be temporarily stored in sealed storage casks until it can be shipped to the repository without disrupting the acceptance from utilities. The basic flows and inventories for this operation are shown in Table A.1.

A.5 PLANNED REPOSITORY OPERATING MODE

The first geologic repository is scheduled to begin operation in 1998, initially receiving fuel at the rate of 400 MTU per year. This rate would be gradually increased, as indicated in Table A.1, until it reaches a full-scale rate of 3000 MTU per year in the year 2003. The 3000-MTU-per-year rate would be continued until the repository reaches its 62,000-MTU capacity of spent fuel.

In shipments from the MRS facility, the repository is expected to receive about 2550 MTU per year of spent fuel consolidated into canisters. The canisters would be packaged (overpacked) as appropriate for the geologic medium, lowered to the disposal area, and emplaced.

The fuel shipped directly to the repository from the western reactors, nominally at 450 MTU per year (Table A.1), is expected to be received primarily as intact spent-fuel assemblies; some utilities, however, may choose to consolidate and canister fuel. Upon arrival at the repository, the fuel would be packaged for disposal, with or without an inner canister as appropriate, and disposed of underground.

In an alternative plan (Table A.2), with all fuel shipped to the MRS facility, the only functions of the repository would be to receive, package and dispose of the consolidated and canistered fuel from the MRS facility. No "bare" (uncanistered) fuel would be handled in routine operations.

With the repository filled to capacity, backfilling of the emplacement tunnels would be completed after approval is received from the NRC. Fuel receipt and disposal activities would then be focused solely at the second repository.

A.6 ALTERNATIVE MRS OPERATIONAL MODES

Inventory-management techniques within the MRS facility can be varied, if desired, to modify the characteristics of the fuel. The MRS storage facilities can be used to age the accepted fuel, thus providing the repository with fuel exhibiting lower and more uniform heat-generation rates.

In accordance with 10 CFR 961, the DOE is committed by contract with the utilities to receive fuel as young as five years after discharge. Such fuel would have heat-generation rates more than 50% greater than the 10-year-old fuel on which many repository design studies have been based. Fuel exposed to higher burnup than today's levels would have similar characteristics. Disposal of fuel with higher heat output, depending on the disposal medium, could require development of larger underground facilities, at increased cost, to permit greater dispersal of the heat.

At the time the DOE begins acceptance of spent fuel, there will be large stocks of aged fuel, 10 years and older. However, at the projected acceptance rates shown in Table A.2, this aged fuel will be largely depleted within about 10 years; the average age of fuel received may approach 5 to 7 years after that.

The fuel inventory in MRS may be managed to provide additional aging of the fuel, reducing the heat-generation. The simplest method is by rotating the storage inventory on an "oldest fuel out" basis. In such a scheme, all short-term-cooled fuel received at the MRS facility would be sent to storage. The oldest fuel received or in storage would be shipped to the repository. The effects of such a fuel-management scheme are illustrated in Figures A.2 and A.3. Figure A.2 shows the estimated age spread of fuel upon receipt at the MRS facility (based on a case assuming that all first-repository fuel is handled at the MRS facility). In the later years of fuel acceptance, after about 2009, most or all of the fuel received is aged less than 10 years since discharge; much of this fuel is projected to be in the 5- to 7-year category. Figure A.3 shows the same fuel received at the repository after age-tailoring as described. With this MRS operational mode, virtually all of the fuel shipped to the repository is aged 10 years or more from discharge.

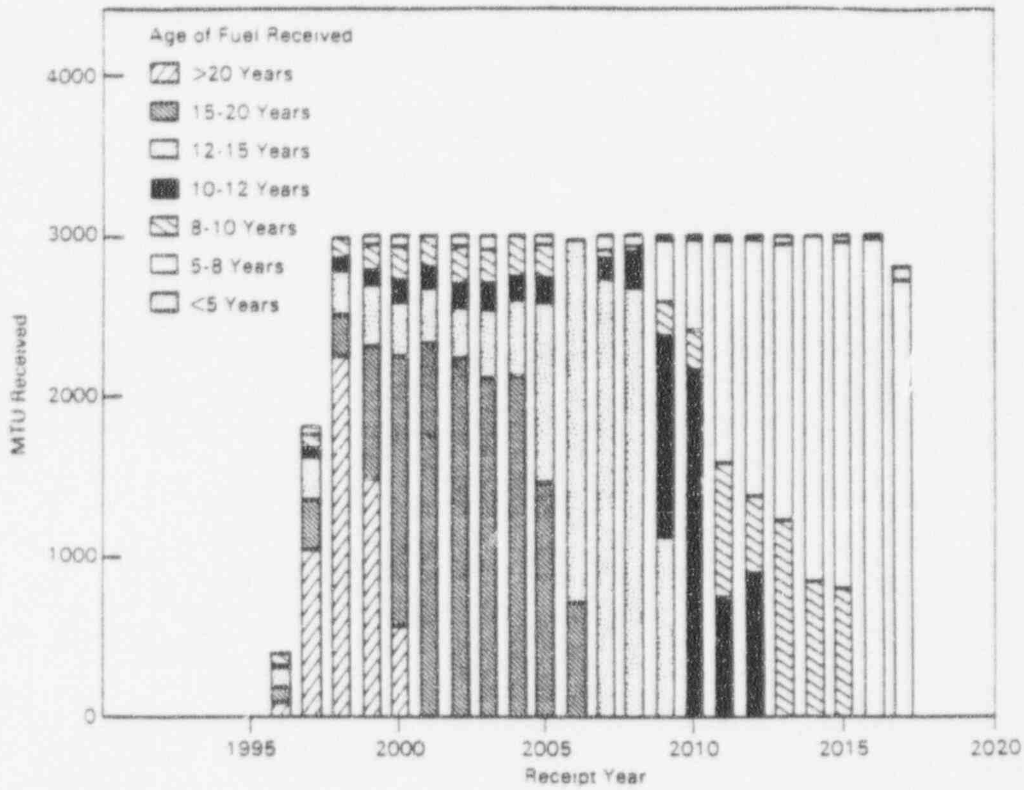

FIGURE A.2. Age Distribution of Fuel Receipts at the MRS Facility

Other potential alternative modes of MRS facility operation include options for the handling of western fuel, previously discussed, and the use of the MRS facility to service the second utility as well as the first. The advantages of the latter alternative MRS role (or alternatively the use of a second MRS facility) would depend heavily on the location of the second repository. The role currently proposed for MRS does not include its use with the second repository. However, if it proves desirable at a later date, it could fulfill this function.

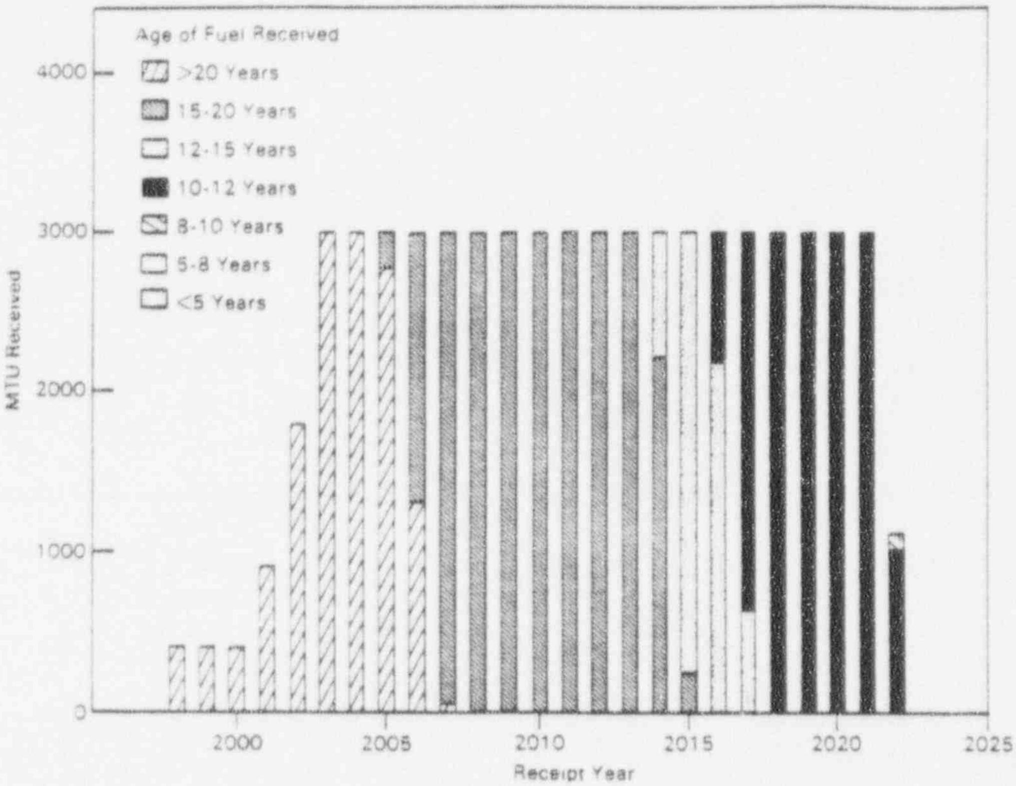

FIGURE A.3. Age Distribution of Fuel Receipts at the First Repository After Age-Tailoring at the MRS Facility

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10 CFR 961. 1985. Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste. Title 10, Part 961, Code of Federal Regulations, U.S. Office of Federal Register.

APPENDIX B

DESCRIPTION OF MRS FACILITY OPERATIONS

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DESCRIPTION OF MRS FACILITY OPERATIONS

This appendix provides a brief description of MRS facility operations based on the conceptual design (R. M. Parsons Company 1985).[a] Section B.1 presents an overview of the requirements and capabilities of the MRS facility. Section B.2 describes the receiving and handling building, which contains the main operating areas in the MRS facility, and Section B.3 discusses MRS storage facilities and related operations.

The MRS conceptual design satisfies the design criteria stipulated in the NWPA and the functional requirements for an integral component of the waste management system. The latter requirements are documented in the Functional Design Criteria (PNL 1985).

B.1 OVERVIEW OF MRS REQUIREMENTS AND CAPABILITIES

The integral MRS facility is intended to serve as a centralized receiving and packaging facility for commercial spent nuclear fuel. In addition, the facility will provide contingency storage capability to accommodate surges or disruptions in any operational element of the federal waste management system.

To achieve these goals and the design criteria above, the facility is designed to receive, process and ship offsite or store onsite, a minimum of 3600 metric tons of uranium (MTU) per year primarily as spent fuel and a small amount (less than 300 canisters total) as high-level waste (HLW).[b] The MRS facility will have in-building lag storage capacity for up to 1000 MTU of consolidated fuel in canisters, plus outdoor storage capacity for up to 15,000 MTU of spent fuel. The design assumes a spent fuel mix of 60% PWR/40% BWR by weight, based on 0.462 MTU per PWR assembly and 0.186 MTU per BWR assembly. It will also be capable of retrieval, overpacking as required, and shipment of at least 3600 MTU or equivalent per year of canistered spent fuel and waste to a geologic repository for disposal. Capability will be maintained

(a) Design verification activities, see Appendix C, may result in some changes in specific processes or equipment; however, the general operations will be as described in this appendix.

(b) The design criteria in the NWPA require that the MRS facility be capable of handling commercial HLW. Although there exists a small amount of commercial HLW at the closed West Valley, New York, reprocessing facility, the DOE plans to receive only commercial spent fuel at the MRS facility.

to receive and ship concurrently at those rates. Surge capacity will be included in the design of receiving, handling, and storage systems to obviate the impacts of credible offsite and onsite disruptions of spent fuel, waste, and material flows.

Hot cell space will be included to accommodate overpack equipment capable of sealing consolidated fuel canisters in a repository-type overpack suitable for disposal. However, the equipment for overpacking is not included in the design.[a]

The MRS facility must be licensed by the NRC. In addition, the design, construction and operation of the facility will be performed in conformance with all applicable industry codes and standards and in compliance with applicable state laws and federal regulations.

The principal operations to be performed in the MRS facility are receipt, disassembly, consolidation and packaging of spent fuel for interim storage, as needed, and ultimately shipment offsite for disposal. The facility provides short-term lag storage capability for intact and consolidated fuel in the R&H building vaults. Long-term storage capability is provided externally in concrete sealed storage casks. The overall layout of the MRS facility, including administrative and support buildings, is shown in Figure B.1. The general layout of the R&H building including the process cells and lag storage vaults is illustrated in Figure B.2.

Reference heat generation rates and levels of radioactivity of spent fuel that will be received, handled and shipped or stored in the MRS facility are listed in the FDC. The facility is designed for spent fuel having exposures of about 30,000 MWD/MTU and having been cooled at the reactor for 10 years. However, the facility can handle up to 10% of the spent fuel with only 5-year cooling with this exposure and 10-year-cooled spent fuel with up to 55,000 MWD/MTU exposure.

B.2 R&H BUILDING DESCRIPTION

The receiving and handling (R&H) building contains the main operating areas of the MRS facility. The general layout of the R&H building is essentially symmetric about a line passing between the canyon cells in the center of the building and in the general direction of material flows. Approximately half of the R&H building is illustrated in the cut-away view in Figure B.2.

(a) At this time it appears to be operationally preferable to perform the overpacking at the repository site.

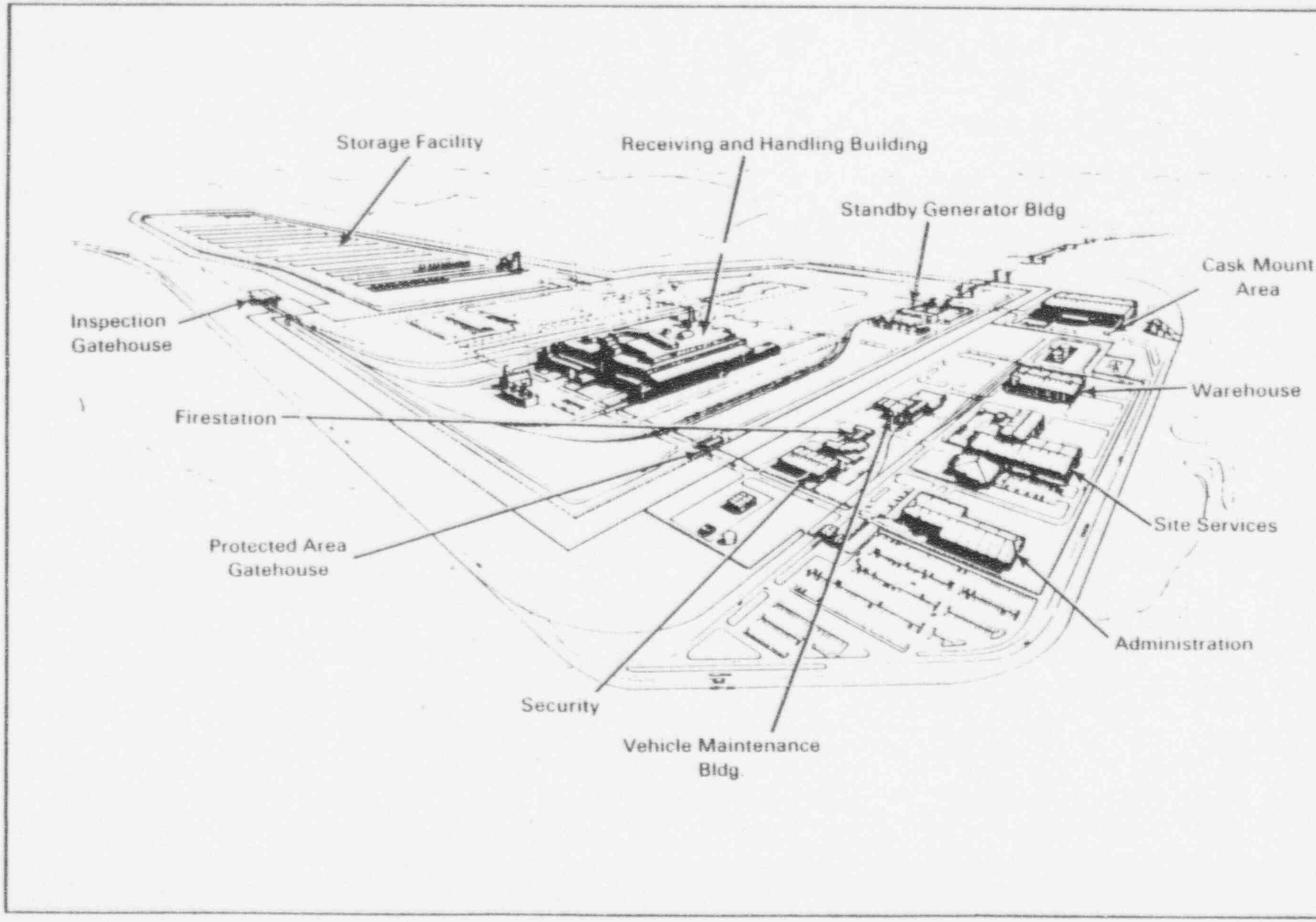


FIGURE B.1. Overview of the MRS Facility Layout

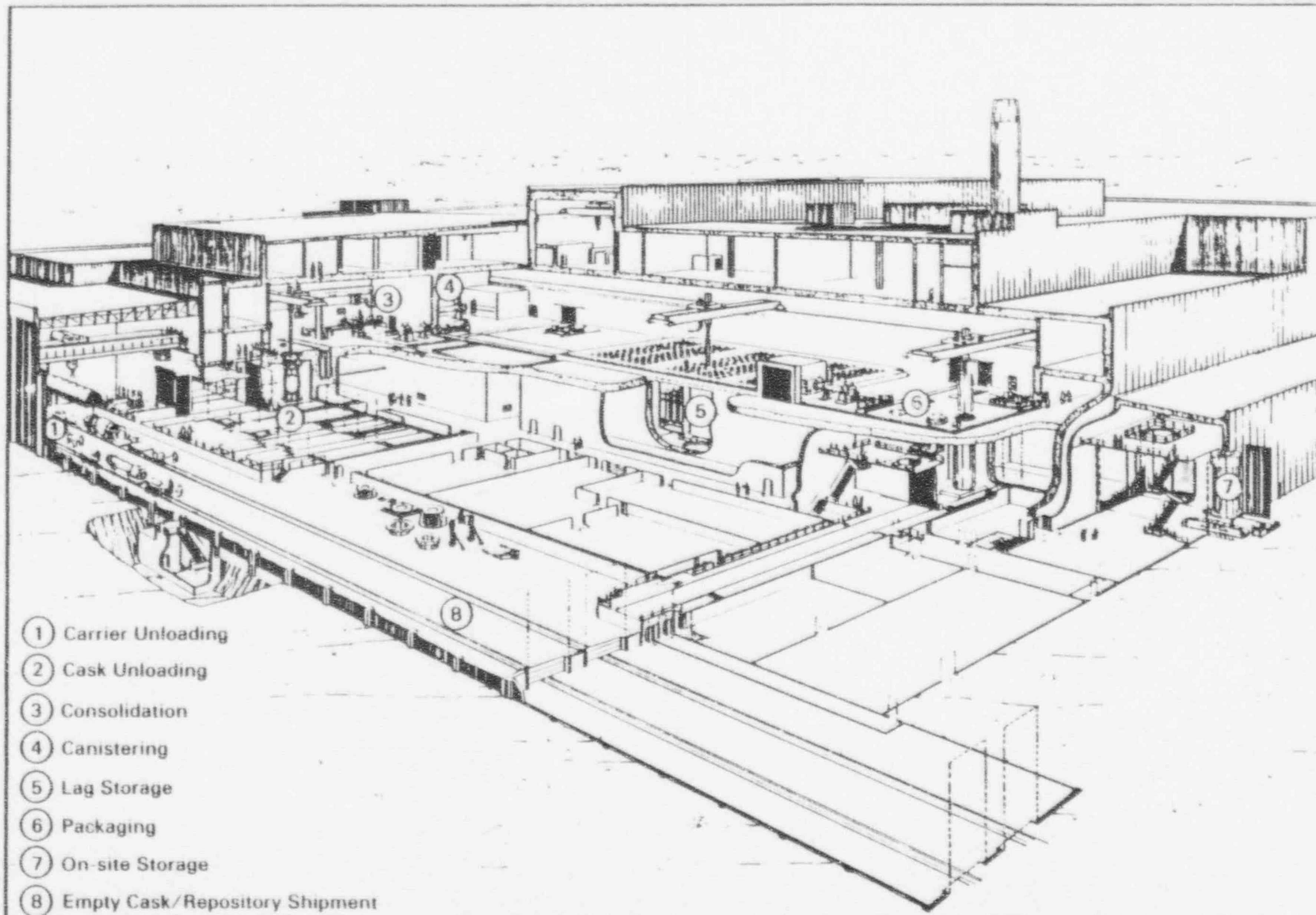


FIGURE B.2. Overview of the MRS Receiving and Handling Building

The principal operating areas and associated operations are as follows:

- fuel receiving and handling areas
- main process cells
- canister weld stations
- lag storage vaults
- sealed storage cask/field drywell loadout/retrieval areas
- overpack installation area (optional)
- transport cask loadout areas.

As previously noted, only the space (no equipment) needed for the installation of overpacks for disposal is provided in the current design.

Other areas of the building include: administration, radwaste treatment, and building services. The administration area contains offices, a lunchroom, a conference room, change rooms and toilet rooms, and the health physics facilities. These areas provide services specifically for the operations and management and support personnel housed within the R&H building.

The radwaste treatment area is separated into two areas: the high-activity waste (HAW) area, for processing highly radioactive wastes, and the low-level waste (LLW) area. The LLW area is further divided into liquid and solid waste treatment areas. The liquid LLW treatment system reduces the volume of the waste by evaporation. The non-radioactive liquid effluent is recycled within the R&H building; the sludge is sent to the solid LLW treatment system. The solid wastes, except HEPA filters, are mixed with a cement grout and placed in 55-gallon drums. The sludge from the liquid radwaste is added to the grout. The drums of waste are cured, decontaminated as necessary and sent through a drum interrogator that determines the presence of transuranic (TRU) material by gamma pulse height analysis. Drums with TRU material (CHTRU) are sent to the onsite CHTRU storage facility. Drums without TRU material (LLW) are sent to the temporary storage area before being shipped to an offsite disposal area. The second- and third-stage HEPA filters are compacted and placed in 55-gallon drums without the cement grout. These drums go through the same decontamination and interrogation process as the grouted drums.

The HAW materials, including the in-cell and first-stage HEPA filters, are processed generally similarly to the LLW materials but are processed within a shielded area using totally remote methods.

The building service areas include:

- analytical laboratory
- aqueous and chemical makeup rooms
- HVAC equipment room

- mechanical equipment rooms
- laundry room
- maintenance rooms
- material receiving and storage rooms.

These areas are typical of most nuclear-related facilities and are not described here.

Spent fuel transport vehicles (trucks and rail cars) enter the R&H building by means of rail lines and paved roads on either side of the building. There are four independent processing cells, two on either side of the canyon cells, each with its own receiving and handling area. Two independent weld stations, accessible from any of the four process cells, are installed in the canyon near the "input" end of the R&H building. The majority of the central canyon is occupied by the air-cooled canister storage vaults. There are two independent canister loadout areas for loading of transport casks for shipment to a repository. These are situated beside the process cells and facing into the canyon near the "output" end of the building. Two independent sealed storage cask loadout/retrieval areas are located at the extreme output end of the canyon cells from which sealed storage casks are loaded for emplacement in the storage facility. The area reserved for canister overpacking is also located in the canyon. Brief descriptions of operations performed in each of the principal operations areas are presented in the subsequent subsections.

B.2.1 Fuel Receiving and Handling

Four independent transport cask unloading areas are located under each of the main process cells, as illustrated in Figure B.3. The R&H cells connect to the rail/truck receiving areas on either side of the R&H Building. Spent fuel casks arriving at the facility are inspected, lifted from the transport vehicle and mounted vertically on a cask transport cart. This cart is then moved into the cask handling and decontamination room where gas samples are taken, the outer cask lid removed, and other preparation tasks completed. The cask is then moved into the cask unloading room, the cask is mated to the operating cell fuel input port, a special "skirt" is lowered over the cask to provide contamination control for fuel unloading operations, and the shield door is closed and sealed.

The cell port cover and cask inner lid are then removed. Fuel assemblies are removed from the cask one at a time, inspected and transferred either to the disassembly table or to the in-cell lag storage pit using a crane in the cell.

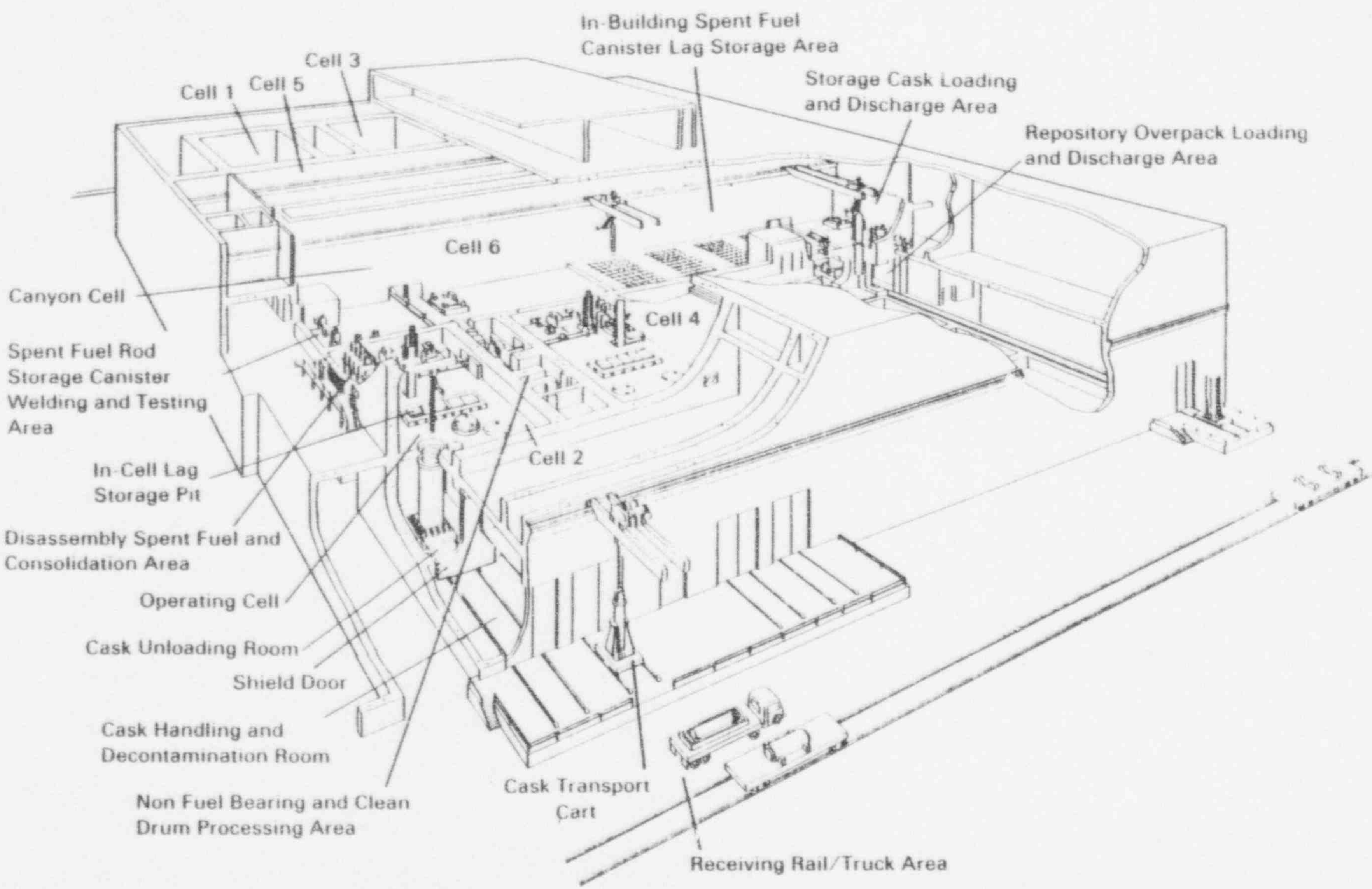


FIGURE B.3. Illustration of the Transport Cask Receiving, Handling and Unloading Facilities

After unloading is completed, the inner cask lid is replaced and sealed, and the port cover is replaced. The unloading port skirt is then withdrawn and the cask disengaged from the cask unloading port. The unloading room door is then opened and the cask is transferred to the cask handling and decontamination room where the cask surfaces are checked and decontaminated if needed and the outer lid is replaced. The cask is then moved to the receiving area where it is lifted off the cart, placed on a transport vehicle and released for dispatch to a reactor for another load. Once the cask is transferred out of the cask unloading room, the room is inspected and decontaminated if needed.

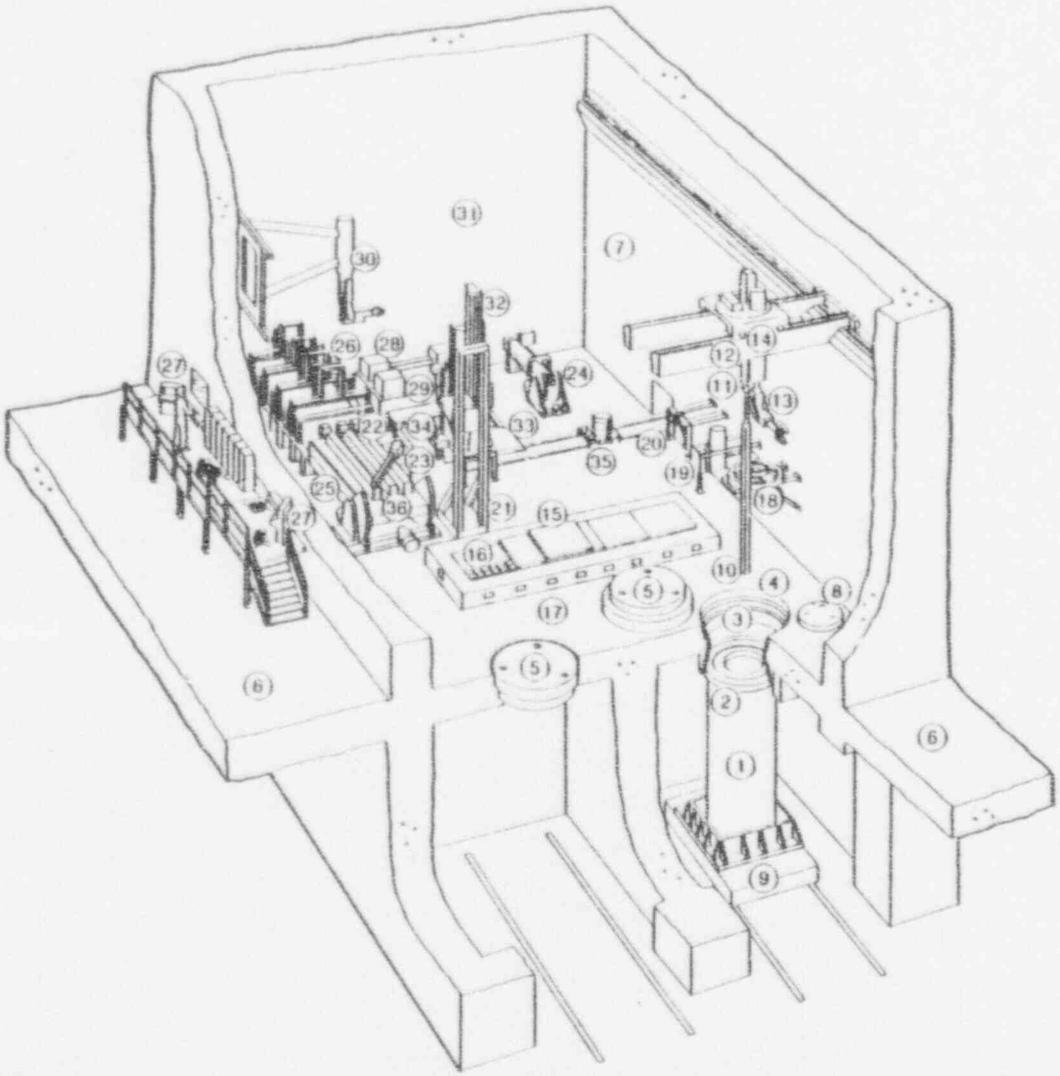
B.2.2 Main Process Cells

The principal operations performed in the four heavily shielded process cells are the disassembly of fuel, bundling and insertion of the rods into a canister and compaction and packaging of the residual fuel hardware. All of these operations are performed remotely. The disassembly equipment is illustrated in Figure B.4. Although each cell can handle either PWR or BWR fuel, they would normally be set up such that two cells would handle PWR fuel and two cells BWR fuel.

Fuel assemblies removed from a cask or from in-cell lag storage are first placed in the fuel assembly upender/disassembly clamping fixture. The fixture will hold either 3 PWR or 7 BWR assemblies for simultaneous processing. The upper fuel rod tie plate/nozzle assemblies are then removed with the upender fixture in the vertical orientation using a computer-controlled laser cutter. The upender fixture is then rotated to the horizontal orientation and the lower fuel rod tie plate/nozzle fixtures are removed using the laser cutter.

The fuel rods are then removed by a mechanical pulling operation in which mechanical grippers or collets individually engage the ends of all rods in either the 3 PWR or the 7 BWR assemblies in the fixture. A system of vertical and horizontal combs is inserted between the rods to support them during the pulling operation. Each rod gripper is designed to release if pulling forces exceed preset limits, thus preventing damage to stuck rods. Special equipment and procedures will be provided to remove and handle stuck or damaged rods.

When the pull is completed, the horizontal combs are removed allowing the loose rods from all of the disassembled fuel assemblies to drop a short distance vertically downward into a semicircular sling-and-die rod reconfiguration system. This device reconfigures and holds the rods in a cylindrical close-packed bundle for insertion into the canister. The cover on the process cell fuel outlet port is then removed. A "pusher" moves the compacted bundle of rods through the process cell outlet port into an empty canister that is mated



1. Shipping Casks
2. Cask Adapter for Contamination Barrier
3. Contamination Barrier
4. Entry Port
5. Entry Port Shield Plugs
6. Operating Gallery
7. Shielded Process Cell #2
8. Shipping Cask Cover
9. Cask Cart
10. Spent Fuel Element
11. Spent Fuel Grapple
12. Power Mast
13. Manipulator
14. 20 Ton Hot Cell Crane
15. Lag Storage Covers
16. Lag Storage
17. Lag Storage Cooling Ducts
18. Port Grapple
19. Fuel Assembly and Pintle Grapples
20. Module Lifting Yokes
21. Laser Cutting System
22. Laser Cutting Head
23. Robotic (Auxiliary)
24. Intact Fuel Assembly Upender
25. Fuel Disassembly Station
26. Fuel Rod Consolidation Station
27. Process System Control Console
28. Maintenance Hatch Jacking Mechanism
29. Maintenance Hatch
30. Wall Mounted Manipulator
31. Shielded Process Cell Contamination Barrier
32. Secondary Waste Shredding System
33. Drum Lidding Station
34. Grid Infeed Chute
35. Drum/Filter Cart
36. Fuel Disassembly Module

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FIGURE B.4. Illustration of the Fuel Disassembly Equipment and Operation to the port and held in a fixture in the central canyon area. After closure of the cell port cover, the canister is removed and transferred to the canister weld station for final closure.

The hardware remaining after fuel disassembly is reduced in volume and packaged in drums in the process cell, as illustrated in Figure B.5. The spacer grids, instrument tubes and other relatively "light" hardware are placed into a shredder that reduces them to smaller pieces and feeds them vertically downward into a drum. The massive end fittings are placed in the drums intact. The drums are then sealed and transferred into the drum decontamination cell for further processing, loadout or storage.

B.2.3 Canister Weld Stations

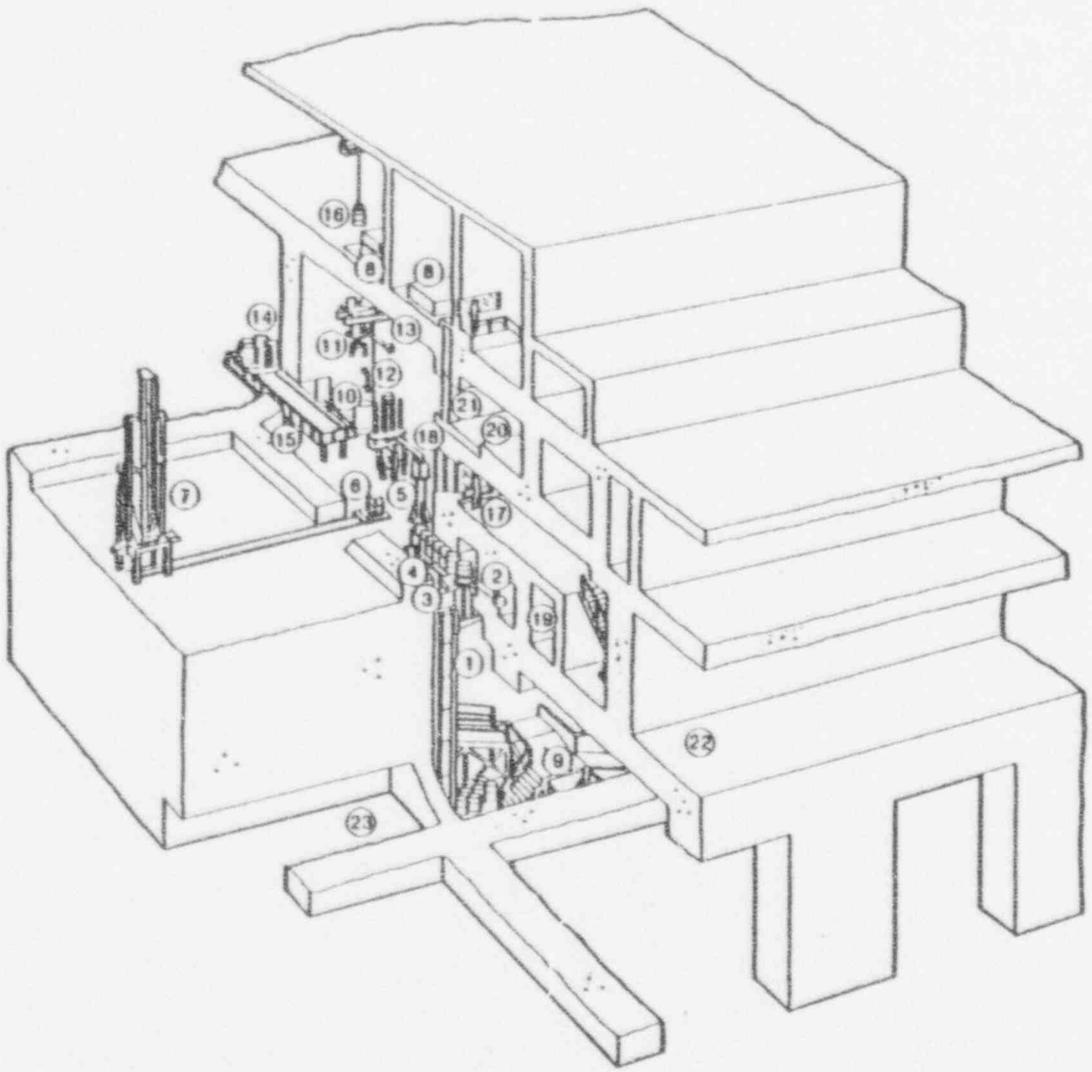
The filled canisters received from the process cells are seal-welded, decontaminated and inspected at the welding stations. Each weld station normally serves the two nearest process cells; however, either station can serve any of the four cells if necessary.

In the canister closure system, illustrated in Figure B.6, loaded canisters are shuttled from the process cell to the weld station on a remotely controlled transfer cart. The canister is inserted into a weld station chamber and the chamber is closed for canister welding operations. The air in the chamber is purged and replaced with an inert gas. The canister lid is installed and seal-welded using a resistance-upset welding device. The welder generator, controls and associated hardware are housed in a shielded room behind the weld station where they are routinely accessible for operation and maintenance. Only the canister clamps and electrodes are located in the weld chamber.

After welding is completed, the canister is decontaminated and leak-tested while still in the weld chamber. The chamber is then opened, the canister withdrawn into the canyon, checked for contamination, and examined with an acoustic NDT system to verify weld integrity. When certified as sealed and free of contamination, the canister is transferred to the vault for short-term storage, to the sealed storage cask loadout cell for emplacement in long-term storage, or to the transport cask loadout area for shipment to the repository.

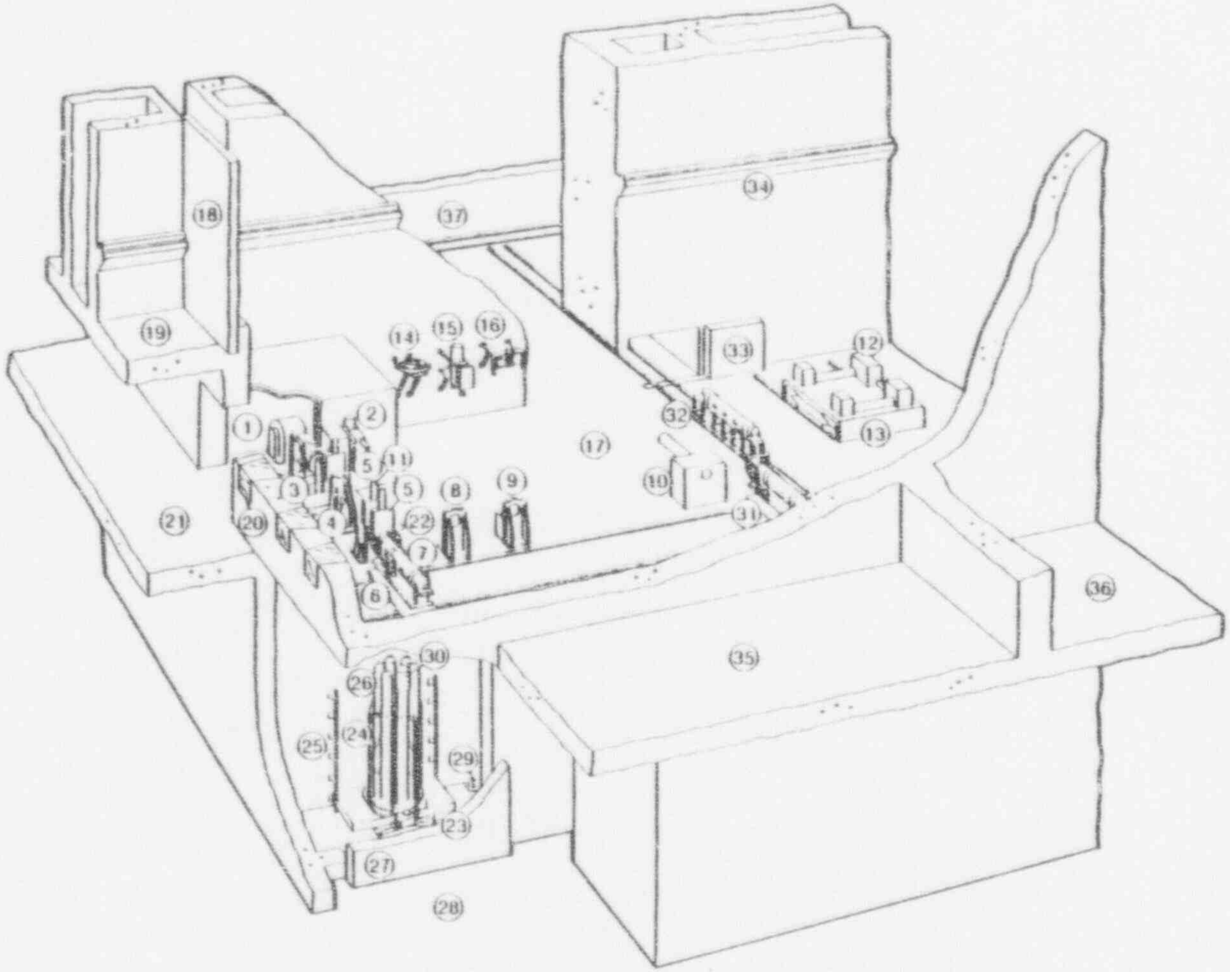
B.2.4 Lag Storage Vault

Air-cooled lag storage vaults for temporary storage of consolidated fuel canisters occupy the bulk of the central operating canyon cells. There are eight canister compartments in the vault, each designed to hold 16 canisters.



1. Clean Drum Elevator
2. Drum Push Mechanism
3. Shield Valve
4. Drum Guidance System
5. Jib Crane w/Drum Grapple
6. Drum Transfer Cart
7. Secondary Waste Shredding System
8. Maintenance Hatch
9. Ramp
10. Drum Decontamination Station
11. Drum Grapple w/Decontam. Station Lid
12. Drum Swipe Arm
13. Overhead Crane w/Manipulator
14. Filled Drum Transfer Cart
15. Filled Drum Transfer Platform
16. HVAC Filter Drum
17. Secondary Waste Processing and Decon System Control Station
18. Observation Window
19. Airlock
20. Crane Maintenance Room
21. Crane Maintenance Shield Door
22. Operating Gallery
23. Clean Drum Storage

FIGURE B.5. Illustration of Fuel Hardware Shredding and Packaging Equipment



1. Welding Power Generator/Equipment Room
2. Canister Lid Supply System
3. Canister Welding Station
4. Canister Decon/Helium Leak Test Chamber
5. Chamber Isolation Valves
6. Canister Upender No. 1
7. Storage Canister
8. Ultrasonic Test Station
9. Canister Cutting Station
10. Fuel Rod Bundle Push Rod System
11. Forge Press Restraint
12. Maintenance Hatch Jacking Mechanism
13. Maintenance Hatch
14. Plug Grapple
15. Pintle Grapple
16. Equipment Lifting Yoke
17. Shielded Canyon Cell #6
18. Maintenance Area Shield Door
19. Crane Maintenance Room
20. Observation Window
21. Operating Gallery
22. Clean Canister and Lid Supply Port
23. Carousel Lift Mechanism
24. Carousel Canister Rack
25. Guide Rail Lift Mechanism
26. Clean Canisters
27. Shield Door
28. Access Corridor
29. Lift Mechanism Hydraulic Pump System
30. Canister Lid Supply Support Tube
31. Canister Upender No. 2
32. Canister Pass-Thru Cart
33. Canister Pass-Thru Shield Door
34. 35 Ton Crane Rails
35. Shielded Process Cell #2
36. Decon Cell
37. Shielded Canyon Cell #5

FIGURE B.6. Illustration of Canister Welding System

Cooling air from a central supply is individually ducted to each compartment and then recollected into a common exhaust. Air is circulated through the vaults by means of fans in the exhaust leg of the circuit. The air is filtered at the inlet to remove dust particulates and insects to keep the ducts clean and at the outlet to preclude the possible spread of contamination from a leaking or contaminated canister. To further protect against the possible spread of contamination, the pressure in the cooling system is maintained below atmospheric but above canyon pressure. In this way, any air leakages that occur will be inward and ultimately into the plant HVAC filters, thus assuring containment of any potential releases from the fuel.

Cooling of fuel canisters is provided by forced ventilation. Heat is removed from the compartments by continuous circulation of cooling air, with cool air entering at the bottom and warm air exiting from the top. Cooling air also passes around the outside of the compartments to keep the concrete wall temperature below specified limits.

Fuel canisters are loaded into and unloaded from the vault through ports in the floor of the canyon cell. Each port is fitted with a removable shield plug. In loading operations, the shield plug is first removed and set aside using the canyon overhead crane. A fuel canister is then obtained from a weld station, transported to the open port, lowered into the vault and the plug is replaced using the same overhead crane. The reverse procedure is used for removing canisters from the vault prior to sealed storage cask or transport cask loadout operations.

B.2.5 Sealed Storage Cask Loading Area

The facilities for loading sealed storage casks are on the extreme output end of the R&H building canyon cells. There is one loading area in each of the canyon cells and canisters from anywhere in the canyon cells can be loaded through either loading area. Loading may occur directly from the canister weld stations or from lag storage. In retrieval operations, canisters removed from sealed storage casks can go back to lag storage or to the transport cask loading areas for shipment to a repository.

In the sealed storage cask loading operation, the casks are first loaded onto a crawler/transporter and transported from the cask staging area into the R&H building. The loading area shield doors are opened to admit the crawler and closed during loading operations. The cask, prepared for loading, is positioned beneath the loading port, engaged to the loading port interface and the outer shield lowered around the top of the cask. The in-cell overhead crane is used to remove the loading port plug and the shield plug of the cask, which are set inside the cell during the loading. Canisters brought in from the weld stations or from lag storage using the crane are loaded one at a time into the sealed storage cask until it is full. The shield plug and loading port plug are replaced and the cask is disengaged from the loading port. The cask is then prepared for closure, with a metal lid installed, seal welded and inspected, and the cask inspected for contamination prior to transfer to the storage facility for emplacement. Retrieval follows essentially the reverse of the above operations.

B.2.6 Transport Cask Loading Area

Two independent transport cask loading areas are located beside the primary operation cells on either side of the canyon cells. Fuel canisters can be brought to either of these cells from the weld stations, from lag storage or from the sealed storage cask loadout areas using the canyon cell overhead crane systems. The procedure for loading transport casks are analogous to those identified above for loading sealed storage casks. However, the lids on the transport casks are mechanically sealed, not welded. When loaded, inspected and certified for release, the cask is removed from the loading cell, lifted off from the transfer cart, laid down horizontally and secured on a railcar for shipment to the repository.

B.3 STORAGE FACILITIES AND OPERATIONS

The MRS facility provides facilities for short-term "lag" storage and longer-term storage to accommodate surges in receipt, processing and/or loadout of spent fuel that may result from routine operating variability and from disruptions in various portions of the waste management system. Facilities in the R&H building for in-cell lag storage of intact fuel and the air-cooled lag storage vault for storage of canisters are described in Section B.2. Facilities provided for long-term storage in sealed storage casks are described here.

The sealed storage cask design developed for the MRS Program for storage of canisters of consolidated spent fuel is illustrated in Figure B.7. The design of sealed storage casks for storage of other materials are similar but with varying cavity dimensions.

The sealed storage cask is a cylindrical vessel with steel reinforced concrete walls, a concrete shield plug, a carbon steel cavity liner and a carbon steel lid. The outside diameters of all sealed storage cask designs are 12 ft except for the top 36 in., which is stepped to 12.7 ft to provide a circumferential lifting surface. The exterior height of a sealed storage cask is 22 ft.

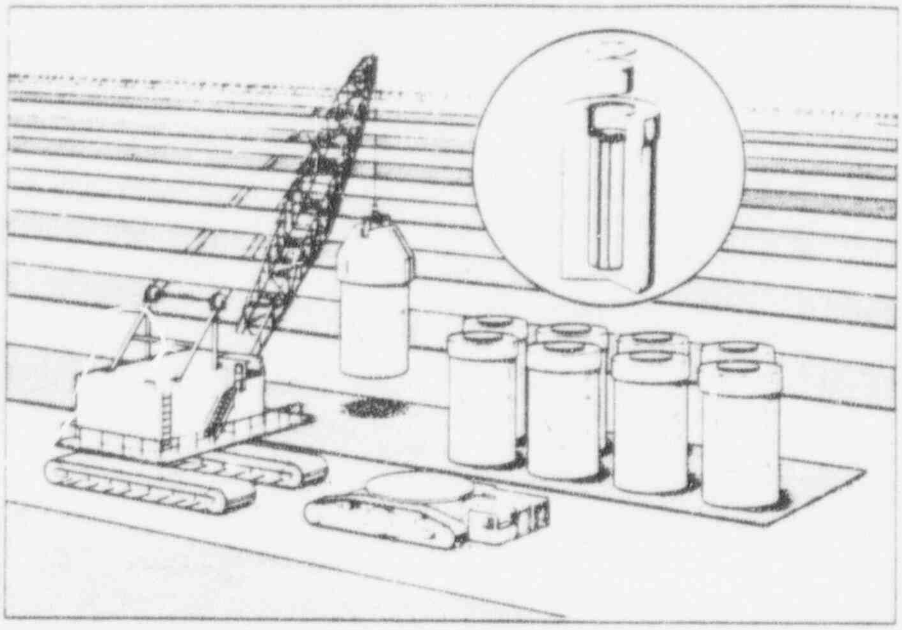


FIGURE B.7. Illustration of Storage Facility Operation and Emplacement for the Sealed Storage Cask

The cavity of the spent fuel cask is 68 in. ID by 194 in. long. The thickness of the walls and bottom of the carbon steel cavity liner are 2 in. and 1/2 in., respectively. The 2-in.-thick carbon steel lid is seal-welded to the top of the cavity liner after the sealed storage cask is filled. The principal function of the liner is to provide containment. However, the 2-in.-wall thickness was established to enhance shielding and heat transfer functions.

Canister support plates are located near the top and bottom of the cavity to laterally constrain the canisters. The canisters rest on the bottom of the cavity liner, but are not otherwise vertically constrained.

Both the inside and outside of the cavity are finned to enhance heat transfer. There are four short and four long 1.5-in.-thick aluminum fins in the cavity between the two support plates. These fins are bolted to the cavity wall. In addition, there are sixteen 3/4 in. by 3.5-in.-long carbon steel fins or ribs on the outside of the liner embedded in the concrete.

The walls and bottoms of sealed storage casks are made of carbon steel reinforced concrete. The rebar cage consists of vertical, radial and circumferential hoop members that are attached to each other and to the fins on the liner surface. The normal functions of the reinforced concrete are shielding and physical protection of the stored wastes. However, the quantity of radial rebar was established primarily to enhance heat transfer through the concrete walls. The carbon steel-encased shield plug fills the top of the cavity resting on a step in the inside diameter of the cavity liner.

Each sealed storage cask contains features to facilitate monitoring of its condition. Three thermowells attached to the liner wall are provided to monitor the temperature at the concrete/liner interface. These temperature measurements will permit assessment of whether the fuel and cask materials are maintained within acceptable limits. Gas sampling ports are also provided on each sealed storage cask to permit periodic sampling and analysis of the cavity gas content and pressure. The gas analyses will be used to monitor canister containment by the presence/absence of tag gases and/or radioactive gases or particulates. Pressure (vacuum) can be used to determine sealed storage cask containment integrity. Area monitors and air monitors in the storage field will be provided to continuously monitor any releases to the atmosphere or degradation of sealed storage cask shielding effectiveness.

The equipment and operations used in sealed storage cask loading/emplacement operations are briefly described in Section B.2 and illustrated in Figure B.7. In a typical loading operation, a sealed storage cask is loaded on the crawler in the cask staging area using a crane; the crawler transports the sealed storage cask to the R&H building where it is loaded with canisters and sealed, and then the crawler transports the loaded sealed storage cask to the storage area where it is lifted off the crawler and emplaced on a pad beside previously emplaced sealed storage casks. Retrieval operations follow essentially the reverse procedure.

REFERENCES

Pacific Northwest Laboratory (PNL). 1985. Functional Design Criteria for an Integral Monitored Retrievable Storage (MRS) Facility. PNL-5673, Richland, Washington.

Ralph M. Parsons Company (Parsons). 1985. Integral Monitored Retrievable Storage (MRS) Facility. Conceptual Design Report. Design Description, Vol. I, Book II. MRS-11, Ralph M. Parsons Company, Pasadena, California.

APPENDIX C

DESIGN VERIFICATION PLAN

APPENDIX C

DESIGN VERIFICATION PLAN

This appendix summarizes the tests and demonstrations needed to optimize the design and support the licensing of the proposed MRS facility. Section C.1 outlines the objectives of MRS design verification testing. In Section C.2, testing needs for each of the MRS functions are identified and discussed. Section C.3 describes several DOE waste management programs that potentially may interface with MRS development. A schedule for the planned MRS design verification tests is provided in Section C.4.

C.1 OBJECTIVES

The MRS system, if approved by Congress, will be designed, licensed and constructed by 1996 in accordance with the DOE's plans outlined in the June 1985 Mission Plan. Although current plans for MRS indicate that this date can be met, the schedule for design, licensing, construction, and preoperational testing of the MRS facility must be carefully planned and integrated to ensure operability and reliability of all components and systems.

The objectives of MRS design verification testing are to support licensing of the MRS facility and to optimize the design for cost and operability. The goal of verification testing is to identify and verify design improvements that will increase safety, reduce complexity, improve operability and efficiency, reduce costs of construction and operation, and demonstrate operability of the facility at the required throughput rates. Although no specific tests have been identified as being critical to the safe design of an MRS facility, verification testing will reduce the design conservatism that licensing considerations would otherwise require. In turn, this would reduce costs. Results of the planned tests will be reflected in final design, equipment procurement, and operational procedures. Verification of the procured systems will be provided during preoperational testing of the facility.

Two principal types of tests are planned for design verification: feature tests and systems demonstrations. Feature tests comprise those tests of individual components or processes before their incorporation into the final MRS facility design. Systems demonstrations are tests of major subsystems or complete systems of the MRS facility intended to demonstrate systems operability under the typical operating conditions.

If Congress approves of the MRS proposal, the DOE will develop detailed test plans and coordinate these plans with other interfacing testing and development activities being performed by the DOE or by private utilities. These DOE activities are the Commercial Spent Fuel Management Program (including the DOE/utility cooperative agreements), the Prototypical Consolidation Demonstration (PCD) Project, the Defense Waste Management Programs, and the Nuclear Waste Treatment Program.

C.2 TECHNOLOGY STATUS AND NEEDS ASSESSMENT

The discussions in the following subsections identify testing needs for each of the MRS functions, such as spent fuel handling, packaging, and storage. Specific areas are identified where experience or data are lacking and general descriptions are given of tests that will be performed to obtain the needed data.

C.2.1 Spent Fuel Receiving and Handling

The operations for receiving, handling, and packaging spent fuel that will take place at the MRS facility are similar to current industry practice, except for the expected size and numbers of casks and spent fuel assemblies to be handled. The scope of these MRS facility operations is illustrated in Figures B.2 through B.6, Appendix B.

Preliminary calculations of occupational radiation exposure indicate that the current MRS design meets the NRC regulatory limits. However, the design may not meet the DOE design objective (20% of the NRC limit) for occupational exposure. The analyses also indicate that the highest exposure arises from handling large numbers of shipping casks. The application of the ALARA (As Low as Reasonably Achievable) principle to the definitive design will probably result in automation of this task that has traditionally been a "hands-on" operation. An interface with the transportation program will be maintained so that the design of the fleet of shipping casks is compatible with the final design of the MRS handling systems. Design prudence dictates that, if found to be economically feasible, the automated or "robotic" systems for handling casks be tested to verify operability and reliability prior to their installation in the MRS facility.

Robotics could be beneficially employed at the MRS facility in removal of cask lids, gas sampling, and other preparation activities prior to unloading the casks. Potentially related testing is currently in progress in the DOE's defense waste program. Incorporation of MRS needs for specific feature testing into existing programs will be deferred until the MRS facility is approved by Congress.

Tests are needed to demonstrate optimum techniques for dealing with radioactive scale that coats the surfaces of the fuel assemblies. There is evidence from West Valley operations that the scale spalls during dry shipment of spent fuel, which may require cleaning of the interior of shipping casks prior to their return to service. Tests will be performed to establish the nature and extent of contamination during dry shipment of spent fuel so that processes and procedures can be developed to clean the casks' interior, if necessary, before their release from the MRS facility. This information is needed to reduce worker radiation dose at the MRS facility as well as at the utilities and to optimize the waste treatment systems.

C.2.2 Spent-Fuel Disassembly and Consolidation

The principal functions of the spent-fuel disassembly operation are: removal of the fuel assembly end-fittings and nozzles, extraction of the fuel rods from the remaining grids and support structure, reconfiguration of the loose rods, and insertion of the rods into a suitable canister. The MRS design that has been submitted with the proposal contains conceptual designs for equipment to perform these functions.

The PCD project at the Idaho National Engineering Laboratory (INEL) will develop prototypic spent-fuel disassembly and consolidation equipment that will be used at the authorized repository projects. Therefore, this program will also support the MRS Program. If Congress approves the MRS proposal, specific needs identified by the MRS conceptual design will be incorporated into the PCD project. The objective is to provide testing of disassembly/consolidation equipment and processes before development of the final designs of this equipment.

The PCD project will also provide data on the nature, frequency, and consequences of rod sticking and breakage for representative types of spent fuel. Data will also be obtained on properties, behavior, and quantities of radioactive scale that may be scraped off during disassembly and handling. In addition, data will be obtained on the possible quantities of zirconium fines generated during disassembly and on the related risk of fires. These data and experience will help optimize the design of radioactive waste collection and treatment systems as well as spent-fuel disassembly/consolidation equipment.

A full-scale demonstration of spent-fuel disassembly and consolidation is proposed that will consist of a prototype production line like that to be used at the MRS facility. This test will demonstrate the capability of achieving the reliability and production rate goals for a large sample of fuel and fuel types. These tests will be done cold (without use of radioactive materials). A decision on the nature and extent of hot tests that may be needed can be delayed until after the PCD project tests and cold tests are completed.

C.2.3 Spent-Fuel Packaging

The design of the canister to be used to store consolidated fuel at the MRS facility will be influenced by repository needs. One option is to package spent fuel into small triangular or rectangular canisters whose shape would allow them to be efficiently bundled into larger packages for disposal. Another option is to package the fuel into large round canisters of a size and type suitable for disposal at a specific repository. The MRS receiving and handling (R&H) building design can remain flexible to adapt to a wide range of canister sizes and types, but canister design reflects back directly to the design of the disassembly and consolidation equipment. Interface drawings for spent-fuel packages will be developed in concert with the repository program and baselined under change control, as shown in the MRS Program Master Schedule (Figure 3.10, Chapter 3).

Important aspects of consolidated fuel packaging are canister welding, weld inspection and leak detection, canister decontamination processes, and integrity under impact loads. Specific processes will be selected for cold feature testing in the PCD project. The selection will be governed by the needs of the MRS conceptual design if construction of the facility is approved by Congress.

The technique selected for the MRS conceptual design for canister welding is upset resistance welding. Although this method has been used in industrial applications and for high-level defense waste canisters, it has not been used for the large-size welds needed for MRS canisters. Demonstration of the quality of weld, process rate, and reliability is needed to support the MRS design. Other welding processes may be identified in definitive design and tested in the PCD project. The welding concept finally selected will also be verified in the disassembly and consolidation systems demonstration described above.

Processes for inspection and leak testing of canister welds will be developed and tested in conjunction with the welder design in the PCD project. These tests will be done as cold feature tests. Again, however, the optimized processes for MRS will be included in the prototypic systems demonstrations.

Freon has been selected as the most promising decontaminating agent for the MRS facility. Radiolytic and thermal decomposition of Freon may result in corrosion that could compromise the long-term integrity of the canister. Therefore, an experimental study will be conducted of Freon decomposition at the temperature and radiation levels that would be experienced in MRS canister decontamination operations. A hot prototypic demonstration will be performed to establish the efficiency and reliability of the canister decontamination system. These tests will also provide data on the necessary size of the waste treatment equipment.

Tests will also be performed to determine the integrity of canisters and welds under impact-loading conditions. Such conditions could occur at the MRS facility as a result of canisters being dropped or otherwise impacted during handling.

C.2.4 Waste Volume Reduction

The principal concerns in the area of volume reduction are the cost and safety of the processes that will be finally selected and the waste acceptance requirements at the repository. Also important are the related problems of collection and control of radioactive wastes during volume reduction and packaging.

The conceptual MRS design specifies a mechanical shredder for volume reduction of the fuel assembly hardware. The shredder is designed to reduce the grids and other hardware, less the end-fittings, into small pieces that can be efficiently packaged for disposal. Shredders of the type needed for MRS have been developed and demonstrated for volume reduction of low-level waste. A potential safety concern to be addressed by further testing is the possible production of zirconium particles sufficiently small to be ignited and thereby cause a zirconium fire. Another concern is the control of radioactive scale that will be dispersed in this mechanical operation. Testing will examine the effectiveness and cost of shrouds and vacuum or airflow systems in collecting the scale material, and will determine filtration needs and filter change frequencies. These data are needed to estimate dose rate buildup within the hot cells and its effect on worker dose. However, other means for volume reduction of fuel assembly hardware may prove to be preferred. In particular, a melting process being developed by DOE in their Nuclear Waste Treatment Program may be superior to shredding. Further design studies will examine all options for cost, safety, and reliability. Tests on appropriate processes will be done as cold and hot feature tests in the PCD project. Final tests of the MRS-specific design will be done in the MRS prototype systems demonstrations.

Volume reduction of combustible waste streams may be cost effective for the MRS facility. Organic materials in the ventilation filters could be oxidized to provide compact packages for the repository. Removal of organics may turn out to be necessary if the final repository acceptance criteria excludes organics. A decision on design and testing of this equipment will be made in consultation with the repository program within one year after MRS approval.

C.2.5 Sealed Storage Casks

At the MRS facility, sealed storage casks are recommended for the long-term storage of spent fuel canisters and drums of compacted fuel hardware.

Tests are needed to optimize and demonstrate the shielding, structural and thermal performance of these casks. The sealed storage cask concept is illustrated in Figure C.1.

The principal performance requirements for the sealed storage casks are that they safely contain and protect the stored materials while dissipating the decay heat and attenuating the direct radiation. The casks must be able to perform these functions during an extended period of storage and during design basis earthquakes and tornadoes. Both short- and long-term performance tests of sealed storage casks are needed to verify that design objectives have been

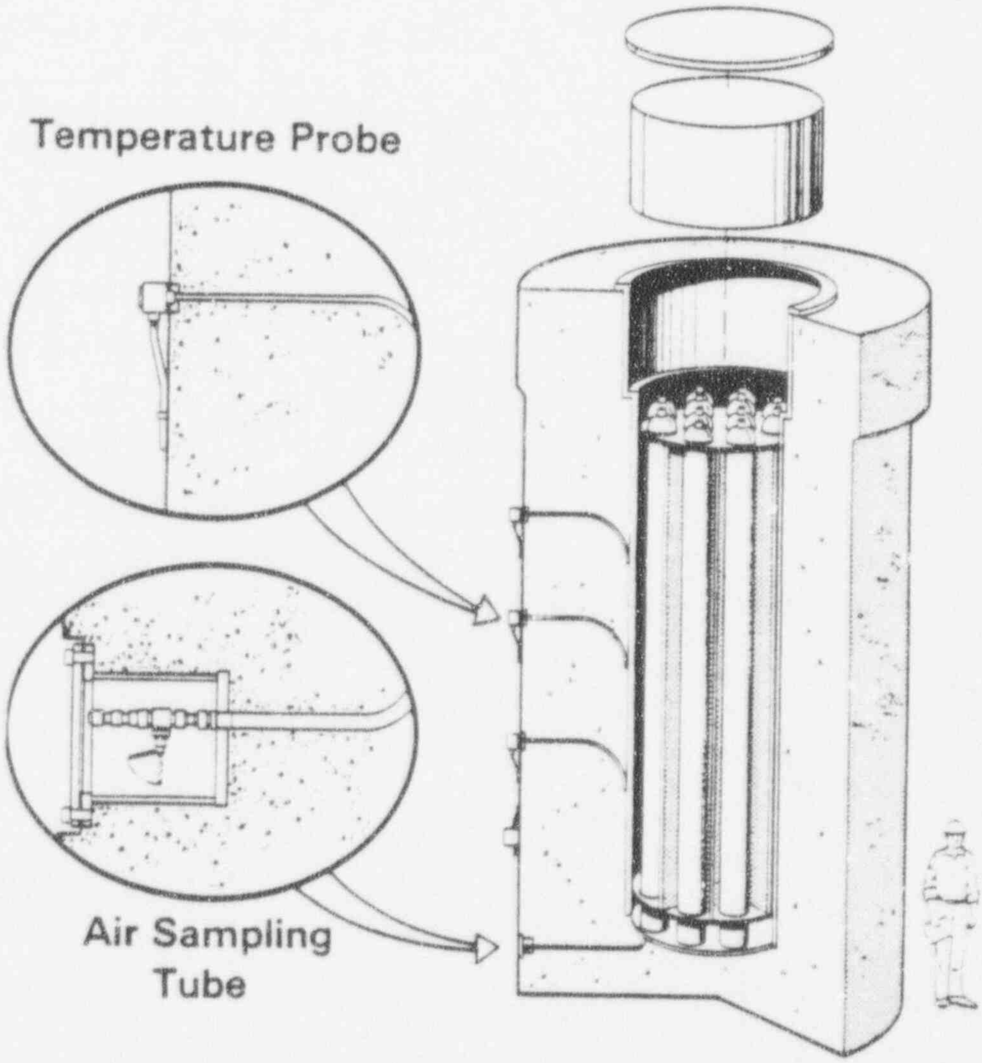


FIGURE C.1. Sealed Storage Cask Concept

achieved and that any degradation over time will not impair their safety function. This information is needed to support the license application and to optimize cost and occupational exposure.

In the short-term tests, sealed storage casks will be filled (at least in part) with instrumented canisters of spent fuel. Measurements will include surface radiation dose and temperature distributions in the fuel canisters and casks. After completing the short-term performance measurements, observations will be continued over the long term to detect degradation of the casks. Samples in the form of plugs will be tested to establish the degradation within the cask body. After a number of years, supplemental heat will be added to determine the limits of satisfactory operation. These performance tests will provide evidence of problems, if any, before MRS operations begin. Information gained from these measurements will be incorporated into the designs.

Structural tests of prototype sealed storage casks will be performed to demonstrate their capability to ensure containment and retrievability under a number of hypothetical accidents. These tests will include drops from heights consistent with cask handling operations and impacts from tornado-generated missiles. The results of the tests will support licensing and design optimization.

C.2.6 Concrete Selection

Concrete is used in the R&H building and in the sealed storage casks. These applications require separate, and different, considerations. The seismic Category I structure surrounding the lag storage vault is designed to remain below the limit of 150°F specified in ANSI/ACI 349-76, the industry standard for concrete. In the event of complete loss of power to the ventilation fans, the wall temperatures would rise slowly, but are not predicted to reach temperatures which, over the short term, would damage their strength. Power outages do not normally last more than a few minutes, or hours at most. However, portable generators could be procured if the outage continued for a few days. The walls of the in-process lag storage pits, though not a containment barrier, will reach temperatures of about 200°F when they are filled with spent fuel assemblies. The pits are cooled by natural convection. Although the walls appear to be structurally adequate, the specification of a high-temperature concrete may afford a cost saving.

The second concrete component, the sealed storage cask, is designed to operate at temperatures far above the normal structural limit of 150°F over much of its volume. However, the function of the concrete is to provide shielding, while the steel rebar and steel liner carry the normal structural and hypothetical impact loads from tornado-generated missiles. Although confirmation of this design has been discussed in the prior section on long-term testing, there are potential economic advantages in selecting high-density, high-thermal conductivity, high-temperature concrete. The design optimization studies to be conducted as a first part of definitive design should have the benefit of a series of short-term accelerated temperature testing in the laboratory to justify the final selection of additives and mix. These tests will be conducted as soon as possible after congressional approval of the MRS proposal.

C.3 RELATED DEVELOPMENT AND TESTING PROGRAMS

The DOE is currently supporting development and testing activities in a number of related waste management programs that interface with MRS development. If the MRS proposal is approved by Congress, MRS design verification test plans will be coordinated with these programs. Brief descriptions of the major related programs and potential areas of commonality with the MRS Program follow.

Transportation Systems Development Program: Spent fuel and waste transport casks developed in the DOE's Transportation Systems Development Program will need to interface with the MRS cask receiving and handling facilities. Cask designs evolving from this program will be issued under change control and used in the final MRS design and design verification tests.

Geologic Repository Programs: The design of spent fuel disposal packages, including the canister shape and size, may be dependent upon the chosen geologic repository media. Thus, MRS design and design verification planning will encompass the needs of all three repository programs until a repository site has been selected for the first repository. The canister type and size, overpack design, and the facility chosen for overpack installation could influence MRS design and design verification needs. Therefore, interface design requirements will be jointly baselined with the repository programs.

Commercial Spent Fuel Management (CSFM) Program: The DOE's CSFM Program is pursuing a number of activities to assist utilities with storage of spent fuel until the MRS facility or repositories become available. These activities include fuel integrity tests to establish spent fuel degradation mechanisms and consequences for dry storage, performance tests of dry storage casks, computer code qualification, fuel consolidation demonstrations, and other potentially applicable studies. The CSFM Program is also supporting a number of DOE/utility cooperative agreements covering a wide range of waste management activities which could be applicable, at least in part, to the MRS design verification program. International agreements coordinated by the CSFM Program could provide useful input to the MRS Program. These activities will be integrated with the MRS design to minimize duplication of effort.

DOE-PRDA Studies: The DOE's Program Research and Development Announcements (PRDA) are currently supporting a number of studies for improving the waste management system. These range from unique, efficient designs of canisters, consolidation systems, casks and other equipment, to alternatives encompassing the entire waste management system. The results of these studies and any follow-up work that may result will be coordinated with MRS activities.

Prototypical Consolidation Demonstration Project: The PCD project was recently initiated by the DOE to develop and test dry spent fuel disassembly, consolidation, packaging, and hardware compaction equipment for use at geologic repositories. The project is managed by DOE-Idaho at the Idaho National Engineering Laboratory. The objective of the project is to test, at or near prototypic scale, a fuel consolidation system. If Congress approves the MRS proposal, the MRS Program will participate by incorporating its testing needs into the PCD project

C.4 SCHEDULE

The schedule for MRS design verification has been integrated with the design, licensing, and procurement activities. The relationship of the MRS test program to other DOE R&D activities depends upon the timing of congressional approval of MRS. The schedule for MRS design verification testing is shown in Figure C.2.

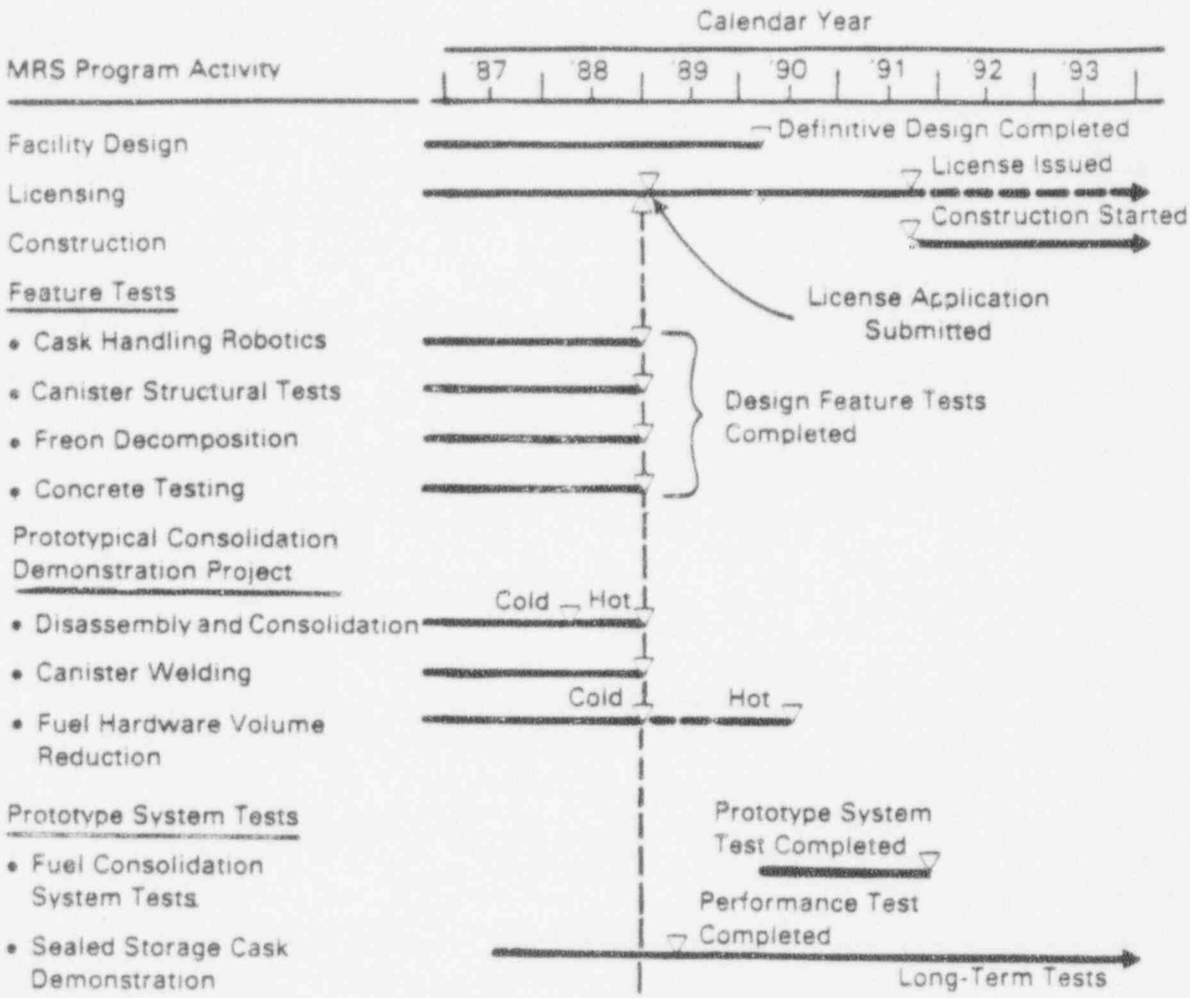


FIGURE C.2. Schedule for MRS Design Verification Testing

APPENDIX D

LICENSING PLAN

APPENDIX D

LICENSING PLAN

The NWPA requires that the MRS facility, if approved by Congress, be licensed by the NRC. The DOE, as the applicant for a license, will be responsible for the design, licensing, construction, operation, and quality assurance of the facility.

The regulations contained in Title 10, Part 72 of the Code of Federal Regulations will be used by the NRC to license the MRS facility. These regulations contain requirements for all project activities from conceptual design to the end of decommissioning. Although the license issued by the NRC will authorize the receipt, possession, and transfer of spent fuel and high-level waste, the requirements of Part 72 relate mainly to the features of the facility and site that afford protection to the public, the working staff, and the environment during operation. The license application provides an assessment of the safety of all structures, systems, and components that are important to safety; it cannot be prepared and submitted to the NRC until after design of these features is complete. The issuance of a license will therefore depend upon actions taken prior to submittal of the application.

This plan summarizes the efforts of the DOE to comply with the requirements of Part 72, mainly by reference to published documents, and the activities planned to obtain a license and to adhere to the conditions of the license. The plans for postlicensing activities are only summarized, since they will be described in detail in several reports that are enclosures to a license application.

The major documents that describe recent accomplishments related to licensing are the MRS Functional Design Criteria (PNL 1985); the MRS Conceptual Basis for Design (R. M. Parsons Company 1985a); the MRS Conceptual Design Report in seven volumes (R. M. Parsons Company 1985b), but especially Volume II, "Regulatory Assessment Document" and Volume VII, Geotechnical Description of the Clinch River Site; the MRS Environmental Assessment (Volume 2 of this submission to Congress); and the Design Verification Plan, Appendix C of this document. All work performed to date has been done in accordance with the quality assurance requirements of the DOE for their nuclear facilities. These requirements are derived from 10 CFR 50 - Appendix B and were incorporated, as applicable, into the programs of each DOE contractor.

It is the nature of the design process to iterate between design and evaluation of the design. First, a conceptual design is performed of structures, equipment, and processes that will accomplish the functions desired, and a preliminary evaluation is made of its safety, cost, and operability. The MRS Program is at this stage of the design process. Then, succeeding phases of design entail 1) the optimization of the design relative to the above evaluation factors and 2) the preparation of detailed information for construction and equipment to be procured. Thus, it is inherent in the design process that a preliminary evaluation of the performance of the MRS facility relative to safety, cost, and operability has been determined during the conceptual design, with later refinements to come as the design matures. For the MRS Program the design yet remaining is called definitive design and has two major milestones. The early design activities will concentrate on optimization of the conceptual design and the final design of structures, systems, and components that are important to safety. This design phase will produce complete information for the license application. The remainder of design will complete the drawings and specifications for construction and procurement.

Section D.1 of this appendix summarizes the content of a license application that must demonstrate how the Part 72 requirements have been or will be satisfied. In addition, the corresponding acceptance criteria of Part 72 that the NRC uses in their evaluation of the application are noted. A summary comparison of a preliminary assessment of the MRS performance with the NRC requirements is also made. Section D.2 describes the activities the DOE plans to undertake to provide a license application that will result in a favorable licensing decision by the NRC. In Section D.3 the postlicensing activities that will be needed to adhere to the requirements of Part 72, including probable conditions of the license, are summarized.

This plan cites data for the Clinch River Breeder Reactor (CRBR) site when specificity is required. The conclusions for the other two sites are not significantly different.

D.1 REQUIREMENTS FOR A LICENSE AND MRS COMPLIANCE

The license application (LA) contains a description of what the applicant proposes that he be licensed to do, and how and where the activities will be performed; it also contains an assessment of the compliance of the proposed operations to the requirements of Part 72.

The form and content of an LA for the MRS facility is shown in Figure D.1, and is described in paragraphs 72.14 through 72.20 in Subpart B of Part 72 (boxes 1-9 of the figure). The LA provides general information (box 1) about

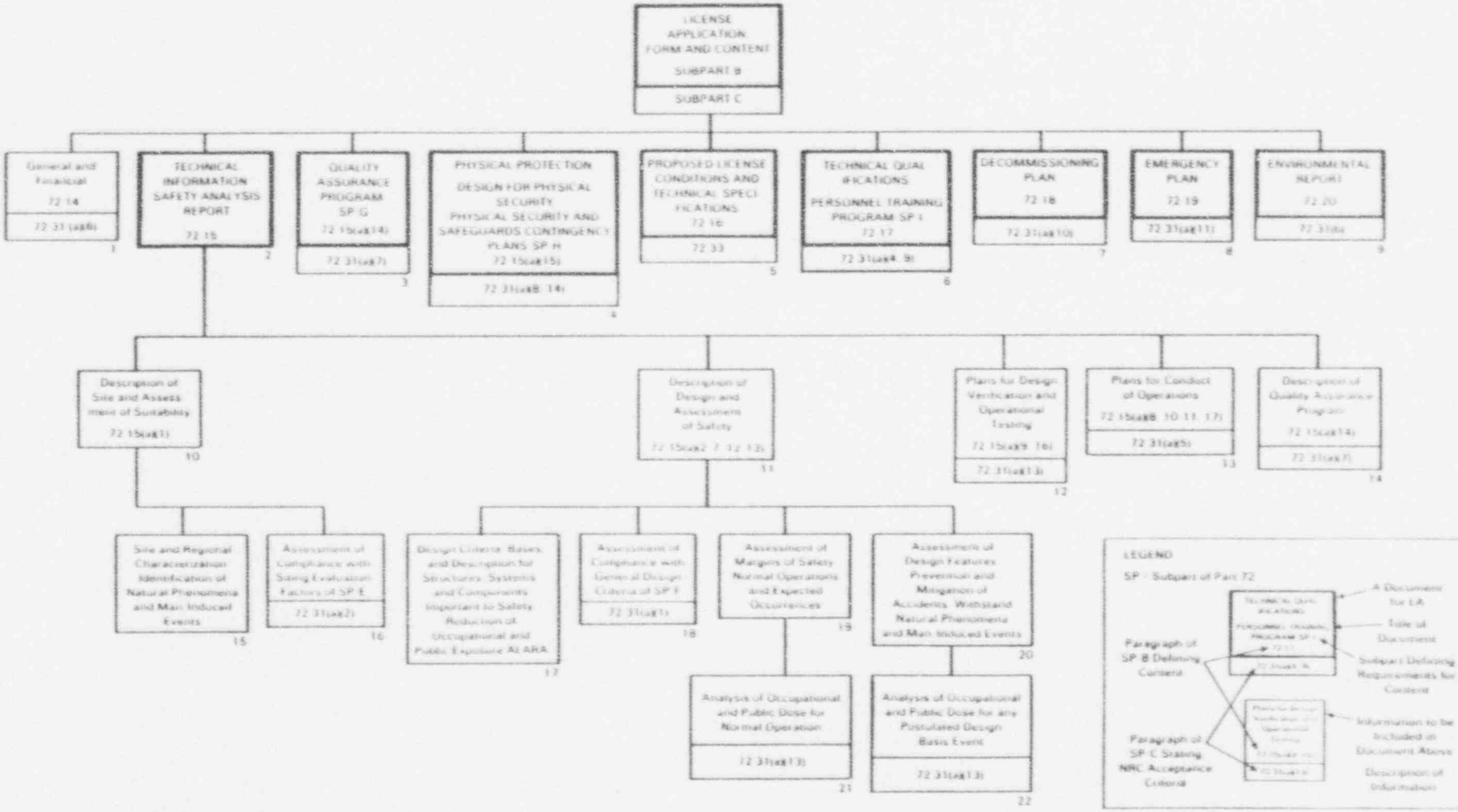


FIGURE D.1. Content and Requirements for a Part 72 License Application the applicant, including his financial capability to construct, operate and decommission the proposed facility; and also summarizes the information contained in other documents (boxes 2-9). These documents are identified by a dark outline in Figure D.1, and are submitted as enclosures to the application. The Safety Analysis Report (SAR) contains the information shown on the third and lower levels. The technical requirements to be fulfilled by the site, facility design, or by the applicant are contained in Subparts (SP) E through I, identified in appropriate boxes in Figure D.1. In an extension below each box (except those containing descriptive information), reference is made to the paragraph in Subpart C, which states the acceptance criteria the NRC will use in making their findings on the acceptability of the related information.

Only two reports, the SAR and the proposed License Conditions and Technical Specifications (boxes 2 and 5), are dependent in large part upon the detailed design of the MRS facility. The site and design information (boxes 10-11) in the SAR are subdivided into site characterization (box 15) and assessment of site suitability (box 16) and into facility description (boxes 17-18) and assessment of facility safety (boxes 19-20). The safety assessment is composed of two parts: the safety under normal operations as measured by the anticipated radiation doses to occupational workers and the public, and the safety under accident conditions or abnormally severe natural events as measured by the calculated doses to the public.

D.1.1 NRC Findings

The regulations require the NRC to make three major findings in their evaluation of acceptability of the LA. These findings relate to public health and safety, and protection of the environment. These findings are described below and are the focus of the discussions in the ensuing sections.

First, on the basis of their review of the application, and especially the analysis of occupational and public radiation doses presented in the SAR (boxes 21-22), the NRC must find that there is reasonable assurance that the operation will protect the health and safety of the public and will be conducted in compliance with Part 72, subject to appropriate conditions on the operations.

Second, on the basis of their review of the application, and especially the Environmental Report (ER) (box 9), the NRC must weigh the benefits and environmental costs of the proposed facility design and construction against the benefits and costs of available alternatives. In accordance with provisions of the NWPA, the NRC may not consider the need for the facility or any alternative to the design criteria stipulated in the NWPA. After these considerations, the NRC must find, pursuant to NEPA, that a license should be issued, subject to appropriate conditions that will protect the environment.

Third, on the basis of the proposed plans for Physical Protection (box 4), the NRC must find that the operation will not be inimical to the common defense and security.

D.1.1.1 Environmental Report

As stated in Sections 3.1 and 3.3 of the MRS Program Plan, the DOE will prepare an ER to be submitted to the NRC with the LA. The environmental information required by 10 CFR Part 51 will be included, as required by paragraph 72.20.

The plans to obtain site and regional data for the ER and facility design will be developed immediately after Congress approves the MRS proposal. These must be obtained before starting definitive design. The dates for obtaining these data are given in the MRS Program Master Schedule (Figure 3.10, Chapter 3).

The 10 CFR regulations require the NRC to evaluate the impact of issuance of a license on environmental values after review of the LA. The DOE will support their efforts by providing additional information as necessary during their review or the environmental hearings.

D.1.1.2 Safety Analysis Report

The SAR will provide the bulk of the information related to the safety of the MRS site, facility, and proposed operations. It also provides a description of the Quality Assurance Program (box 14) that has been used to obtain this information.

The assessment of the suitability of the site (box 16) is made with respect to the requirements presented in Subpart E. NRC's acceptance criterion is stated in 72.31(a)(2), which refers to the requirements of Subpart E. The suitability of the site is based upon the magnitude and certainty of the projected radiological dose to real individuals living outside the controlled area during normal operation and the potential dose to an individual at the boundary of the controlled area after the occurrence of any design basis accident (the maximum hypothetical accident) (boxes 21-22). The maximum acceptable radiological doses given in Subpart E are shown in Table D.1. However, the NRC acceptance criteria require additional assessments by the applicant, especially the possible further reduction of doses to the public during normal operation to values that are as low as reasonably achievable (ALARA).

The assessment of the safety of the facility design is made with respect to (box 18) the requirements of Subpart F, General Design Criteria, which apply to the structures, systems, and components important to safety (SIS), and with

TABLE D.1. Radiological Dose Limits of 10 CFR 72

General Public	Normal Operation (rem, annual)	Design Basis Accident (rem, each)
Real Individual		
Whole Body	0.025	
Thyroid	0.075	
Other Organs	0.025	
Person at Edge of Controlled Area		
Whole Body		5.0
Other Organs		5.0
Occupational Workers		
Operating Personnel[(a)]		
Whole Body	5.0	
Other Organs	5.0	

(a) Referenced from 10 CFR 20.

respect to (boxes 21-22) the dose limits of Table D.1. The NRC safety criteria, stated succinctly in 72.31(13), are that there is reasonable assurance that the activities to be licensed will not endanger the health and safety of the public and will be conducted in compliance with the applicable regulations of Part 72. In addition to compliance with the above requirements, the regulations require consideration of various design features to meet the objective of reducing the dose to occupational workers during normal operation to values that are ALARA.

D.1.2 Preliminary Assessment of MRS Compliance

A SAR is not required at this stage of the MRS Program. However, a preliminary assessment of site suitability and facility safety has been performed to assure a safe facility is being designed and to identify SIS. The final design of SIS (box 17) must meet the requirements of Subpart F of Part 72 (box 18).

An overall summary of the site and facility assessments performed to date is presented here with reference made to documents that provide the detailed results.

D.1.2.1 Site Assessment

Consideration of environmental protection is the responsibility, under NEPA, of both the DOE and the NRC. The DOE has issued an Environmental Assessment (Volume 2 of this submission to Congress) of the six site-design combinations as directed by the NWPA. The conclusion is that the construction, operation, and decommissioning of an MRS facility for any of the combinations would not significantly affect the quality of the environment. The DOE expects that the NRC would be able to make a similar finding for the selected site and final design after review of the LA.

Similar conclusions have been reached in previously published studies on storage of spent fuel and high-level waste. Among them are the DOE's Final Environmental Impact Statement on Management of Commercially Generated Radioactive Waste (DOE 1980) and two NRC studies: Final Generic Environmental Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel (NRC 1979) and Environmental Assessment for 10 CFR Part 72 (NRC 1984). The conclusions of both NRC studies are conditioned, however, upon compliance of any proposed operations with the requirements of Part 72, particularly with respect to the safe handling of spent fuel and the engineered confinement features. The last cited study was prepared to specifically assess the impacts of licensing the long-term, dry storage of consolidated or unconsolidated spent fuel and high-level waste in an MRS facility for a 70-year period of time.

The safety assessment of the site is based upon a characterization of the site and its surrounding region (box 15). The magnitude of natural phenomena and the certainty with which they may be predicted, for example, bears on the safety of a site. The DOE used site suitability as a dominant factor in its site screening process by recommending 3 out of 11 sites which had previously been considered for nuclear activities. Data on the preferred Clinch River Breeder Reactor (CRBR) site has been obtained from the CRBR files, including that documented in their preliminary SAR (PMC 1975) and amendments to the PSAR (PMC 1982), and some additional information published in the open literature since their PSAR was filed. A description of the geology and hydrology of the site has been prepared as Volume VII of the Conceptual Design Report (R. M. Parsons Company 1985b). It characterizes the seismic, flooding, and ground stability of the site and region and confirms the applicability to the CRBR site of the corresponding design parameters specified in the Functional Design Criteria for the MRS.

The safety of the site is assessed (box 16) with respect to the limits of Table D.1. The radiological impacts on the public have been calculated, documented in the EA, and are presented for the CRBR site in Table D.2 for comparison with the limits of Table D.1.

TABLE D.2. Radiological Doses at CRBR Site

General Public	Normal Operation From Annual Release (rem)[(a)]	Design Basis Accident From Each Occurrence (rem)[(a)]
Real Individual		
Whole Body	0.00024	
Thyroid	0.0013	
Other Organs	0.00024	
Person at Edge of Controlled Area		
Whole Body		0.0044
Other Organs		0.03
Occupational Workers		
Operating Personnel		
Whole Body	3.7-4.9[(b)]	

(a) 50-year dose commitment.
(b) Maximum dose for two crafts.

The calculated maximum doses to individuals living outside the controlled area from normal operation and from anticipated abnormal operation given in the table are 0.00024, 0.0013, and 0.00024 rem per year for doses to the whole body, thyroid, and other organs, respectively. These doses are to be compared to the limits of Table D.1 of 0.025, 0.075, and 0.025 rem per year, respectively. Any assumptions that are made in the calculations are believed to be conservative. The doses from MRS operations are realistically expected to be more than forty times less than the regulatory limits. For comparison, the annual background dose at the CRBR site is approximately 0.15 rem per year.

The EA also describes the maximum hypothetical accidents postulated at the MRS facility and presents their radiological consequences. For the CRBR site and the sealed storage cask concept, the maximum potential release of radioactivity results from dropping a PWR fuel assembly, having a 55,000 MWD/MTU irradiation exposure. Assuming that all the fuel rods are broken and using conservative assumptions, the whole body dose to a person at the edge of the controlled area is calculated to be 0.0044 rem and 0.03 rem to the thyroid. This dose is only 20 times higher than that resulting from normal operation over a year's period of time, and less than one-hundredth of the regulatory limit.

For the drywell concept there is one hypothetical accident that could result in substantially higher doses, which are still below the NRC limit. In this accident it is postulated that an earthquake occurs as a fully loaded canister is being lowered into a drywell. It is further assumed that the transport vehicle is shifted in such a manner that the canister and its fuel assemblies are sheared with the escape of volatile fission products. The probability of such an accident would be very low and could be made vanishingly small by added design features.

A description of the manner in which the design complies with each requirement of the Siting Evaluation Factors of Subpart E is described in the Regulatory Assessment Document (RAD), Volume II of the Conceptual Design Report referred to earlier.

D.1.2.2 Facility Design Assessment

The MRS design and its intended manner of operation (box 17) are described in the Conceptual Design Report, Volume I, Book II, Design Description. Book I of Volume I contains an Executive Summary. The RAD, as discussed earlier, contains a preliminary assessment (boxes 18-20) of its safety. The material presented in these volumes is detailed, even if only conceptual.

The RAD presents the MRS design criteria and describes the way in which they meet the NRC General Design Criteria of Subpart F. The RAD also establishes a basis for later assessments of the margins of safety by developing a preliminary set of expected occurrences, abnormal events, and potential accidents that the conceptual design should, and does, accommodate with appropriate design features. From this analysis the structures, systems, and components important to safety (SIS) were preliminarily identified and the criteria of Subpart F were applied, as appropriate for conceptual design.

The SIS were classified, using engineering judgment at this early stage of design, in accordance with their importance to safety: as Category I if they must remain functional after a design basis earthquake or tornado; and as Quality Assurance Level I or II, according to whether their failure could have offsite radiological consequences beyond the limits of Table D.1 to the public (Level I) or whether their failure would affect the immediate area of, and have consequences beyond Table D.1 to, the working staff (Level II). The exact definitions of these terms and the preliminary classification of the SIS are in the RAD.

The features of the facility which provide the primary boundary for containment of radioactive material are of the most importance to safety. They are the shipping casks, concrete walls of the hot cells in the receiving and handling (R&H) building, filters and tornado dampers in the R&H building ventilation system, and the steel canisters into which the spent fuel is placed for storage. Safe design of these features is well understood from many years of experience inside and outside the nuclear industry. They are neither novel nor new. A favorable assessment of their safety therefore depends upon 1) the quality of their construction and installation, 2) their testing during operation to assure their continued performance, and 3) an acceptable backup or margin of safety in the event of their unexpected failure.

The results of analyses of the maximum occupational doses to two classes of workers from exposure to radiation performed to date are presented in Table D.2, and are to be compared to the NRC limits of Table D.1. The calculated occupational doses are not very meaningful at this stage of design since optimization for ALARA is performed in definitive design (see Sections D.2.1.5 and D.2.2.2). The indicated occupational doses, although less than the limits of the NRC, are above the guidelines of 1 rem per year in the DOE Orders for facilities under their ownership. During definitive design additional shielding, remote operations, and other design features will be provided so that expected occupational doses will be as low as reasonably achievable.

The DOE believes that the conceptual design, described in the seven volumes of the Design Report, provides a detailed starting point for definitive design; and that its safety can be demonstrated in a future license application.

D.1.2.3 Assessment of the Design for Physical Protection

The details of the design and plans for security of the plant and the radioactive materials possessed (box 4) are withheld from the public by the NRC as a deterrent to potential sabotage. However, the measures that are used to provide physical protection are not withheld. The conceptual design report and the RAD describe the features to be provided and their compliance with the requirements. Figure D.2 shows the fence that is the boundary of the controlled area of the CRBR site and the two security fences, with an alarm zone between them, which surround the protected area. Nuclear materials are not handled or stored outside of the protected area.

Since these matters are common to all licensed facilities, they are not discussed further in this plan. The detailed designs and plans will be provided to the NRC with the LA.

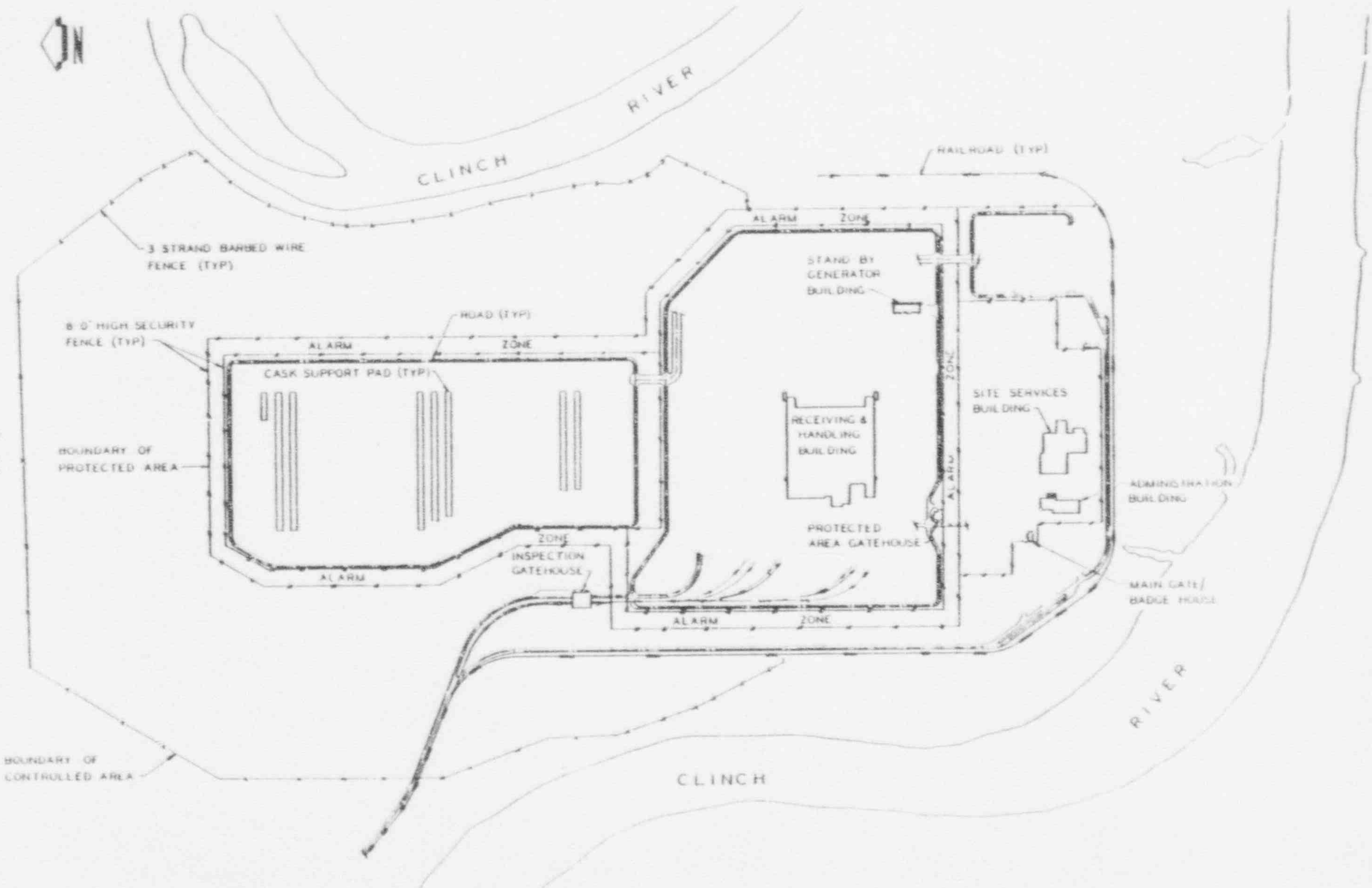


FIGURE D.2. Layout of MRS Installation at CRBR Site

D.2 PRELICENSING PLANS

This section describes the major activities that are planned to develop an LA for the MRS facility, if approved by Congress. The activities are discussed according to the time sequence in which they will be performed. In contrast, Section D.1 presented the informational needs and site and facility design requirements that the activities must satisfy.

The activities needed to obtain a license span almost the entire breadth of the project activities, so that brief, or no, mention is made of some activities which, though important, are not unusual for the MRS facility. The activities will be described with reference to Figure D.3, which shows the general sequence of activities related to licensing. Since the figure is not a detailed logic network, only major interfaces of activities are shown, and the detailed feedback of information within an activity or, from one activity to another, will take place as needed. The schedule for these activities are shown in the MRS Program Master Schedule (Figure 3.10, Chapter 3).

The activities described will be performed by the DOE and their contractor(s). The DOE will obtain expert services for the design, procurement, construction, technical support during design and licensing, and operation of the facility.

The preproposal activities are shown to illustrate the DOE's intent to adhere to the NRC requirements in performance of these activities.

D.2.1 Preparation for Definitive Design and Environmental Report

The purpose of the first column of activities after congressional approval, shown in Figure D.3, is to plan and collect data for development of the ER and the facility design. These activities are summarized, from the top down. They are then described in more detail in subsequent sections.

Early interactions with the NRC staff will provide input to a Regulatory Compliance Plan, which will provide guidance to other program activities, and will contain detailed plans and schedules for the assessment of site and facility safety. In parallel, site and regional data will be confirmed, and new data obtained where necessary, for the ER and facility design. The scope of environmental data to be contained in the ER will be determined after consultation with the State of Tennessee, the NRC, and the EPA. Finally, to prepare for definitive design, the Mission Plan, guidance from Congress, and the existing EA and conceptual design documents will be used to establish the technical baseline for the approved MRS facility.

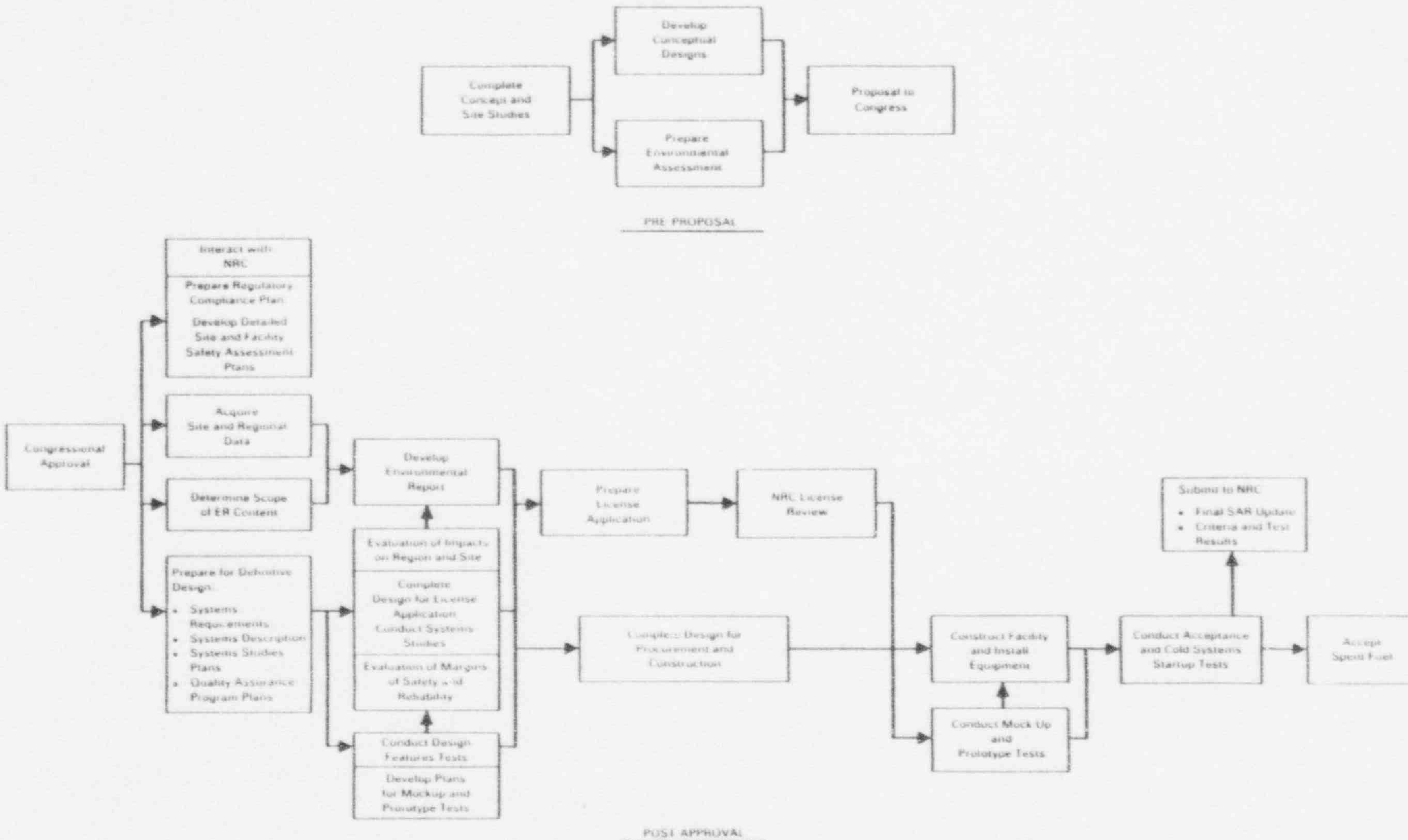


FIGURE D.3. Activities Related to NRC Licensing of an MRS Facility

D.2.1.1 Interactions with the NRC

As soon as possible after congressional approval, the DOE proposes to enter into a Procedural Agreement with the NRC to foster cooperation on planning of licensing activities and an open information exchange between the DOE and the NRC. The Procedural Agreement will provide for agreement on plans, schedules, and the responsibilities, including NEPA, of each agency. The existing Procedural Agreement (NRC 1983) between the DOE and the NRC for the conduct of the geologic repository program could be extended to include the MRS Program.

The Procedural Agreement will provide for meetings prior to submittal of a license application at which appropriate management personnel of both agencies could discuss plans, review progress, and facilitate the resolution of problems. Similarly, provisions will be made for technical meetings for review and discussion of technical matters, such as interpretations of requirements, design data or options, and the adequacy and sufficiency of information or data. The schedule for meetings will be published in advance, and they will be open to attendance by interested parties. Summary minutes of the meetings will be made available to interested parties.

Any meetings to be held after submittal of an application for a license will be conducted in accordance with existing NRC procedures since the DOE would then be an Applicant subject to NRC regulations.

The Procedural Agreement will also provide for exchange of documents and other information or data developed by either party. NRC observers will be encouraged to review the progress of design and development activities. The DOE will request that the NRC staff review and comment on topical reports that the DOE and the NRC mutually agree upon. The purpose of these reports will be to receive a degree of assurance from the NRC staff, before submittal of the license application, that the DOE efforts are meeting the requirements foreseen by the NRC. In turn, review of these reports will provide the NRC with early information on the MRS Program. Examples of such reports that would facilitate early activities and later NRC review of the license application are:

- the MRS Quality Assurance Program
- Quality Assurance Plans for: acquisition of site and regional data, definitive design, procurement, construction, and design verification testing
- seismic design methodology and codes
- design for prevention of criticality

- validation and verification of heat transfer codes

- canister and storage cask designs and testing

- hypothetical accidents for analysis for SAR.

D.2.1.2 Regulatory Compliance Plan

In parallel with discussions with the NRC, a Regulatory Compliance Plan will be developed to provide guidance to other program elements on the 1) requirements each is to satisfy and 2) plans, in the form of a logic network, of information and data that will be needed for the preparation of the LA, particularly for the safety assessment of the site and facility design. The Regulatory Compliance Plan will contain schedules and identify feedback loops for the iterative sequence of: development of data used as input to the design, validation of design methods, identification of structures, systems, and components important to safety (SIS), performance of design studies, and evaluation of the margins of safety during operation. These activities are interdependent and are essential to the timely preparation of the LA. The plan will need to be maintained up-to-date as the program develops.

D.2.1.3 Site and Regional Data Acquisition

From many prior studies of the CRBR site and surrounding region, a broad scope of data is available. The additional needs are 1) confirmation of the validity and applicability of existing data, 2) updating of data that may have changed with time, and 3) development of some detailed data not now in hand, such as an engineering characterization of site properties for the placement and foundation design of MRS facilities. Part of this information will be obtained immediately upon the start of definitive design to confirm the acceptability of the layout and conceptual design of the MRS facilities. Baseline environmental data for the ER, if current data is found to be insufficient, would take one year to span a complete cycle of seasonal variations of meteorology and climatology.

After collecting and analyzing the data, the results will be input to the ER and definitive design. The information required in box 15 of Figure D.1 can be assembled and submitted as a topical report. The report would characterize the geology, hydrology, seismology, meteorology, demography, and nearby industrial or other activities in the region and interpret the information in terms of design criteria for earthquakes, flooding, tornados, and protection against man-induced events. An NRC review of the report would reduce the risk of later design changes, provide the MRS staff with experience in interacting with NRC staff, shorten the time required for review of the LA, and promote early understanding of MRS design criteria by NRC staff.

D.2.1.4 Scope of Environmental Report Content

An early series of discussions with the state and local entities and federal agencies will scope the issues that may need to be addressed in the ER that are additional to those in the current MRS Environmental Assessment (Volume 2 of this submission to Congress). The data needed to consider these issues or to update data already available will be factored into the site investigation studies. In addition, some of the data may need to be considered in the layout and design of the MRS facility. The ER will contain a comprehensive discussion of the impacts of construction and operation on the environment.

Consultation with the NRC in the early identification of environmental data needs will provide added certainty to the completeness of the ER.

D.2.1.5 Preparation for Definitive Design

A revised and expanded set of project documents will be needed for management and technical control of the definitive design. In accordance with OCRWM policy, this need will be satisfied at the top level by developing an MRS Systems Requirements document. This document will contain the functional requirements and performance criteria for the MRS facility and its subsystems. In addition, a System Description document will be prepared that will describe the design criteria and bases, the system configuration, and the interfaces between each of the MRS subsystems. These documents will be based upon the conceptual design documents listed on page D.1. The documents will be baselined, under change control, for use in the definitive design. Changes will be made in the documents as the iteration between design definition and design evaluation proceeds toward a final design.

A Systems Studies Plan will be developed to schedule and guide the optimization of the MRS system design. Optimization may be performed with respect to any one or more factors such as cost, safety, product performance, and schedule. A number of such studies were identified during conceptual design and deferred to definitive design. These studies are presented in the Conceptual Design Report, Volume I, Appendix G.

Preparation of quality assurance documents, expanded beyond those currently in use, to cover the collection of field data and performance of design and testing will be scheduled for the earliest possible date. The first of such documents will cover the overall DOE management of the program for an MRS facility, and the DOE contractors' program for technical support activities, including design, field investigations, and design features and materials testing. Submittal of these documents to the NRC for review and comment will add to the certainty that the management and technical control of MRS activities meet the NRC requirements.

D.2.2 Development of the Environmental Report and Definitive Design

The activities depicted in the second column of boxes in Figure D.3 will produce the ER and complete the final design information required for a license application. All of the design that bears upon the LA, including the ER, will be planned for completion at the earliest possible time. However, the LA requires complete designs and specifications for all SIS. Therefore, careful planning and sequencing of the design studies are needed to ensure acceptance of the LA by the NRC for review.

D.2.2.1 Development of the Environmental Report

Within one year after the start of definitive design, the conceptual design will have been confirmed and any changes in the magnitude of the impacts on the environment of construction, operation, and decommissioning will be known. The radiological impact on the public, expected to be below acceptable regulatory limits on the basis of the conceptual design, will have been reviewed, with the ALARA concept being the criterion for mitigation of radiological impacts. Information on the use of land and of other resources and the studies of demography, meteorology, background radiation, rare and endangered species and other subjects will also have been developed. The ER will be prepared with particular attention to the requirements of the NRC, as given in 10 CFR 51.

D.2.2.2 Completion of Design for License Application

The first activity in definitive design will be a review of the DOE's Systems Requirements document, System Studies Plans, other baseline management and technical documents, and the plans for site and facility safety assessment. (These documents were discussed earlier.) In parallel, the contractor performing the design will prepare his quality assurance program and procedures for DOE approval. With this understanding, the design activities will concentrate on the optimization of design by performance of studies identified in the Systems Studies Plans or by review of the conceptual design. Three of the more important studies which are related to safety considerations are:

- a study of the wall thickness and steel reinforcement of the sealed storage cask versus the resulting changes in occupational exposure of workers in the storage field, in the temperature and perhaps the lifetime of the concrete, in its ability to withstand tornado-generated missile impacts, and in the cost of manufacture (ALARA and margins of safety).

- a study of the use of additional remotely controlled equipment versus the resulting decrease in occupational exposure but at increased capital and, perhaps, at increased operating cost and lower availability (ALARA).

- a study of the capacity of the lag storage vault versus the resulting changes in operational flexibility, in the vault cooling requirements or changes in lifetime of the concrete walls, in changes in the margins of safety in the event of loss of multiple power sources, and in the cost of the building and support equipment (margins of safety).

In addition to the systems studies, a large number of safety questions will be addressed in this phase of the design. They obviously overlap in an iterative fashion with the evaluation of the margins of safety described in a later section, but are described here for clarity. Some of these have been documented in the RAD or Appendix G of the Conceptual Design Report. A few of those involving considerations of safety are listed in Table D.3. Close inspection of the items listed and comparison with the current conceptual design will reveal that many of the items also pertain to potential cost reduction, or value-engineering studies. As in the usual design process, conservative decisions were made during MRS conceptual design in the absence of final studies on the effects of failures and on existing margins of safety.

Concurrent with the design, parts of the LA will be prepared that are not dependent upon the detailed and final safety analyses. These may be submitted for early NRC review if it appears likely that this would reduce the license review time or would assist in making design decisions. In rough order of their dependence upon final safety assessments, they are:

- Technical Qualifications: Personnel Training Program
- Physical Security Plan
- Safeguards Contingency Plan
- Design for Physical Security
- Decommissioning Plan
- Emergency Plan.

Each of these is described below, following Table D.3.

TABLE D.3. Safety Considerations for License Application Design

- Magnitude of radioactive particulate deposited in cells and on filters and methods of reducing their quantity
- Methods of waste collection, decontamination, and volume reduction of both liquids and solids
- Agreement with repository program on acceptability of encapsulation of contaminated organic materials
- Re-evaluation of need and placement of monitoring equipment for radioactive gaseous effluents, sanitary sewer system, and seismicity
- Re-evaluation of need for various monitoring and control functions to be supplied by uninterruptible power, i.e., rather than offsite or backup generator power
- Re-evaluation of need for various functions to be controlled at both local and remote control rooms under off-normal conditions or design basis accidents
- Re-examination of the basis for the CHTRU building to be resistant to severe earthquakes for operating flexibility or public safety
- Re-examination of possible causes of fires or explosions and any further design features to mitigate their effects
- Final determination of shielding wall thickness to result in occupational doses that are ALARA

The nucleus of an operations staff will review the design for operability and maintainability, providing input to the design. Using this experience, the staff will develop the Personnel Training Program. Training will begin as soon as the full set of prototypic systems are installed in the training cell, as described in Section 3.5 of Chapter 3.

The Physical Security and Safeguards Contingency Plans can, likewise, be prepared after confirmation of the conceptual design and performance of some design work not involving the SIS.

The Design for Physical Security, the Decommissioning Plan, and the Emergency Plan rely on more information than exists in the conceptual design, but could be prepared for the NRC in advance of submittal of the LA.

D.2.2.3 Design Feature and Systems Tests

Some features incorporated into the conceptual design need further testing to justify their choice, may not be optimum among all the choices, or have been assigned operating limits that need to be confirmed by testing. The information needed generally relates to achievement of an acceptable margin of safety. In addition to the tests identified in the conceptual design report, additional tests may be identified during definitive design. Those feature tests that were identified in the conceptual design are described in the Design Verification Plan, Appendix C. Some of these tests will determine performance limits, such as concrete testing at high temperatures, and some will determine the capacity and shielding needed for systems to treat wastes generated at the MRS facility.

In addition to the feature tests, a series of tests will be performed on the disassembly and consolidation system. These are planned to be completed before the LA is submitted to the NRC, as described in Appendix C.

At this stage of design, plans can be developed for mockup and prototype tests to verify operability of the final components to be procured. There are tests already identified in Appendix C that will be considered for completion during design and construction. Augmenting these plans with those for operational testing of the MRS facility after construction will provide information for the SAR (box 12 of Figure D.1).

Planning for the operation of the facility will also be completed to satisfy another of the items in the SAR, Plans for the Conduct of Operations (box 13 of Figure D.1).

D.2.2.4 Evaluation of Margins of Safety and Reliability

After sufficient design information is available on portions of the design of the SIS to warrant reassessment of their importance to safety and their margins of safety, studies of reliability and operability will be performed to assure that the operability goals of the DOE (stated in the Systems Requirements document) and the safety performance requirements of the NRC are met. Some of the input data will be obtained from failure modes and effects analyses. In turn, the results provide input to assessments of the margins of safety between normal operations and operations under either severe natural phenomena or design basis accident conditions. The results will be used in an assessment of the likelihood, and analysis of the effects, of improbable events and design basis accidents. A description of these studies is needed for the SAR (boxes 19 and 20 of Figure D.1).

The conceptual design effort used engineering judgment instead of failure and reliability studies to proceed to the identification of possible off-normal and serious accidents. More than eighty events of varying severity were considered and are presented in the MRS conceptual design report. As mentioned earlier, these considerations allowed a preliminary identification of the SIS.

The quantitative analyses discussed above will be performed using reliability and other data for specific components and systems defined during definitive design. Some of the more important of such studies are listed in Table D.4, although it is acknowledged that, at times, it is difficult to distinguish between design studies like those in Table D.3 and design assessments like those in Table D.4. Again, Table D.4 is derived in part from references already cited.

TABLE D.4. Failure Modes and Effects and Reliability Studies

- Effects of the successive loss of sources of alternative power
- Dynamic analyses to determine pressures versus time upon failure of tornado valve; and to determine their importance to safety and testing requirements
- Consequences of exceeding yield strength of reinforced concrete under high temperature, seismic, or tornado-generated missile stresses
- Human factors study to identify effects of potential operator responses
- Modes and consequences of fuel cladding and canister failure and ultimate temperature limits for safe storage
- Consequences of a design basis earthquake and tornado-generated missile on storage cask and canisters in the storage field and final classification of their importance to safety, including the steel liner in the cask
- Effects of multiple failures, including human

At the conclusion of these studies the information will be used for performing the final analysis of the radiological effects of exceeding the margins of safety (boxes 21 and 22 of Figure D.1). The information will also be used to confirm the final classification of structures, systems and components that are important to safety. This classification is subsequently used in designation of the quality standards to be used in procurement, construction, and testing of the SIS.

D.2.3 Completion of the License Application

The next column of activities in the sequence shown in Figure D.3 involves the use of design and other information to develop the LA. Upon completion of the safety assessments described in previous sections, the SAR will be assembled.

The information for the development of the remaining enclosure to the LA, Proposed License Conditions and Technical Specifications (box 5 of Figure D.1), will be available at varying times during design, but the final specifications can be confirmed only after the analysis of the hypothetical design basis accidents. For example, the license condition which specifies the maximum quantity and characteristics of fuel to be stored under the license will be known early, but specification of the set-points and range for radiation monitors on the stack must await the final determination of the rate and magnitude of the radioactive gaseous effluent from hypothetical accidents.

The LA and its accompanying reports will then be submitted to the NRC and, after their review for completeness, the NRC will docket the application.

D.2.4 Review of License Application

The NRC review process is scheduled to take 30 months from application to issuance of a license. Although a longer review period may be required in the event of serious contentions which require extensive hearings and appeals, a shorter period would be needed in the absence of contentious issues. The DOE believes that the scheduled 30 months is a reasonable allowance of time in view of the proposed extensive prelicensing interactions with the NRC and the opportunities for the public to be involved in the review of technical documents.

Questions from the NRC staff are expected during their review and will be responded to in a timely manner to expedite the license review.

The remaining design of items not important to safety, including detailed drawings and specifications for procurement, construction, and installation, will be completed during NRC review of the application.

D.3 POSTLICENSING PLANS

The requirements prescribed for a licensee are found in Subparts C and D of Part 72. They relate to Conditions of Licenses; and Records, Reports, Inspections and Enforcement, respectively. The activities planned for the MRS Program are shown in Figure D.3. More detailed descriptions and milestones are given in Chapter 3.

After receipt of a license, the DOE will proceed with site preparation and construction. During this period, inspections will be performed to assure that quality standards specified in the design are met for purchased materials and equipment, and for major construction and installation; and that the conditions of the license are met. Resident NRC staff from the Office of Inspection and Enforcement will be housed at the construction site to facilitate their inspection of the work in progress. Inspection and acceptance services will also be provided by the contractor who designed the facility.

Construction of the MRS facility will be scheduled so that the mockup and training cell in the site services building will be completed at the earliest time that is compatible with orderly construction and economy. Advanced procurement of prototypic spent fuel handling equipment will allow installation of these prototypes as soon as the mockup and training cell is complete. After installation, these prototypes will be operated for the dual purposes of training operators and maintenance staff and of operating and testing the equipment under simulated operating conditions. Any desirable design changes may be made during procurement of MRS equipment, or be back-fit if necessary.

During completion of construction and testing, the SAR will be updated and submitted to the NRC every 6 months, with the final submittal not later than 3 months before spent fuel or high-level waste is to be received. The acceptance criteria and test results of the preoperational tests using cold or simulated spent fuel will be submitted to the NRC for their review at least 30 days before spent fuel or high-level waste is to be received.

After the receipt of actual spent fuel, the preoperational tests will be repeated, but under radioactive conditions, sequentially in one cell at a time. The throughput rate of the facility will be judiciously increased during the operational demonstration, as more experience is gained in the use of the operating procedures and in the operating characteristics of the processes and equipment. A ramp-up of the throughput to full operations is expected to take approximately one year after the start of hot operations.

All radioactive operations of the MRS facility will be in accordance with the limits prescribed in the Technical Specifications, which are part of the conditions of the license.

After completion of its mission, the MRS facility will be decontaminated and decommissioned in accordance with the Decommissioning Plan approved by the NRC.

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APPENDIX E

COST AND FUNDING ANALYSES

APPENDIX E

COST AND FUNDING ANALYSES

The purpose of this appendix is to provide further details on the cost estimates and funding plan included in the body of the MRS Program Plan. Section E.1 describes the basic approach and assumptions for cost estimation. Sections E.2 and E.3 present and discuss the details of the cost estimates for the preferred site-design case and the five alternative cases. Section E.4 presents an analysis of cost sensitivities. Section E.5 discusses the alternative funding approaches considered, explains the selected approach, and details the plan for funding the MRS Program. The change in the total cost of the federal waste management system, due to addition of the MRS facility, and the spending and funding schedules are also provided in Section E.5. Section E.6 presents additional detailed cost and data tables.

E.1 COSTING APPROACH AND ASSUMPTIONS

The approach to estimating the costs for deploying, operating, and decommissioning the MRS facility is discussed and an explanation of cost categories and economic assumptions is provided. This is followed by a discussion of the basic assumptions for costing, such as site-design combinations, waste logistics, facility design, and costs not included.

E.1.1 Approach to Cost Estimation

In developing the cost estimates for the MRS facility, the activities in the facility deployment, operations, and decommissioning processes are evaluated and information on the manpower, materials, and capital equipment are developed from the conceptual design of the MRS facility. The assumptions used are consistent with the improved-performance system described in the OCRWM Mission Plan (DOE 1985) and in Appendix A of this document.

Costs were estimated for activities in each of the nine MRS program elements: 1) Environmental Evaluations, 2) Design, 3) Regulatory Compliance, 4) Construction, 5) Training and Testing, 6) Operation, 7) Decommissioning, 8) Institutional Interactions, and 9) Program Management. The costing framework is shown below:

Costing Framework

1.1 Environmental Evaluations
- Environmental report
- Environmental data

1.2 Design
- R&H building
- CHTRU facility
- Support facilities
- Storage facility
- Site design data
- Site improvements
- Utilities
- Design verification
- Design and management support

1.3 Regulatory Compliance
- NRC license application
- Permits
- License review
- License amendments
- Operational reports
- Decommissioning amendment

1.4 Construction
- R&H building
- CHTRU facility
- Support facilities
- Storage facility
- Site improvements
- Utilities
- Construction management and support

1.5 Training and Testing
- Training and certification program
- Safety and radiological
- Operations and maintenance
- Emergency response
- Offsite systems testing
- Onsite test start-up
- Operational demonstration

1.6 Operation
- R&H building
- CHTRU facility
- Support facilities
- Storage facility
- Environmental surveillance
- Operations management & support
- Capital modifications/additions

1.7 Decommissioning
- Decommission plan
- R&H building
- CHTRU facility
- Support facilities
- Storage facility
- Site improvements

1.8 Institutional Interactions
- Public information programs
- Consultation and cooperation agreements
- Financial assistance

1.9 Program Management
- System engineering and configuration management
- Intergovernmental relations
- Project planning and control
- Subcontract management
- Management services
- Quality assurance

Cost Categories

The nine cost categories represent the nine program elements. A description of activities in each category is presented below.

Environmental Evaluations costs are those associated with the compilation and verification of ecological, hydrological, meteorological, and socioeconomic site data for the preparation of the Environmental Report (ER) and the interactions with NRC required for preparing the ER. Site data collection and evaluations in this cost category include all data except those needed only for design and construction purposes, such as rock and soil mechanics. Manpower requirements for each activity and associated cost were estimated in accordance with the proposed deployment schedule.

Design costs encompass all activities that are required to complete design documents, including drawings, descriptions, specifications, and engineering studies for R&H building, CHTRU facility, storage facility, support facilities, site improvements and utilities. The engineering studies include analyses required for the development of the Safety Analysis Report and other documents needed for an NRC license application. Other preconstruction costs included under this element are those for site data confirmation, design verification, and design management and support. Costs for design engineering support after initiation of operations are included in the Operation element. A contingency of 20% is also included.

Regulatory Compliance costs pertain to permitting and licensing activities throughout the life span of the MRS facility. These activities support applications at local, state, and federal levels. Licensing and permitting fees, if any, are not included in the cost estimates.[a] Preconstruction activities include preparation of the license application to NRC and various permit applications as required, and licensing review support. License amendment support is required throughout construction and operation. Finally, costs for preparing and submitting a decommissioning amendment are also included.

Construction costs cover actual construction of the MRS facility based on the drawings and specifications prepared in the Design element.[b] They include labor, materials, equipment, contingencies, support services, site improvements, utilities and construction contractor management. Construction costs are considered capital investments. These expenditures are of three types: 1) direct costs - paid to construction contractors for expenses on behalf of the project, such as construction of the R&H building (including receipt and inspection facility), CHTRU facility, support facilities, storage facility, utilities and other site improvements; 2) construction management

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(a) See Section E.1.5 for reasons why the licensing and permitting fees are not estimated.

(b) Note that the Design and Construction elements in this costing framework refer to all costs during the design and construction phases, including both capital-funded and operating expense funded costs. In the conceptual design report (Ralph M. Parsons Company 1985), the architect-engineer used the term "construction" to cover the capital-funded portion of the combined design and construction costs. The reconciliation of the difference between these two cost estimates for the combined design and construction categories for the preferred site-design case is explained in Section E.2.1 (Construction). This distinction between the term "construction" used in this appendix and that in the conceptual design report should be kept in mind throughout this appendix as well as the Program Plan.

costs - costs for performing construction management and support services; and 3) contingency costs - a reserve for unexpected events or requirements not specifically foreseen. The latter costs are estimated as a percentage (20%) of the sum of direct costs and construction management costs.

Training and Testing will begin prior to the completion of facility construction to ensure that the MRS facility and operations staff will be prepared to perform their intended functions safely and within quality requirements by the time the facility becomes operational. The training and certification programs will cover safety and radiological monitoring groups, operations and maintenance crews, and emergency response teams. Testing starts with offsite systems testing. Personnel training and operations testing will sequence through the mockup facility in the training cell in the site services building, the cold tests in the R&H building (full complement of equipment installed in the hot cells without using actual spent fuel assemblies), and the hot test (using actual spent fuel assemblies). Also included in the estimates for this program element are costs for preparing the necessary training documentation and a 20% contingency allowance.

Operation costs include salaries and benefits for operating and maintenance personnel and were estimated for activities associated with receiving, consolidating, packaging, shipping offsite, or temporarily storing and then shipping offsite, spent nuclear fuel and the associated waste from handling and consolidating the spent fuel. The costs were developed from the Ralph M. Parsons Company estimates of the numbers of operating and maintenance personnel required for operating and maintaining the R&H building, CHTRU facility, storage facility and support facilities plus administrative and support staff, together with the costs of materials. Additional costs are included in this program element for continuing environmental monitoring during the operational period of the facility, and for operations management and support. Costs for facility improvement and modifications and for storage casks and canisters are also included.

The costs incurred during facility operation include both capital-funded and operating expense-funded expenditures. Capital-funded expenditures include costs for the sealed storage casks and facility improvements. Operating expense-funded expenditures include the following general categories: 1) labor--determined by a composite annual wage rate that includes all labor costs and the number of staff persons; 2) consumables--items used during operation and maintenance of the facility, such as canisters, drums, filters, and miscellaneous items; 3) maintenance, supplies and contract labor--paid to suppliers for parts, supplies, and labor used for facility maintenance and operation; and 4) utilities, including fuel oil/diesel and gasoline. A 20% contingency allowance was made to cover the normal uncertainty in cost estimate at this stage of design.

Decommissioning costs begin to be incurred approximately four years before the end of operations when the decommissioning plan is prepared and the storage casks are unloaded and decontaminated in preparation for decommissioning. The major part of decommissioning costs associated with decommissioning the R&H building, CHTRU facility, and the storage and support facilities will not begin until the last of the consolidated spent fuel has been shipped to the repository. Costs for site improvements or reclamation are included. This cost category also includes a 20% contingency allowance.

Institutional Interactions costs are incurred 1) to provide timely and full information exchange and appropriate participation between and among the DOE, the public, the State, and local officials regarding the development, deployment, operation, and decommissioning of the MRS facility; and 2) to ensure that the State and local governments receive fair and reasonable financial assistance for the effects of construction and operation of the MRS facility. In this analysis, only costs associated with public information programs are estimated, because the other cost elements are still under discussion.[a]

Program Management costs cover the period from congressional approval through operational demonstrations of the MRS facility. Services provided include 1) system engineering and configuration management, 2) project planning and control for a major systems acquisition, 3) management of subcontracts, 4) management services such as procurement, financial services and program office staff, and 5) quality assurance. These costs were based on estimates of the annual level of effort required. During facility operation, all program management costs are estimated under the Operation program element. During the period when the facility is being decommissioned, costs of program management are estimated separately.

Economic Assumptions

Unless otherwise noted, costs included in this appendix are specified in terms of 1985 constant dollars, and thus do not include the effect of general inflation. When making comparisons of cost estimates in future years, it would be necessary to convert the cost estimates in this appendix to the dollar terms of the year in which the new cost estimates are being specified.

E.1.2 Site and Design Combinations

Section 141(b)(4) of the NWPA requires that the MRS proposal include at least three alternative sites and at least five alternative combinations of

(a) Refer to the MRS proposal (Volume 1) for a description of the DOE's proposed program.

such proposed sites and facility designs. The DOE has chosen the sealed storage cask as the primary storage method for the proposed MRS facility. The field drywell was selected as the alternative storage method. The DOE has selected the former Clinch River Breeder Reactor site in the State of Tennessee as the preferred site for locating the MRS facility. Two alternative sites were also identified for evaluation: the DOE Reservation at Oak Ridge, Tennessee, and the former Hartsville nuclear plant site near Nashville, Tennessee. Six site-design combinations were evaluated: one preferred and five alternative cases. Cost estimates have been prepared for all six cases.

E.1.3 Waste Logistics

The waste logistics used in this analysis are based on the schedule for waste acceptance, storage, and shipment from the MRS facility to the first repository, shown in Table 2-3 of the Mission Plan (Waste Acceptance Schedule-Improved Performance System). This schedule indicates a maximum required receipt and shipping rate of 3,000 MTU, total throughput of 62,000 MTU, and expected onsite maximum inventory of 13,300 MTU. For costing purposes, all spent fuel destined for the first repository, including spent fuel from western reactors, was assumed to be shipped first to the MRS facility for consolidation and canistering.[a] The MRS facility will receive spent fuel from reactors from 1996 to 2017, and will ship to the first repository from 1998 to 2022. Defense waste will be sent directly to the first repository and the second repository will operate independently of the MRS facility.

E.1.4 Facility Design

The conceptual design for the MRS facility has a design receipt rate of 3,600 MTU/year and onsite storage capacity of 15,000 MTU. Operations would be on a five-day, 3 shifts/day mode (with a standby mode on the weekends) to accommodate an operating receipt/ship rate of 3,000 MTU per year. A total plant operating staff of about 600 employees would be required at these throughput rates during steady-state operation. For the first few years of operation of the MRS facility, some of the consolidated spent fuel would be placed into temporary storage while other fuel would be shipped to the repository (after 1998). In subsequent years, the facility would serve primarily as

(a) This is different from the position taken in the Need and Feasibility section of the EA (Volume 2 of this submission to Congress), which indicates that spent fuel from western reactors will be shipped directly to the first repository. Shipment of western fuel directly to the first repository would probably lower the MRS receiving rate to approximately 2550 MTU per year and lower the MRS facility cost estimated herein accordingly.

a receiving and packaging facility for the first repository. The major elements of the MRS facility are the R&H building, the CHTRU facility, the support facilities and the storage facility.

E.1.5 Costs Not Included

Certain items are not included in the cost estimates presented in the next sections. These are discussed below.[a]

As discussed in the MRS proposal (Volume 1), it is recommended that financial assistance be made available to local units of government affected by MRS deployment upon congressional approval. When agreements are reached and the costs can be estimated, they will be included in MRS life-cycle cost estimates.

The DOE is recommending that Congress direct that revenues equivalent to taxes be provided to the State of Tennessee and affected units of local government for the MRS facility. This will provide revenues to the State and localities equivalent to those which would be received if a commercial facility were built on the site. When costs have been identified, they will also be included in MRS life-cycle cost estimates.

Pursuant to Section 117(b) and (c) of the NWPA, binding Consultation and Cooperation Agreements will be sought with Tennessee within 60 days after congressional approval of the MRS Program. Since these agreements have not been negotiated, there are no cost estimates available at this time.

Also not included in the cost estimates are licensing and permitting costs associated with other federal, state and local entities. At this time, there is no clear indication whether the federal entities will make these costs part of their request for congressional budget appropriations or whether they may directly charge the Waste Fund under Title 10 Code of Federal Regulations,

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(a) The cost of transporting spent nuclear fuel within the federal waste management system is a major component of the total system life-cycle costs of the federal waste management system. (For the improved-performance system, the other three major components are development and evaluation (D&E) costs, repository costs, and MRS costs.) Hence, any changes in total system costs attributable to the transportation component are being estimated separately, instead of being included in the MRS facility costs. In other words, the impacts on transportation cost of incorporating an MRS facility into the federal waste management system is a valid consideration, but it is more properly evaluated from a total system perspective and is not included as part of the life-cycle cost estimate for the MRS facility per se.

Part 170--Fees for Facilities and Materials Licenses and other Regulatory Services under the Atomic Energy Act of 1954, as Amended. Currently, Part 170 does not discuss MRS. State and local permitting fees have not been identified at this time.

Site acquisition costs have also not been estimated at this time. These costs can vary among the three sites. However, they would not significantly impact the life-cycle costs.

E.2 COST ESTIMATE FOR THE PREFERRED SITE-DESIGN CASE

The preferred site-design case cost estimate is the life-cycle cost of developing, constructing, operating, and decommissioning an MRS facility using the sealed storage cask concept at the Clinch River Breeder Reactor (CRBR) site in Tennessee. This section presents the details of this cost estimate by first explaining individual cost components and then discussing the total facility life-cycle costs. Major uncertainties concerning the cost estimates are then explored. Unless otherwise noted, all cost estimates are expressed in constant 1985 dollars.

E.2.1 Cost Categories

This section presents the details of the preferred site-design case cost estimate by cost category. The nine cost categories were defined in Subsection E.1.1. Due to the need to consider funding categories in the later analysis, whether or not a cost category includes capital-funded or operating expense-funded items is indicated in the following discussion.

Environmental Evaluations

The costs for Environmental Evaluations activities, such as environmental data confirmation and verification and preparation of the ER, are estimated to be $5.3 million. All environmental data collection and documentation will need to follow strict quality assurance (QA) requirements. For example, all existing environmental documentation will be verified by onsite sampling and inspection to comply with QA requirements for an NRC license application. The environmental data collection, confirmation and verification activity accounts for $3 million. Preparation of the ER and public interactions will require that another $2 million and $0.3 million is reserved for responding to questions following submittal of the ER. Costs for this element are expense-funded.

Design

The costs associated with the Design element of the MRS Program are estimated to be about $97 million, including 20% contingency allowance. The major cost components are as follows:

Cost Item	Millions of Constant 1985 Dollars[a]
R&H building	$47.3
CHTRU facility	0.2
Support facilities	10.6
Storage facility	2.9
Site data	5.5
Site improvements	1.4
Utilities	2.6
Design verification	17.0
Design management	9.7
Total Design	$97.2

These cost estimates are based on estimates of the number of drawings required and the assumption that 160 hours of labor is required per drawing. The hourly charge to produce drawings is assumed to $50 dollars per hour. In addition, cost incurred by the design contractor for design verification ($1 million) and for licensing support during the license application period are included. These latter cost items are distributed 90% to the R&H building and 10% to the storage facility. $65 million of the cost in the design phase is capital-funded. All other costs are operating expense-funded.

Regulatory Compliance

The costs for complying with regulatory requirements include those incurred for 1) preparing a license application to the NRC including guidance to and review of designs, 2) obtaining various permits from the State and other entities, and 3) preparing license review supplements prior to construction. Also included in this cost category are the costs incurred for 4) preparing and submitting license amendments during construction, 5) conducting license-related activities during operation, and 6) submitting a decommissioning amendment. The total cost of Regulatory Compliance is estimated to be $25.7 million and is expense-funded. The major cost components are shown below:

(a) All costs greater than $0.1 million were utilized in the estimates in this appendix. When summed, the totals may therefore give an appearance of greater precision than actually exists.

Cost Item	Millions of Constant 1985 Dollars
NRC license application	$4.0
Permits	0.6
License review and amendments	2.5
License amendments during construction	3.7
Operation reporting	10.8
Decommissioning amendments	4.1
Total Regulatory Compliance	$25.7

Construction

Total cost in the construction phase is estimated to be $646.4 million, including 22% contingency allowance.[a] The details of this estimate are as follows:

Cost Item	Millions of Constant 1985 Dollars
R&H building	$421.6
CHTRU facility	1.3
Support facilities	38.8
Storage facility	31.4
Site improvements	58.4
Utilities	4.9
Construction management & support	90.0
Total Construction Phase	$646.4

Excluding construction management and support, the others are construction contracts totaling about $556 million. Construction management and support costs include $52 million for construction management, $28 million for field engineering, inspection and review of submittal, and $10 million for operational support to construction. Except for the $10 million for operational support to construction, all costs during the construction phase are capital-funded.

(a) The specific contingency allowances used, by building, are as follows:

R&H Building	25%
CHTRU	10
Site	10
Storage facility	15
Support and utilities facility	10
Average	22% (Ralph M. Parsons Company 1985)

The capital-funded cost of combined design and construction phases of the MRS Program totals $701.4 million.[a] This is composed of the following:

Cost Item	Millions of Constant 1985 Dollars
Design and license support	$65.0
Field engineering and vendor submittal review	28.0
Construction management	52.0
Construction contracts	556.4
Total Design & Construction (Capital-Funded)	$701.4

Training and Testing

Total training and testing costs are estimated to be $62.0 million, including 20% contingency allowance. This total includes costs for developing the operating procedures, training the operators, testing equipment, conducting preoperational testing of the facility and equipment, and training for fire protection and security. All the costs are expense-funded. The details of this cost category are shown below:

Cost Item	Millions of Constant 1985 Dollars
Operating procedure & training	$35.5
Preoperational testing	22.0
Fire protection and security training	4.5
Total Training and Testing	$62.0

Operation

Total operation cost through 2022, when the last of the stored spent fuel is retrieved and shipped to the repository, is estimated to amount to $1,915 million, including 20% contingency allowance. This total includes costs for procurement of the storage casks, capital additions and modifications, operating staff salary and benefits, canisters, other consumables such as drums and filters, and utilities including electricity and fuel oil. These are shown below:

(a) This is the "construction" cost estimate included in the design report (Ralph M. Parsons Company 1985) noted earlier in Section E.1.1.

Cost Item	Millions of Constant 1985 Dollars
Casks and capital additions	$509.0
Staff	675.4
Canisters	414.7
Other consumables	135.7
Utilities	180.2
Total Operation	$1915.0

According to the items included in the costing framework in Subsection E.1.1, total operating costs can also be disaggregated as follows:

Cost Item	Millions of Constant 1985 Dollars
R&H building	$1026.4
CHTRU facility	1.0
Support facilities	284.2
Storage facilities	17.1
Environmental surveillance	17.8
Operations management and support	59.5
Capital modifications/additions	509.0
Total Operation	$1915.0

Costs incurred during the operation phase are both capital- and operation expense-funded. A total of $509 million will be capital-funded, including $297 million for storage casks and $212 million for capital additions or modifications.

Decommissioning

Decommissioning costs are assumed to be 12% of facility construction cost and 5% of the cost of all sealed storage casks produced. These assumptions are based on experience and engineering judgment (Engineering News Report 1984). Of the total cost incurred during the construction phase of $646.4 million, $90 million is for construction management and support, not directly related to physical facilities at the MRS site. Hence, these are excluded in computing the facilities-related decommissioning cost. Moreover, approximately $23 million of the remaining $558 million of construction costs is for excavation and other earth work and is not used in computing the decommissioning cost for capital facilities. Hence, the total construction cost used for computing decommissioning costs is only $535 million. Total decommissioning cost is estimated to be $79.0 million and is expense-funded. Since the construction cost used for computing decommissioning cost includes 20% contingency allowance, the decommissioning cost can be viewed as containing the same 20% contingency allowance. The detailed breakout is shown below:

Cost Item	Millions of Constant 1985 Dollars
R&H building	$50.6
CHTRU facility	0.1
Support facilities	4.7
Storage facility (incl. casks)	17.3
Site improvements (incl. utilities)	6.4
Total Decommissioning	$79.1

Institutional Interactions

As discussed in Subsection E.1.5, the total costs for institutional interactions will include financial assistance to state and local entities, which is still under discussion. However, the cost of public information programs is estimated to be $2.1 million for the period 1986 through 1991. This cost category is expense-funded.

Program Management

Program management costs include those costs associated with system engineering and configuration management, institutional relations, project planning and control, subcontract management, management services, and quality assurance. Annual program management costs are estimated for three periods: 1) preoperation until the start of full-scale operation, 2) operation, and 3) postoperation. The latter period contains only quality assurance costs. During the operation years, all program management costs, including QA costs, are included in the cost estimate for operations. During the postoperational period, program management costs other than QA costs are included in the decommissioning costs. This cost category is expense-funded. The cost components are shown below:

Cost Item	Millions of Constant 1985 Dollars
System engineering & configuration management	$17.0
Institutional relations	3.7
Project planning and control	19.7
Subcontract management	6.5
Management service	10.1
Quality assurance	12.7
Total Program Management	$69.7

E.2.2 Total MRS Facility Life-Cycle Cost of the Preferred Site-Design Case

Table E.1 presents the preferred site-design case cost estimates for the MRS facility using the 12-inch-diameter current design storage canister as the basis for costing. Total life-cycle cost for the MRS facility is estimated to be $2902 million. Among the nine cost categories, operations accounts for the largest share, about 66%. Construction is second with 22%. Preconstruction activities of environmental evaluation, design, and regulatory compliance combined account for 4%. Training and testing accounts for 2%. Decommissioning and program management account for 3% and 2%, respectively. It should be noted that among the nine cost categories, contingency allowances of 20% were explicitly incorporated into the categories of design, construction, training and testing, operation, and decommissioning. The other four categories do not include such allowances.

Table E.2 presents the annual costs by cost category for the preferred site-design case. Annual expenditures are highest during the construction period and initial facility operation years, ranging from $91 million to $203 million per year. When the MRS facility is in steady-state operation, the annual cost is estimated to be about $71 million per year. The estimated staffing requirement for operation during this period is 601 people.

Disaggregation of Costs By Function

The MRS facility life-cycle cost estimates shown in Tables E.1 and E.2 can also be disaggregated by function of the MRS operation. The MRS performs functions such as spent fuel consolidation, storage, and related support functions. The spent fuel consolidation function is performed within the R&H building.

Viewed in this manner, the estimate of total facility cost can be disaggregated into the following components by function:

Function	Millions of Constant 1985 Dollars
R&H operation	$1715.1
Storage	392.3
Support	795.0
TOTAL	$2902.4

TABLE E.1. Life-Cycle Cost Estimate for the Preferred Site-Design Case (MRS Facility at the Clinch River, Tennessee, Site Using the Sealed Storage Cask)

Cost Element	Constant 1985 Dollars (Millions)	Constant 1985 Dollars (%)
Environmental Evaluations	5.3	0.2
Design	97.2	3.3
Regulatory Compliance	25.7	0.9
Construction	646.4	22.3
Training and Testing	62.0	2.1
Operation	1915.0	66.0
Decommissioning	79.0	2.7
Institutional Interactions	2.1	0.1
Program Management	69.7	2.4
Total MRS Facility	2,902.4	100.0

TABLE E.2. Annual Cost Estimate for the MRS Facility, By Cost Category (millions of constant 1985 dollars)

Design: Sealed Storage Cask   Site: Clinch River, Tennessee

Fiscal Year	Environmental Evaluations	Design	Regulatory Compliance	Construction	Training and Testing	Operation	Decommissioning	Institutional Interaction	Program Management	Total Program
1986	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.1	1.9	2.8
1987	3.2	8.5	1.5	0.0	0.0	0.0	0.0	0.4	7.0	20.6
1988	1.2	24.2	1.5	0.0	0.0	0.0	0.0	0.4	8.2	35.5
1989	0.4	29.4	1.5	0.0	0.4	0.0	0.0	0.4	8.5	40.6
1990	0.3	23.7	1.5	1.5	0.7	0.0	0.0	0.4	6.7	34.8
1991	0.0	6.5	1.2	37.4	1.4	0.0	0.0	0.4	6.3	53.2
1992	0.0	4.5	0.8	142.5	2.6	0.0	0.0	0.0	6.6	157.0
1993	0.0	0.1	0.8	174.2	5.3	0.0	0.0	0.0	6.2	186.6
1994	0.0	0.0	0.8	174.2	12.1	9.0	0.0	0.0	6.5	202.6
1995	0.0	0.1	0.8	110.3	15.4	11.5	0.0	0.0	4.8	142.9
1996	0.0	0.0	0.4	6.3	24.1	62.2	0.0	0.0	2.2	95.2
1997	0.0	0.0	0.4	0.0	0.0	102.6	0.0	0.0	0.8	103.8
1998	0.0	0.0	0.4	0.0	0.0	135.7	0.0	0.0	0.0	136.1
1999	0.0	0.0	0.4	0.0	0.0	123.7	0.0	0.0	0.0	124.1
2000	0.0	0.0	0.4	0.0	0.0	135.7	0.0	0.0	0.0	136.1
2001	0.0	0.0	0.4	0.0	0.0	90.6	0.0	0.0	0.0	91.0
2002	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2003	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2004	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2005	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2006	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2007	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2008	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2009	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2010	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2011	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2012	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2013	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2014	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2015	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2016	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2017	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2018	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2019	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2020	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2021	0.0	0.0	0.4	0.0	0.0	24.6	1.4	0.0	0.0	26.4
2022	0.0	0.0	0.9	0.0	0.0	9.6	16.2	0.0	0.5	27.2
2023	0.0	0.0	0.9	0.0	0.0	0.0	19.1	0.0	1.0	21.0
2024	0.0	0.0	0.9	0.0	0.0	0.0	17.9	0.0	1.0	19.8
2025	0.0	0.0	0.9	0.0	0.0	0.0	12.4	0.0	1.0	14.3
2026	0.0	0.0	0.9	0.0	0.0	0.0	10.8	0.0	0.5	12.2
TOTAL	5.3	97.2	25.7	646.4	62.0	1915.0	79.0	2.1	69.7	2902.4

E.3 COST ESTIMATES FOR ALTERNATIVE CASES

In addition to the cost estimates for the preferred site-design case explained above, cost estimates are also developed for the five alternative cases. Alternative cases involving the sealed storage cask design at the alternative sites of Hartsville and Oak Ridge, Tennessee, are considered first. The cases involving the alternative storage design (field drywell) at the three alternative sites are then presented. All cost estimates are based on a 12-inch-diameter current design storage canister, which is not specific to the geologic medium of the first repository.

E.3.1 Sealed Storage Cask at Alternative Sites

Table E.3 presents the life-cycle cost estimates for an MRS facility using a sealed storage cask design for all three sites. The difference in cost for these two alternative cases from the preferred site-design case result from the

TABLE E.3. Life-Cycle Cost Estimates for the MRS Facility at the Preferred and Alternative Sites for the Sealed Storage Cask Design

Cost Categories	Millions of Constant 1985 Dollars		
	Clinch River	Hartsville	Oak Ridge
Environmental Evaluations[a]	$5.3	$5.3	$5.3
Design	97.2	97.2	97.2
Regulatory Compliance	25.7	25.7	25.7
Construction	646.4	653.4	635.2
Training and Testing	62.0	62.0	62.0
Operation	1915.0	1915.0	1915.0
Decommissioning	79.0	79.0	79.0
Institutional Interactions	2.1	2.1	2.1
Program Management	69.7	69.7	69.7
Total MRS Facility	$2902.4	$2909.4	$2891.2

(a) The $5.3 million cost is the best estimate at this time for the Clinch River site. Since more data are available for the Clinch River site than the other two sites, costs can be expected to be somewhat higher for the Hartsville and Oak Ridge sites. However, separate estimates have not been made for the other sites.

differences in the site preparation required during construction. The life-cycle cost for the Oak Ridge site is estimated to be about $11 million lower, and that for the Hartsville site is about $7 million higher, than the preferred site-design case.

E.3.2 Field Drywell at the Preferred and Alternative Sites

Table E.4 presents the cost estimates for the MRS facility using the field drywell design at the preferred (Clinch River) site and two alternative sites. The differences in costs, compared to the sealed storage cask design, occur mainly in the cost categories of construction and operation. There are also

TABLE E.4. Life-Cycle Cost Estimates for the MRS Facility with the Field Drywell Design, by Potential Site

	Millions of Constant 1985 Dollars		
Cost Categories	Clinch River	Hartsville	Oak Ridge
Environmental Evaluations[(a)]	$ 5.3	$ 5.3	$ 5.3
Design	97.2	97.2	97.2
Regulatory Compliance	25.7	25.7	25.7
Construction	741.4	717.8	726.9
Training and Testing	62.0	62.0	62.0
Operation	1718.0	1718.0	1718.0
Decommissioning	73.4	73.4	73.4
Institutional Interactions	2.1	2.1	2.1
Program Management	69.7	69.7	69.7
Total MRS Facility	$2794.8	$2771.2	$2780.3

(a) The $5.3 million cost is the best estimate at this time for the Clinch River site. Since more data are available for the Clinch River site than the other two sites, costs can be expected to be somewhat higher for the Hartsville and Oak Ridge sites. However, separate estimates have not been made for the other sites.

smaller differences in costs for decommissioning. There are no differences in the cost estimate for the other six cost categories.[a] Table E.5 presents the specific differences using the preferred Clincn River, Tennessee, site as an example. Total facility life-cycle cost for an MRS facility using the drywell concept is estimated to be $108 million, or about 4% less than the cost estimate for one using the sealed storage cask design. The field drywell design has higher construction costs, yet lower operation and decommissioning costs, than the sealed storage cask design.

TABLE E.5. Cost Differentials Due to Difference in Storage Design at the Clinch River Site

	Millions of Constant 1985 Dollars		
Cost Category	Sealed Storage Cask (SSC)	Field Drywell (FD)	Differences (SSC-FD)
Construction	$646.4	$741.4	-$95
Operation	1915.0	1718.0	197
Decommissioning	79.0	73.4	5.6
Subtotal	$2640.4	$2532.8	$107.6
All other costs	262.0	262.0	
Total Life Cycle	$2902.4	$2794.8	$107.6

E.4 COST SENSITIVITIES AND OTHER FACTORS

While the cost estimates presented above are based upon the best information presently available, actual technical, economic, and institutional factors might deviate from those incorporated into the assumptions used for deriving the cost estimates. The impact of some of these factors can be analyzed through sensitivity testing, while impacts of other factors can only be discussed qualitatively. The sensitivities of the life-cycle cost estimates to changes in the assumptions concerning the staffing requirements during operations, unit labor cost, and real escalation in labor cost are examined first. Other factors affecting cost estimates are then discussed qualitatively.

(a) Because the required size of the site for the MRS facility is different for the two designs, the acquisition costs, if any, are also likely to be different. However, the cost estimates presented do not include such cost items.

E.4.1 Sensitivity to Operations Staffing Requirements

The production operation of the MRS facility is based on 3000 MTU throughput per year. Actual storage conditions at the reactors may dictate either a higher or lower production rate. This could lead to some adjustments in the staffing requirements during operations. If the operation manpower requirement over the operating life of the facility is either 10% higher (or lower) than that of the preferred site-design case, total facility life-cycle cost would be 2.5%, or $73 million, higher (or lower) than the preferred site-design case (see Table E.14, Section E.6).

E.4.2 Sensitivity to Unit Labor Cost

The cost estimate for the preferred site-design case is based on the assumption that unit labor cost stays constant in real terms over the entire program period. The cost estimate would change if either the per person annual wage cost used were changed or if some real wage escalation were assumed. For example, if the unit labor cost for operations over the operating life of the facility is 20% higher (or lower) than that used for the preferred site-design case, the MRS life-cycle cost estimate will be 5%, or $145 million, higher (or lower). Similarly, if unit labor cost is assumed to be escalating at a 1% real rate during operation instead of the 0% real escalation in the preferred site-design case, then the life-cycle cost of the MRS facility can be expected to be 5.1% higher (see Table E.15, Section E.6).

E.4.3 Other Factors Affecting Cost Estimates

Other factors that could potentially affect the cost estimates for the preferred site-design case include the geological medium of the first repository, the timing of congressional approval of the MRS Program, and delays in construction for any reason. The following provides brief qualitative discussions on each of these items.

First, it is useful to note that, among the nine cost categories included in the preferred site-design case cost estimate, the five categories of design, construction, training and testing, operation, and decommissioning, which account for about 96% of total life-cycle costs, have explicitly incorporated a contingency allowance of about 20% to take care of normally unexpected occurrences in the required activities in each of the five elements (see Sections E.1 and E.2).

At this time, three potential geological media are under consideration for the first repository: basalt, salt, and tuff. The requirements for canistering consolidated waste materials at the MRS facility could differ according to the geological medium of the repository. If the waste disposal is to be in either a basalt or a salt repository, packaging the waste canisters into another container might be required. In contrast, the waste might be consolidated and placed into a single container for disposal in a tuff repository. The costs of canisters would differ, depending on the repository geological medium, as would the life-cycle cost estimates for the facility.

The designs for repository-specific canisters are expected to be larger than the current-design MRS canisters and these each can contain larger numbers of consolidated fuel per canister. Therefore, although the cost per repository-specific canister may be higher, total canister costs could be lower than that incorporated into the preferred site-design case using the current design canister, because of the reduced number of canisters needed. At this time, the current design (12-inch-diameter) canister has been used in the preferred site-design case. In this sense, the cost estimate can be viewed as conservative.

The preferred site-design case cost estimate assumed congressional approval for the construction of the MRS facility by July 1986. If approval is delayed, then there would be some added cost involved in carrying and maintaining the program in a ready status for activation until the time approval is granted. The project carrying costs would depend on the actual date of the congressional decision, but is not expected to be high. The major concern, however, is the potential impact the timing of the congressional decision would have on the schedule for deployment of the MRS facility. If the schedule is compressed and overtime is required for construction, then construction cost may be raised. Similarly, substantial delays in construction due to labor- and weather-related work stoppages beyond those covered by the contingency allowances would also add to costs.

E.5 FUNDING

Section 141(b)(2)(B) of the NWPA requires that a funding plan be developed to finance the deployment, operation, and decommissioning of an MRS facility and Section 302 of the NWPA authorizes use of the Nuclear Waste Fund for all MRS activities. Other provisions of the NWPA preclude using appropriated funds from the DOE's regular budget to fund the MRS facility.

This section describes analyses of alternative funding approaches, the rationale for selecting the proposed approach, and the proposed plan to fund the MRS Program. The impact on the total waste management system life-cycle cost is discussed and the annual and cumulative funding requirements for the MRS Program are provided.

E.5.1 Analysis of Alternative Funding Approaches

In this section, the possible alternative approaches for funding the MRS Program are first reduced to those successfully meeting the initial screening criteria. A second set of evaluation criteria are then explained and applied to those alternatives satisfying the initial screening criteria to select the proposed funding approach.

Description and Initial Screening of Alternative Approaches

Two criteria were used for initial screening of potential approaches to funding the MRS Program. First, given the cost burden requirement of the NWPA, any potential funding approach not meeting such requirement need not be considered further. Thus, any approach to finance the MRS Program from the general revenues of the federal government through the regular DOE budget is excluded. Second, the MRS facility is intended to be an integral part of the federal waste management system--the "improved-performance system" of the May 1985 DOE (OCRWM) Mission Plan. From this perspective, an approach that imposes a surcharge on only the generators and owners of spent fuel which passes through the MRS facility would be inconsistent with the integral nature of the MRS facility. The decision of which fuel will pass through the MRS facility rests on overall system considerations and not on the preferences of individual utilities. Hence, this approach is not considered further.

Given the above criteria considerations, there are only two potential alternative approaches to funding the MRS Program:

1. Waste Fund Approach: With this approach all MRS Program costs would be financed by the Nuclear Waste Fund, established under Section 302(c) of the NWPA to cover the cost of the federal waste management system. The current Nuclear Waste Fund fee is being assessed at 1-mill per kWh of electricity generated from all nuclear power plants. If a required annual review of the fee adequacy were to conclude that the 1-mill per kWh fee would not ensure full cost recovery, then an adjustment to the fee could be requested.

2. Overall Surcharge Approach: With this alternative a separate surcharge would be assessed on all generators and owners of HLW and SNF in order to set up a separate MRS fund to finance the MRS Program.

Evaluation Criteria

Four criteria were used to evaluate these two funding approaches:

1. Cost of Administration: To the extent that alternative approaches achieve the same overall objective, the ones that are easier and less costly to administer and implement would be preferred.

2. Flexibility in Response to Changing Situations: Due to potentially changing economic and operational situations, the charge for waste disposal may need to be adjusted. The approaches that are more flexible from a system standpoint would be preferable to those that are less flexible.

3. Regulatory Acceptance: Nuclear utilities are subject to state and federal regulation through approval of costs and ratesetting. Approaches that require setting up additional reserves for paying waste disposal fees in the future are more likely to run into difficulties in securing regulatory acceptance, particularly in determining the appropriate size of the reserve account.

4. Incentive for Cost-Effective Management of the System: Since the waste management system is complex, costly and has a long planning horizon, it is necessary to have some built-in mechanism which encourages efficient management so that the cost to ratepayers can be kept at the lowest possible level consistent with meeting the overall objective of the waste management system.

Discussion

With the Waste Fund approach, there would be no need, except for accounting purposes, to distinguish between funds used to finance MRS activities and funds used to finance other waste management system activities. With the overall surcharge approach, a separate MRS fund would need to be established and the surcharge amount would be determined separately from the waste fee to ensure that the separate MRS fund would be adequate to finance MRS activities. This additional step would tend to raise the cost of administering the total waste management system. Hence, from the perspective of cost and ease of administration, the Waste Fund approach is preferable to the overall surcharge approach.

Both the Waste Fund and overall surcharge approaches have about the same flexibility to respond to changing economic and waste management system situations. The 1-mill per kWh fee would probably gain wider regulatory acceptance more easily than the overall surcharge approach because it is clearly mandated by Congress in the NWPA, has been in practice since April 1983, and the 1-mill per kWh charge appears relatively fixed and easily understood. In contrast, to determine the amount of separate charge, precise cost estimates of the MRS facility and how the charge would be allocated among utilities would need to be determined. To the extent the cost estimates and utility charges may be contested in regulatory proceedings, there is more uncertainty in the overall surcharge approach concerning regulatory acceptance than the Waste Fund approach.

It could be argued that because the overall surcharge approach would cover only the MRS Program activities whereas the Waste Fund approach covers the overall waste management system, the overall surcharge approach might be more conducive to cost-effective management and control of the MRS activities than the Waste Fund approach. Nevertheless, it should be possible to closely monitor and control the cost of MRS activities under the Waste Fund approach and to achieve the same cost-effective management of the MRS activities as could be achieved under the overall surcharge approach.

The Waste Fund approach is consistent with both the philosophy and the provisions of the NWPA. Section 302(d) of the NWPA provides that expenditures can be made from the Waste Fund only for purposes of radioactive waste disposal activities under Title I and II of the NWPA, including the following (emphasis added):

> "(1) the identification, development, licensing, construction, operation, decommissioning, and post-decommissioning maintenance and monitoring of any repository, monitored, retrievable storage facility or test and evaluation facility constructed under this Act;
> (2) the conducting of nongeneric research, development, and demonstration activities under this Act;
> (3) the administrative cost of the radioactive waste disposal program;
> (4) any costs that may be incurred by the Secretary in connection with the transportation, treating, or packaging of spent nuclear fuel or high-level radioactive waste to be disposed of in a repository, to be stored in a monitored, retrievable storage site or to be used in a test and evaluation facility;
> (5) the costs associated with acquisition, design, modification, replacement, operation, and construction of facilities at a repository site, a monitored, retrievable storage site or a test and evaluation facility site and necessary or incident to such repository, monitored retrievable storage facility or test and evaluation facility; and
> (6) the provision of assistance to States, units of general local government, and Indian tribes under sections 116, 118, and 219."

This statutory language clearly envisions the use of the Waste Fund for MRS-related activities. Funding MRS directly through the Waste Fund rather than through a separate fund via the surcharge approach is more appropriate in that the MRS facility confers benefits directly and indirectly to all contributors to the Waste Fund through improvements in the waste management system, including better integration and performance, and provision of a cost-effective capability to accommodate potential repository schedule changes. Based upon the above considerations, the DOE is confident that financing the MRS Program through the Nuclear Waste Fund is fully justified under the provisions of the NWPA and recommends that the MRS Program be funded through the Waste Fund.

E.5.2 Funding Plan

Based upon the above considerations, the DOE's plan for funding the MRS Program is as follows:

1. The MRS Program will be financed through the Nuclear Waste Fund.

2. Although the federal waste management system is self-financing, the amount of money allowed to be spent from the Nuclear Waste Fund is governed through the federal budget process. The NWPA requires that a budget be submitted for the NWF and provides that appropriations be subject to triennial authorization. The Fund Management Plan (DOE 1984) has been developed for implementation. The budgeting and financial management of the MRS Program will be in accordance with the DOE Fund Management Plan.

3. Each year, the annual costs from the most recent update of the MRS facility cost estimates will be converted into a budget request and incorporated into the overall Nuclear Waste Fund budget request. This budget request will go through the federal budgeting process and would be subject to congressional authorization and appropriation.

4. Disbursement of authorized and appropriated funds for the MRS Program will be controlled and reported according to DOE Order 2200, "Financial Management of Civilian Nuclear Waste Activities."

5. The DOE will continue to conduct an annual review of the 1 mill per kWh fee for waste disposal to determine whether the revenues would be sufficient to finance the total costs of the federal waste management system, including the cost of the MRS facility. If it is determined that the fee is inadequate to assure full cost recovery, an adjustment to the 1-mill per kWh fee will be proposed.

E.5.3 Nuclear Waste Fund

This section briefly explains the revenue sources and temporary financing mechanisms of the Nuclear Waste Fund. The primary source of revenues to the Waste Fund is the fee collected from the owners and generators of HLW and SNF. A secondary source of revenue is the interest income derived from investing any positive balance of the Fund. In the event that there are revenue shortfalls, temporary financing mechanisms are available in the form of congressional appropriations and borrowings from the Treasury.

The DOE has interpreted that the NWPA authorizes collection of a fee of 1 mill per kWh on gross generation of electricity from nuclear power plants on or after April 6, 1983, and a one-time fee on SNF and HLW discharged by April 6, 1983, as well as in-core spent fuel or spent fuel planned to be reinserted into the core as of April 6, 1983 [NWPA, Section 302(a)(2) and (3)]. The NWPA also requires the DOE to annually review the adequacy of the fees collected in funding the waste management activities and to propose adjustment to the unit disposal fee to ensure that the Waste Fund will achieve full cost recovery.

For the fees on gross generation, payments by utilities will be based on actual generation that occurred during a quarter. According to the contractual arrangement, individual utilities must report quarterly on the amount they owe to the Waste Fund, and payments must be made within thirty days after the end of the quarter. Late payments would be assessed with interest charges (10 CFR 961). For long-term planning purposes, the DOE is relying on the Energy Information Administration's mid-growth forecast of electricity generation.

It is estimated that the one-time fee for all accumulated SNF and HLW, in-core spent fuel, or spent fuel planned to be reinserted into the core as of April 6, 1983, for all operating reactors totaled about $2.32 billion. Utilities have three payment options: 1) a single payment by June 30, 1985, 2) payments in 40 quarterly installments, and 3) payments at time of delivery of waste to the federal system. Whereas the 1985 single-payment option is interest free, the delayed-payment options would incur interest charges based on the U.S. Treasury bill rate from 1983 until payments are made (Engel 1985). The amount of single payment under Option 1 was previously assumed to be $770 million (Engel 1985, p. 4.4). As of July 1, 1985, the amount paid into the Waste Fund via the single-payment option was $1.4 billion, almost twice the previously assumed amount.

The President has authorized that defense high-level waste be disposed at the repository. Therefore, the federal government would be paying into the Waste Fund according to a fee schedule to be determined through a ratemaking process that is presently under way. This fee payment by the federal government would become a source of revenue to the Waste Fund.

During the early period of the waste management program, revenues to the Waste Fund could exceed the expenses. In that event, the temporary excess funds are to be invested, and the interest income realized will become a supplemental source for funding the waste management activities in later years [NWPA, Section 302(e)(3)].

Likewise, during the beginning years and prior to substantial payments by utilities, the current expenses could exceed the revenues. The NWPA authorizes congressional appropriations to fund the initial program start-up activities [NWPA, Section 302(c)(2) and (d)]. The Waste Fund can also borrow from the Treasury to meet cash flow requirements [NWPA, Section 302(e)(5)]. However, both the separate appropriations and borrowing from the Treasury will need to be repaid with interest [NWPA, Section 302(e)(6)].

E.5.4 Impact on Total System Life-Cycle Cost

One impact of including an MRS facility in the federal waste management system is that the total system life-cycle cost will be changed, based on current plans and schedules. From the federal waste system perspective, total system life-cycle cost is composed of four major components: development and evaluation (D&E), repositories, MRS, and transportation. As the federal waste management system is changed from one without an MRS facility to the improved-performance system with an integral MRS facility, the four cost components change as follows:

1) Although the new system cost estimates are not yet available, the D&E cost component is not expected to be significantly affected because most of the D&E costs associated with the MRS facility have been included in the MRS life-cycle cost estimate.

2) The costs of surface facilities at the first repository will be reduced because of the transfer of the R&H building and its spent fuel handling, consolidation, and associated support functions from the repository to the MRS facility.

3) The MRS cost component increases from zero to the facility life-cycle cost estimate.

4) The system transportation cost may also change because of the changes in routing and characteristics of spent fuel shipments.

The Development and Evaluation (D&E) cost component includes program costs that support, but are not directly attributable to, the program facility cost categories of design, construction, operation and decommissioning. Typical D&E cost components include:

- DOE program management costs associated with the facility or system components
- system engineering costs
- design verification costs
- environmental documentation costs
- regulatory compliance costs
- training and testing costs
- impact payments, grants, etc. to affected state/local agencies.

Another D&E cost category, in the case of MRS, would be the costs of preparing the proposal to Congress. This "sunk" cost, however, is not included either in the Program Plan or in the Need and Feasibility section of the EA; only estimated-forward (post-proposal) costs are considered in these reports.

The MRS life-cycle cost estimates reported herein contain estimates for cost components equivalent to six of the seven D&E categories itemized above (refer to Section E.1.1). No estimates were included, however, for permitting or NRC licensing of the MRS facility (the federal fee bases have not yet been promulgated) or for state grants and impact payments, which are subject to negotiation under the consultation and cooperation agreements specified in the NWPA.

Repository cost estimates used by the MRS/Repository Interface Task Force (DOE 1985b), and reflected herein in net system cost comparisons with and without MRS, also contained some undefined components of D&E costs. Transportation system cost estimates, however, did not contain such cost estimates. The Task Force adopted the assumption that the D&E costs were a relatively minor component of the total cost, and that changes in non-MRS D&E costs (for the repository and the transportation system) would tend to compensate when an MRS facility is added to the system. That assumption is inherent in the life-cycle cost comparisons used herein.

Estimated changes in the total federal waste management system life-cycle cost components with the inclusion of the MRS facility are shown in Table E.6. The net increase in total system cost ranges from about $1.4 to $2.0 billion in constant 1985 dollars. The MRS facility cost of about $2.9 billion is partially offset by reductions in surface facility costs at the first repository in the range of $1.0 to $1.4 billion. The change in transportation cost is estimated to be in the range of -$0.1 billion to +$0.1 billion.

TABLE E.6. Changes in Total System Life-Cycle Cost of the Waste Management System Due to Inclusion of the Integral MRS Facility[a] (billions of constant 1985 dollars)

Cost Components	Changes in Cost
Development and Evaluation	$0.0
First Repository	-1.4 to -1.0
MRS	+2.9
Transportation	-0.1 to +0.1
Net Change in System Cost	+$1.4 to +$2.0

(a) This analysis assumes all spent fuel, including that from western reactors, is sent to the MRS facility for consolidation and canistering. In the EA, the net change in total system life-cycle cost for the case assuming no western fuel is sent to the MRS facility also is in the range of +$1.4 to +$2.0 billion.

According to the 1985 Fee Adequacy Review (Engel 1985), total waste management system costs, excluding an MRS facility, ranged from $24.5 to $30.6 billion in constant 1985 dollars.[a] Therefore, the incremental costs amount to increases in the total system costs of between 5% to 8%, which is within the uncertainty range of current estimates of total system cost without an MRS facility. Based on results of the 1985 fee adequacy review, and the DOE's assessment of the projected growth of the U.S. nuclear economy, the NWF generated at the current 1-mill per kWh fee level would be adequate for funding the improved performance waste management system (including an integral MRS facility). Consistent with the MRS funding plan described above and with past practice, the annual review of fee adequacy for FY-1986 is currently being conducted, using updated waste management system cost estimates and revenue projections. If this review should indicate that the 1-mill per kWh fee would not generate sufficient revenue to assure full cost recovery for the authorized system, and in the future if Congress approves the improved-performance system, an adjustment to the fee would be submitted for congressional approval.

(a) An inflation rate of 3.8% was used to convert the cost estimates in constant 1984 dollars to constant 1985 dollars.

E.5.5 Funding and Spending Schedules

Table E.7 provides a summary of funding requirements for the preferred site-design case, separating the capital-funded from the operating expense-funded items. Total capital-funded items are estimated to be about $1200 million, including about $700 million for facility design and construction, about $210 million for facility improvements, and about $300 million for the production of the sealed storage casks. The majority ($1410 million) of the operating expense-funded items of $1690 million goes to facility operation. The other operating expense-funded items are preoperational support (about $100 million), decommissioning ($80 million), and other support (about $100 million). (Note that all cost estimates and budget authority cited in this discussion are in terms of constant 1985 dollars.)

It is useful to illustrate the relationship between the funding items shown in Table E.7 and the cost categories shown in Table E.1. Among the nine cost categories shown in Table E.1 (and explained in Sections E.1 and E.2), six categories are treated as totally operating expense-funded: Environmental Evaluations, Regulatory Compliance, Institutional Interactions, Program Management, Training and Testing, and Decommissioning. Except for the two cost categories of Training and Testing and Decommissioning, the other four of the six are grouped under the "Other Support" item in Table E.7.

The cost categories of Design, Construction, and Operation have both capital-funded and operating expense-funded components. For example, the total estimated cost for the Design phase, $97.2 million, is composed of $65 million capital-funded for the design and $32.2 million operating expense-funded. This is shown below:

	Millions of Constant 1985 Dollars		
Design Phase	Capital-Funded	Operating Expense-Funded	Total
Design	$65.0		$65.0
Design Verification		$17.0	17.0
Site Data		6.0	6.0
Operational Support		9.2	9.2
Total Design Phase	$65.0	$32.2	$97.2

TABLE E.7. Summary of Funding Requirements for the MRS Program for the Preferred Site-Design Case

Funding Items		Millions of Constant 1985 Dollars
Capital-Funded		
Facility Construction		$701.4
Design-Construction		
Design Phase	$65.0	
Construction Phase	80.0	
Construction Contractors	556.4	
Capital Improvement		212.0
Casks		297.0
Total Capital-Funded		$1210.4
Operating Expense-Funded		
Preoperational Support		$ 104.2
Design Verification	$17.0	
Site Data	6.0	
Operational Support Cost During Design Phase	9.2	
Operational Support Cost During Construction Phase	10.0	
Training and Testing	62.0	
Facility Operation		1406.0
Staff	675.4	
Consumable	550.4	
Utilities	180.2	
Decommissioning		79.0
Other Support		102.8
Environmental Evaluation	5.3	
Regulatory Compliance	25.7	
Institutional Interactions	2.1	
Program Management	69.7	
Total Operating Expense-Funded		$1692.0
TOTAL MRS FACILITY		$2902.4

Similarly, the total Construction cost of $646.4 million is composed of $636.4 million capital-funded and $10.0 million operating expense-funded, as shown below:

Construction Phase	Millions of Constant 1985 Dollars		
	Capital-Funded	Operating Expense-Funded	Total
Design-Construction Management	$80.0		$80.0
Construction Contractors	556.4		556.4
Operational Support		$10.0	10.0
Total Construction Phase	$636.4	$10.0	$646.4

As shown below, the total Operation cost of $1915.0 million includes capital-funded items of capital improvements and casks:

Operation Phase	Millions of Constant 1985 Dollars		
	Capital-Funded	Operating Expense-Funded	Total
Facility Operation		$1406.0	$1406.0
Capital Improvements	$212.0		212.0
Casks	297.0		297.0
Total Operation Phase	$509.0	$1406.0	$1915.0

Table E.8 illustrates the annual and total funding requirements for the life-cycle of the MRS facility for the preferred site-design case. Table E.16 provides further details on the annual funding authority, indicating capital-funding or expense-funding. The funding authority required through 1996, when operation starts, is $998 million, including $701.4 million capital funds for the design and construction phases.

Annual funding requirements for the MRS Program will be heaviest during construction and initial operation years, 1991 through 2001. They will range from about $80 million to about $190 million. During the period 2002 through 2016 when the MRS facility is in steady-state operation, annual spending is estimated to be $71.4 million per year. The funding requirement for facility decommissioning is $79 million.

TABLE E.8. Spending and Funding Schedule for the Preferred Site-Design Case (millions of constant 1985 dollars)

Fiscal Year	Capital-Funded		Expense-Funded		Total Project	
	BA	BO	BA	BO	BA	BO
1986	0.0	0.0	7.4	2.8	7.4	2.8
1987	6.2	2.0	18.6	18.6	24.8	20.6
1988	19.0	17.0	17.8	18.5	36.8	35.5
1989	23.8	25.0	15.4	15.6	39.2	40.6
1990	24.4	20.0	15.1	14.8	39.5	34.8
1991	63.2	37.4	16.0	15.8	79.2	53.2
1992	148.6	140.7	15.8	16.3	164.4	157.0
1993	174.5	172.2	16.2	14.4	190.7	186.6
1994	166.0	181.2	21.7	21.4	187.7	202.6
1995	103.4	120.6	27.6	22.3	131.0	142.9
1996	52.1	51.9	45.3	43.3	97.4	95.2
1997	58.0	52.7	53.6	51.1	111.6	103.8
1998	71.1	74.1	62.0	62.0	133.1	136.1
1999	65.1	62.1	62.0	62.0	127.1	124.1
2000	62.8	74.1	62.0	62.0	124.8	136.1
2001	24.1	29.0	62.0	62.0	86.1	91.0
2002	9.4	9.4	62.0	62.0	71.4	71.4
2003	9.4	9.4	62.0	62.0	71.4	71.4
2004	9.4	9.4	62.0	62.0	71.4	71.4
2005	9.4	9.4	62.0	62.0	71.4	71.4
2006	9.4	9.4	62.0	62.0	71.4	71.4
2007	9.4	9.4	62.0	62.0	71.4	71.4
2008	9.4	9.4	62.0	62.0	71.4	71.4
2009	9.4	9.4	62.0	62.0	71.4	71.4
2010	9.4	9.4	62.0	62.0	71.4	71.4
2011	9.4	9.4	62.0	62.0	71.4	71.4
2012	9.4	9.4	62.0	62.0	71.4	71.4
2013	9.4	9.4	62.0	62.0	71.4	71.4
2014	9.4	9.4	62.0	62.0	71.4	71.4
2015	9.4	9.4	62.0	62.0	71.4	71.4
2016	9.4	9.4	62.0	62.0	71.4	71.4
2017	7.1	9.4	52.9	62.0	60.0	71.4
2018	0.0	0.0	25.4	25.4	25.4	25.4
2019	0.0	0.0	25.4	25.4	25.4	25.4
2020	0.0	0.0	25.6	25.4	25.6	25.4
2021	0.0	0.0	26.6	26.4	26.5	26.4
2022	0.0	0.0	25.6	27.2	25.6	27.2
2023	0.0	0.0	20.7	21.0	20.7	21.0
2024	0.0	0.0	18.4	19.8	18.4	19.8
2025	0.0	0.0	13.8	14.3	13.8	14.3
2026	0.0	0.0	9.1	12.2	9.1	12.2
Total MRS Facility	1210.4	1210.4	1692.0	1692.0	2902.4	2902.4

BA = Budget Authority.
BO = Budget Outlays.

E.6 DETAILED COST AND DATA TABLES

Tables E.9 through E.13 present the detailed annual cost estimates for the alternative site-design combinations. Table E.14 presents the sensitivity cases for changes in staffing requirements during operation. Table E.15 presents the sensitivity cases for changes in unit labor costs. Table E.16 provides additional details on the spending and funding schedules shown in Table E.8.

TABLE E.9. Annual Cost Estimate for the MRS Facility, By Cost Category (millions of constant 1985 dollars)

Design: Sealed Storage Cask   Site: Hartsville, Tennessee

Fiscal Year	Environmental Evaluations	Design	Regulatory Compliance	Construction	Training and Testing	Operation	Decom-missioning	Institutional Interaction	Program Management	Total Program
1986	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.1	1.9	2.8
1987	3.2	8.5	1.5	0.0	0.0	0.0	0.0	0.4	7.0	20.6
1988	1.2	24.2	1.5	0.0	0.0	0.0	0.0	0.4	8.2	35.5
1989	0.4	29.4	1.5	0.0	0.4	0.0	0.0	0.4	8.5	40.6
1990	0.3	23.7	1.5	1.5	0.7	0.0	0.0	0.4	6.7	34.8
1991	0.0	6.5	1.2	37.7	1.4	0.0	0.0	0.4	6.3	53.5
1992	0.0	4.5	0.8	144.2	2.6	0.0	0.0	0.0	6.6	158.7
1993	0.0	0.1	0.8	176.1	5.3	0.0	0.0	0.0	6.2	188.5
1994	0.0	0.0	0.8	176.1	12.1	9.0	0.0	0.0	6.5	204.5
1995	0.0	0.1	0.8	111.5	15.4	11.5	0.0	0.0	4.8	144.1
1996	0.0	0.0	0.4	6.3	24.1	62.2	0.0	0.0	2.2	95.2
1997	0.0	0.0	0.4	0.0	0.0	102.6	0.0	0.0	0.8	103.8
1998	0.0	0.0	0.4	0.0	0.0	135.7	0.0	0.0	0.0	136.1
1999	0.0	0.0	0.4	0.0	0.0	123.7	0.0	0.0	0.0	124.1
2000	0.0	0.0	0.4	0.0	0.0	135.7	0.0	0.0	0.0	136.1
2001	0.0	0.0	0.4	0.0	0.0	90.6	0.0	0.0	0.0	91.0
2002	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2003	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2004	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2005	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2006	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2007	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2008	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2009	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2010	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2011	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2012	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2013	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2014	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2015	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2016	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2017	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2018	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2019	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2020	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2021	0.0	0.0	0.4	0.0	0.0	24.6	1.4	0.0	0.0	26.4
2022	0.0	0.0	0.9	0.0	0.0	9.6	16.2	0.0	0.5	27.2
2023	0.0	0.0	0.9	0.0	0.0	0.0	19.1	0.0	1.0	21.0
2024	0.0	0.0	0.9	0.0	0.0	0.0	17.9	0.0	1.0	19.8
2025	0.0	0.0	0.9	0.0	0.0	0.0	12.4	0.0	1.0	14.3
2026	0.0	0.0	0.9	0.0	0.0	0.0	10.8	0.0	0.5	12.2
TOTAL	5.3	97.2	25.7	653.4	62.0	1915.0	79.0	2.[illegible]	69.7	2909.4

TABLE F.10. Annual Cost Estimate for the MRS Facility, By Cost Category (millions of constant 1985 dollars)

Design: Sealed Storage Cask Site: Oak Ridge, Tennessee

Fiscal Year	Environmental Evaluations	Design	Regulatory Compliance	Construction	Training and Testing	Operation	Decommissioning	Institutional Interaction	Program Management	Total Program
1986	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.1	1.9	2.8
1987	3.2	8.5	1.5	0.0	0.0	0.0	0.0	0.4	7.0	20.6
1988	1.2	24.2	1.5	0.0	0.0	0.0	0.0	0.4	8.2	35.5
1989	0.4	29.4	1.5	0.0	0.4	0.0	0.0	0.4	8.5	40.6
1990	0.3	23.7	1.5	1.5	0.7	0.0	0.0	0.4	6.7	34.8
1991	0.0	6.5	1.2	36.9	1.4	0.0	0.0	0.4	6.3	52.7
1992	0.0	4.5	0.8	139.9	2.6	0.0	0.0	0.0	6.6	154.4
1993	0.0	0.1	0.8	171.1	5.3	0.0	0.0	0.0	6.2	183.5
1994	0.0	0.0	0.8	171.1	12.1	9.0	0.0	0.0	6.5	199.5
1995	0.0	0.1	0.8	108.4	15.4	11.5	0.0	0.0	4.8	141.0
1996	0.0	0.0	0.4	6.3	24.1	62.2	0.0	0.0	2.2	95.2
1997	0.0	0.0	0.4	0.0	0.0	102.6	0.0	0.0	0.8	103.8
1998	0.0	0.0	0.4	0.0	0.0	135.7	0.0	0.0	0.0	136.1
1999	0.0	0.0	0.4	0.0	0.0	123.7	0.0	0.0	0.0	124.1
2000	0.0	0.0	0.4	0.0	0.0	135.7	0.0	0.0	0.0	136.1
2001	0.0	0.0	0.4	0.0	0.0	90.6	0.0	0.0	0.0	91.0
2002	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2003	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2004	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2005	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2006	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2007	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2008	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2009	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2010	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2011	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2012	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2013	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2014	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2015	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2016	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2017	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2018	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2019	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2020	0.0	0.0	0.4	0.0	0.0	24.6	0.4	0.0	0.0	25.4
2021	0.0	0.0	0.4	0.0	0.0	24.6	1.4	0.0	0.0	26.4
2022	0.0	0.0	0.9	0.0	0.0	9.6	16.2	0.0	0.5	27.2
2023	0.0	0.0	0.9	0.0	0.0	0.0	19.1	0.0	1.0	21.0
2024	0.0	0.0	0.9	0.0	0.0	0.0	17.9	0.0	1.0	19.8
2025	0.0	0.0	0.9	0.0	0.0	0.0	12.4	0.0	1.0	14.3
2026	0.0	0.0	0.9	0.0	0.0	0.0	10.8	0.0	0.5	12.2
TOTAL	5.3	97.2	25.7	635.2	62.0	1915.0	79.0	2.1	69.7	2891.2

TABLE E.11. Annual Cost Estimate for the MRS Facility, By Cost Category (millions of constant 1985 dollars)

Design: Field Drywells Site: Clinch River, Tennessee

Fiscal Year	Environmental Evaluations	Design	Regulatory Compliance	Construction	Training and Testing	Operation	Decommissioning	Institutional Interaction	Program Management	Total Program
1986	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.1	1.9	2.8
1987	3.2	8.5	1.5	0.0	0.0	0.0	0.0	0.4	7.0	20.6
1988	1.2	24.2	1.5	0.0	0.0	0.0	0.0	0.4	8.2	35.5
1989	0.4	29.4	1.5	0.0	0.4	0.0	0.0	0.4	8.5	40.6
1990	0.3	23.7	1.5	1.5	0.7	0.0	0.0	0.4	6.7	34.8
1991	0.0	6.5	1.2	50.0	1.4	0.0	0.0	0.4	6.3	65.8
1992	0.0	4.5	0.8	159.5	2.6	0.0	0.0	0.0	6.6	174.0
1993	0.0	0.1	0.8	195.4	5.3	0.0	0.0	0.0	6.2	207.8
1994	0.0	0.0	0.8	195.4	12.1	0.0	0.0	0.0	6.5	214.8
1995	0.0	0.1	0.8	133.3	15.4	0.0	0.0	0.0	4.8	154.4
1996	0.0	0.0	0.4	6.3	24.1	16.1	0.0	0.0	2.2	49.1
1997	0.0	0.0	0.4	0.0	0.0	80.9	0.0	0.0	0.8	82.1
1998	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
1999	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
2000	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
2001	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2002	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2003	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2004	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2005	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2006	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2007	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2008	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2009	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2010	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2011	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2012	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2013	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2014	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2015	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2016	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2017	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2018	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2019	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2020	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2021	0.0	0.0	0.4	0.0	0.0	24.6	1.5	0.0	0.0	26.5
2022	0.0	0.0	0.9	0.0	0.0	9.6	14.9	0.0	0.5	25.9
2023	0.0	0.0	0.9	0.0	0.0	0.0	17.5	0.0	1.0	19.4
2024	0.0	0.0	0.9	0.0	0.0	0.0	16.4	0.0	1.0	18.3
2025	0.0	0.0	0.9	0.0	0.0	0.0	11.4	0.0	1.0	13.3
2026	0.0	0.0	0.9	0.0	0.0	0.0	9.9	0.0	0.5	11.3
TOTAL	5.3	97.2	25.7	741.4	62.0	1718.0	73.4	2.1	69.7	2794.8

TABLE E.12. Annual Cost Estimate for the MRS Facility, By Cost Category (millions of constant 1985 dollars)

Design: Field Drywells Site: Hartsville, Tennessee

Fiscal Year	Environmental Evaluations	Design	Regulatory Compliance	Construction	Training and Testing	Operation	Decom-missioning	Institutional Interaction	Program Management	Total Program
1986	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.1	1.9	2.8
1987	3.2	8.5	1.5	0.0	0.0	0.0	0.0	0.4	7.0	20.6
1988	1.2	24.2	1.5	0.0	0.0	0.0	0.0	0.4	8.2	35.5
1989	0.4	29.4	1.5	0.0	0.4	0.0	0.0	0.4	8.5	40.6
1990	0.3	23.7	1.5	1.5	0.7	0.0	0.0	0.4	6.7	34.8
1991	0.0	6.5	1.2	48.6	1.4	0.0	0.0	0.4	6.3	64.4
1992	0.0	4.5	0.8	154.3	2.6	0.0	0.0	0.0	6.6	168.8
1993	0.0	0.1	0.8	189.0	5.3	0.0	0.0	0.0	6.2	201.4
1994	0.0	0.0	0.8	189.0	12.1	0.0	0.0	0.0	6.5	208.4
1995	0.0	0.1	0.8	129.1	15.4	0.0	0.0	0.0	4.8	150.2
1996	0.0	0.0	0.4	6.3	24.1	16.1	0.0	0.0	2.2	49.1
1997	0.0	0.0	0.4	0.0	0.0	80.9	0.0	0.0	0.8	82.1
1998	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
1999	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
2000	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
2001	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2002	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2003	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2004	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2005	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2006	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2007	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2008	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2009	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2010	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2011	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2012	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2013	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2014	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2015	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2016	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2017	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2018	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2019	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2020	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2021	0.0	0.0	0.4	0.0	0.0	24.6	1.5	0.0	0.0	26.5
2022	0.0	0.0	0.9	0.0	0.0	9.6	14.9	0.0	0.5	25.9
2023	0.0	0.0	0.9	0.0	0.0	0.0	17.5	0.0	1.0	19.4
2024	0.0	0.0	0.9	0.0	0.0	0.0	16.4	0.0	1.0	18.3
2025	0.0	0.0	0.9	0.0	0.0	0.0	11.4	0.0	1.0	13.3
2026	0.0	0.0	0.9	0.0	0.0	0.0	9.9	0.0	0.5	11.3
TOTAL	5.3	97.2	25.7	717.8	62.0	1718.0	73.4	2.1	69.7	2771.2

TABLE E.13. Annual Cost Estimate for the MRS Facility, By Cost Category (millions of constant 1985 dollars)

Design: Field Drywells Site: Oak Ridge, Tennessee

Fiscal Year	Environmental Evaluations	Design	Regulatory Compliance	Construction	Training and Testing	Operation	Decom-missioning	Institutional Interaction	Program Management	Total Program
1986	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.1	1.9	2.8
1987	3.2	8.5	1.5	0.0	0.0	0.0	0.0	0.4	7.0	20.6
1988	1.2	24.2	1.5	0.0	0.0	0.0	0.0	0.4	8.2	35.5
1989	0.4	29.4	1.5	0.0	0.4	0.0	0.0	0.4	8.5	40.6
1990	0.3	23.7	1.5	1.5	0.7	0.0	0.0	0.4	6.7	34.8
1991	0.0	6.5	1.2	49.1	1.4	0.0	0.0	0.4	6.3	64.9
1992	0.0	4.5	0.8	156.3	2.6	0.0	0.0	0.0	6.6	170.8
1993	0.0	0.1	0.8	191.5	5.3	0.0	0.0	0.0	6.2	203.9
1994	0.0	0.0	0.8	191.5	12.1	0.0	0.0	0.0	6.5	210.9
1995	0.0	0.1	0.8	130.7	15.4	0.0	0.0	0.0	4.8	151.8
1996	0.0	0.0	0.4	6.3	24.1	16.1	0.0	0.0	2.2	49.1
1997	0.0	0.0	0.4	0.0	0.0	80.9	0.0	0.0	0.8	82.1
1998	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
1999	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
2000	0.0	0.0	0.4	0.0	0.0	102.0	0.0	0.0	0.0	102.4
2001	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2002	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2003	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2004	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2005	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2006	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2007	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2008	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2009	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2010	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2011	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2012	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2013	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2014	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2015	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2016	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2017	0.0	0.0	0.4	0.0	0.0	71.0	0.0	0.0	0.0	71.4
2018	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2019	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2020	0.0	0.0	0.4	0.0	0.0	24.6	0.6	0.0	0.0	25.6
2021	0.0	0.0	0.4	0.0	0.0	24.6	1.5	0.0	0.0	26.5
2022	0.0	0.0	0.9	0.0	0.0	9.6	14.9	0.0	0.5	25.9
2023	0.0	0.0	0.9	0.0	0.0	0.0	17.5	0.0	1.0	19.4
2024	0.0	0.0	0.9	0.0	0.0	0.0	16.4	0.0	1.0	18.3
2025	0.0	0.0	0.9	0.0	0.0	0.0	11.4	0.0	1.0	13.3
2026	0.0	0.0	0.9	0.0	0.0	0.0	9.9	0.0	0.5	11.3
TOTAL	5.3	97.2	25.7	726.9	62.0	1718.0	73.4	2.1	69.7	2780.3

TABLE E.14. Sensitivities of Preferred Site-Design Case Cost Estimate to Changes in Staffing Requirements During Facility Operation (millions of constant 1985 dollars)

Design: Sealed Storage Casks Site: Clinch River, Tennessee

Fiscal Year	(1) Total MRS Program	(2) Labor Cost During Operation	(3) Change in Labor Cost due to 10% Change in Staffing Requirements (SR)	(4) Total MRS Program Costs With the Changes In SR: 10% Higher	(5) Total MRS Program Costs With the Changes In SR: 10% Lower	(6) Deviations From Column (1): 10% Higher	(7) Deviations From Column (1): 10% Lower
1986	2.8	0.0	0.0	2.8	2.8	0.0	0.0
1987	20.6	0.0	0.0	20.6	20.6	0.0	0.0
1988	35.5	0.0	0.0	35.5	35.5	0.0	0.0
1989	40.6	0.4	0.0	40.6	40.6	0.1	-0.1
1990	34.8	0.7	0.1	34.9	34.7	0.2	-0.2
1991	53.2	1.4	0.1	53.3	53.1	0.3	-0.3
1992	157.0	2.6	0.3	157.3	156.7	0.2	-0.2
1993	186.6	4.9	0.5	187.1	186.1	0.3	-0.3
1994	193.6	8.5	0.9	194.5	192.8	0.4	-0.4
1995	151.9	11.8	1.2	153.1	150.7	0.8	-0.8
1996	95.2	27.5	2.8	98.0	92.5	2.9	-2.9
1997	103.8	23.2	2.3	106.1	101.5	2.2	-2.2
1998	136.1	28.3	2.8	138.9	133.3	2.1	-2.1
1999	124.1	28.3	2.8	126.9	121.3	2.3	-2.3
2000	136.1	28.3	2.8	138.9	133.3	2.1	-2.1
2001	91.0	28.3	2.8	93.8	88.2	3.1	-3.1
2002	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2003	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2004	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2005	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2006	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2007	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2008	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2009	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2010	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2011	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2012	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2013	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2014	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2015	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2016	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2017	71.4	28.3	2.8	74.2	68.6	4.0	-4.0
2018	25.4	18.3	1.8	27.2	23.6	7.2	-7.2
2019	25.4	18.3	1.8	27.2	23.6	7.2	-7.2
2020	25.4	18.3	1.8	27.2	23.6	7.2	-7.2
2021	26.4	18.3	1.8	28.2	24.6	6.9	-6.9
2022	27.2	6.0	0.6	27.8	26.6	2.2	-2.2
2023	21.0	0.0	0.0	21.0	21.0	0.0	0.0
2024	19.8	0.0	0.0	19.8	19.8	0.0	0.0
2025	14.3	0.0	0.0	14.3	14.3	0.0	0.0
2026	12.2	0.0	0.0	12.2	12.2	0.0	0.0
TOTAL	2902.4	726.2	72.6	2975.0	2829.8	2.5	-2.5

Sources and Notes: Col. (1): from Table F.2; Col. (2): derived from R. M. Parsons 1985; Col. (3): (0.1) x Col. (2); Col. (4): Col. (1) + Col. (3); Col. (5): Col. (1) - Col. (3); Col. (6): [Col. (4)/Col. (1) - 1.0] x 100%; Col. (7): [Col. (5)/Col. (1) - 1.0] x 100%.

TABLE E.15. Sensitivities of Preferred Case Cost Estimate to Changes in Unit Wage Cost During Facility Operation (millions of constant 1985 dollars)

Design: Sealed Storage Cask   Site: Clinch River, Tennessee

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				Changes in	Total MRS Cost With Changes			% Deviations from Column (2)		
Fiscal Year	Adjustment Factor for 1% Escalation	Total MRS Program	Labor Cost During Operation	Labor Cost With 20% Change in Unit Labor Cost	Labor Cost 20% Higher	Labor Cost 20% Lower	1% Real Escalation	Labor Cost 20% Higher	Labor Cost 20% Lower	1% Real Escalation
1986	0.000	2.8	0.0	0.0	2.8	2.8	2.8	0.0	0.0	0.0
1987	0.000	20.6	0.0	0.0	20.0	20.6	20.6	0.0	0.0	0.0
1988	0.000	35.5	0.0	0.0	35.5	35.5	35.5	0.0	0.0	0.0
1989	1.000	40.6	0.4	0.1	40.7	40.5	40.6	0.2	-0.2	0.0
1990	1.010	34.8	0.7	0.1	34.9	34.7	34.8	0.4	-0.4	0.0
1991	1.020	53.2	1.4	0.3	53.5	52.9	53.2	0.5	-0.5	0.1
1992	1.030	157.0	2.6	0.5	157.5	156.6	157.1	0.3	-0.3	0.1
1993	1.041	186.6	4.9	1.0	187.6	185.6	186.8	0.5	-0.5	0.1
1994	1.051	193.6	8.5	1.7	195.3	191.9	194.0	0.9	-0.9	0.2
1995	1.062	151.9	11.8	2.4	154.3	149.5	152.6	1.6	-1.6	0.5
1996	1.072	95.2	27.5	5.5	100.7	89.7	97.2	5.8	-5.8	2.1
1997	1.083	103.8	23.2	4.6	108.4	99.2	105.7	4.5	-4.5	1.9
1998	1.094	136.1	28.3	5.7	141.8	130.4	138.8	4.2	-4.2	1.9
1999	1.105	124.1	28.3	5.7	129.8	118.4	127.1	4.6	-4.6	2.4
2000	1.116	136.1	28.3	5.7	141.8	130.4	139.4	4.2	-4.2	2.4
2001	1.127	91.0	28.3	5.7	96.7	85.3	94.6	6.2	-6.2	3.9
2002	1.138	71.4	28.3	5.7	77.1	65.7	75.3	7.9	-7.9	5.5
2003	1.150	71.4	28.3	5.7	77.1	65.7	75.6	7.9	-7.9	5.9
2004	1.161	71.4	28.3	5.7	77.1	65.7	75.0	7.9	-7.9	6.4
2005	1.173	71.4	28.3	5.7	77.1	65.7	76.3	7.9	-7.9	6.8
2006	1.184	71.4	28.3	5.7	77.1	65.7	76.6	7.9	-7.9	7.3
2007	1.196	71.4	28.3	5.7	77.1	65.7	76.9	7.9	-7.9	7.8
2008	1.208	71.4	28.3	5.7	77.1	65.7	77.3	7.9	-7.9	8.2
2009	1.220	71.4	28.3	5.7	77.1	65.7	77.6	7.9	-7.9	8.7
2010	1.232	71.4	28.3	5.7	77.1	65.7	78.0	7.9	-7.9	9.2
2011	1.245	71.4	28.3	5.7	77.1	65.7	78.3	7.9	-7.9	9.7
2012	1.257	71.4	28.3	5.7	77.1	65.7	78.7	7.9	-7.9	10.2
2013	1.270	71.4	28.3	5.7	77.1	65.7	79.0	7.9	-7.9	10.7
2014	1.282	71.4	28.3	5.7	77.1	65.7	79.4	7.9	-7.9	11.2
2015	1.295	71.4	28.3	5.7	77.1	65.7	79.8	7.9	-7.9	12.7
2016	1.308	71.4	28.3	5.7	77.1	65.7	80.1	7.9	-7.9	12.2
2017	1.321	71.4	28.3	5.7	77.1	65.7	80.5	7.9	-7.9	12.7
2018	1.335	25.4	18.3	3.7	29.1	21.7	31.5	14.4	-14.4	24.1
2019	1.348	25.4	18.3	3.7	29.1	21.7	31.8	14.4	-14.4	25.1
2020	1.361	25.4	18.3	3.7	29.1	21.7	32.0	14.4	-14.4	26.0
2021	1.375	26.4	18.3	3.7	30.1	22.7	33.3	13.9	-13.9	26.0
2022	1.389	27.2	6.0	1.2	28.4	26.0	29.5	4.4	-4.4	8.6
2023	1.403	21.0	0.0	0.0	21.0	21.0	21.0	0.0	0.0	0.0
2024	1.417	19.8	0.0	0.0	19.8	19.8	19.8	0.0	0.0	0.0
2025	1.431	14.3	0.0	0.0	14.3	14.3	14.3	0.0	0.0	0.0
2026	1.445	12.2	0.0	0.0	12.2	12.2	12.2	0.0	0.0	0.0
TOTAL		2902.4	726.2	145.2	3047.6	2757.2	3051.6	5.0	-5.0	5.1

Sources and Notes: Col. (1): $(1.01)^{t-1989}$ where t is year from 1989 on. For 1987 through 1988, the adjustment factor is assigned 1.0. Col. (2): from Table F.2; Col. (3): Derived from R. M. Parsons, 1985; Col. (4): (0.2) x Col. (3); (Col. (5): Col. (2) + Col. (4); Col. (6): Col. (2) - Col. (4); Col. (7): Col. (2) + [Col. (1) - 1.0] x Col. (3). Col. (8): [Col. (5)/Col. (2) - 1.0] x 100; Col. (9): [Col. (6)/Col. (2) - 1.0] x 100; Col. (10): [Col. (7)/Col. (2) - 1.0] x 100.

TABLE E.16. Detailed Spending and Funding Schedules (millions of constant 1985 dollars)

Fiscal Year	Capital-Funded: Facility Construction BA	BO	Facility Modification BA	BO	Casks BA	BO	Operating Expense-Funded: Preoperation Support[(a)] BA	BO	Facility Operation BA	BO	Decommissioning BA	BO	Other Project Support[(b)] BA	BO	Total Project BA	BO
1986	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.2	0.0	0.0	0.0	0.0	5.6	2.6	7.4	2.8
1987	6.2	2.0	0.0	0.0	0.0	0.0	6.7	6.5	0.0	0.0	0.0	0.0	11.9	12.1	24.8	20.6
1988	19.0	17.0	0.0	0.0	0.0	0.0	6.6	7.2	0.0	0.0	0.0	0.0	11.2	11.3	36.8	35.5
1989	23.8	25.0	0.0	0.0	0.0	0.0	5.1	4.8	0.0	0.0	0.0	0.0	10.3	10.8	39.2	40.6
1990	24.4	20.0	0.0	0.0	0.0	0.0	6.4	5.9	0.0	0.0	0.0	0.0	8.7	8.9	39.5	34.8
1991	63.2	37.4	0.0	0.0	0.0	0.0	8.2	7.9	0.0	0.0	0.0	0.0	7.8	7.9	79.2	53.2
1992	148.6	140.7	0.0	0.0	0.0	0.0	8.5	8.9	0.0	0.0	0.0	0.0	7.3	7.4	164.4	157.0
1993	172.2	172.2	0.0	0.0	2.3	0.0	9.1	7.4	0.0	0.0	0.0	0.0	7.1	7.0	190.7	186.6
1994	156.4	172.2	0.0	0.0	9.6	9.5	14.8	14.1	0.0	0.0	0.0	0.0	6.9	7.3	187.7	202.6
1995	83.3	109.1	0.0	0.0	20.1	11.0	22.7	16.7	2.0	0.0	0.0	0.0	4.9	5.6	131.0	142.9
1996	4.2	5.8	0.0	0.0	47.8	46.1	14.3	24.6	28.7	16.1	0.0	0.0	2.3	2.6	97.4	95.2
1997	0.0	0.0	5.3	0.0	52.7	52.7	0.0	0.0	52.8	49.9	0.0	0.0	0.8	1.2	111.6	103.8
1998	0.0	0.0	18.4	21.4	52.7	52.7	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	133.1	136.1
1999	0.0	0.0	12.4	9.4	52.7	52.7	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	127.1	124.1
2000	0.0	0.0	18.4	21.4	44.4	52.7	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	124.8	136.1
2001	0.0	0.0	9.4	9.4	14.7	19.6	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	86.1	91.0
2002	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2003	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2004	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2005	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2006	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2007	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2008	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2009	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2010	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2011	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2012	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2013	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2014	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2015	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2016	0.0	0.0	9.4	9.4	0.0	0.0	0.0	0.0	61.6	61.6	0.0	0.0	0.4	0.4	71.4	71.4
2017	0.0	0.0	7.1	9.4	0.0	0.0	0.0	0.0	47.8	61.6	0.1	0.0	0.4	0.4	60.0	71.4
2018	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.6	24.6	0.4	0.4	0.4	0.4	25.4	25.4
2019	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.6	24.6	0.4	0.4	0.4	0.4	25.4	25.4
2020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.6	24.6	0.6	0.4	0.4	0.4	25.6	25.4
2021	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.8	24.6	5.1	1.4	0.7	0.4	26.6	26.4
2022	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	9.6	17.0	16.2	1.5	1.4	25.6	27.2
2023	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.8	19.1	1.9	1.9	20.7	21.0
2024	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.5	17.9	1.9	1.9	18.4	19.8
2025	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0	12.4	1.8	1.9	13.8	14.3
2026	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.1	10.8	1.0	1.4	9.1	12.2
TOTAL	701.4	701.4	212.0	212.0	297.0	297.0	104.2	104.2	1406.0	1406.0	79.0	79.0	102.8	102.8	2902.4	2902.4

(a) Preoperation support includes costs of design verification, collection of design-related site data, operation contractor support to design ($9.2M) and construction ($10M), and training and testing ($62M).
(b) Other project support includes costs for four categories: Environmental Evaluations, Regulatory Compliance, Institutional Interactions, and Program Management.
BA - Budget authority; BO - Budget outlays.

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U.S. Department of Energy (DOE). 1984. Fund Management Plan. DOE/S-0010/1, Office of Civilian Radioactive Waste Management, Washington, D.C.

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

U.S. Department of Energy (DOE). 1985b. Report of the Task Force on the MRS/Repository Interface. DOE/RW-0044, Washington, D.C.

1) Non-Category I concrete, liner
NRC Casks are Non-Category I

2) Parsons will change

3) Parson sticking with QA III

4) Parsons checking

5) Part 72 will require missile protection

6) Parsons will check

7) No analysis at the moment

8) Parsons will make consistent

9) Ketzlach

10) Parsons will change

11) No alternate in cell, in canyon 2 cranes

12) Jacks will be used.

13) NUREG / CR-1312

14) Parsons checking

15) No cleanup. - Mobile unit.

16) Nicety

17) Parsons looking at

18) Parsons will change

19) Parsons will qualify

20) Metzlach

21) No criticality monitors in casks.
Inconsistant table

22) Parsons checking.

23) Parsons will change. EA will have

ATTACH. (1)

August 2, 1985

EBASCO'S COMMENTS ON THE PRELIMINARY MRS CONCEPTUAL DESIGN REPORT, VOL. II - REGULATORY ASSESSMENT DOCUMENT, REPORT NO. MRS-07, APRIL 1985

1) Page C-4: it is stated that the sealed storage casks and the dry wells have been designated Non-Category I, while Appendix A, page A-60 indiates these to be Category I. We assume the Appendix to be correct. Also, we question why the dry wells have been designated QA level II, and isn't "100% testing of all welds" done for the sealed storage cask as well as the dry wells? o.k.

2) Page C-9: rationale for item 3) Lag Storage Vault HVAC System classification requires additional explanation for the case of loss of this system (i.e., the lag storage without HVAC operational will not result in fuel damage).

3) Page C-10: on item 5), why is the Standby Power System classified QA Level III (i.e., off-the-shelf item) rather than QA Level II? Although not necessarily safety related, loss of power at all systems not connected to UPS could result in undue operations difficulties. — NRC worry ?

Item 7) page C-10 indicates certain Instr. and Control sub-systems are Category I. It should be mentioned that I&C for other QA Level sub-systems [e.g., Item 1) and 6)] will also be QA Lev ` I.

On item 8), justification for the assumption that no fires could result in release of radionuclides or prevent safe shutdown should be provided.

4) Page C-11: on item 15), the instrument air has been designated Non-Category I, yet certain Cat. I systems will require Cat. I instrument air. o.k.

The explosion-detection and suppression systems should be included in this section which discusses "Systems and Components Important to Safety."

5) Page F-7: second paragraph, "designing for tornado missiles is currently not required by 10CFR72" over states the case; as noted on page F-3, only protection from tornado missiles need not be provided. tornado missiles is for dry storage

6) Page F-[illegible] a) the storage of compacted HEPA filters (RHTRU) may pose a fire hazard because of the presence of combustible dust; b) the CHTRU facility will contain up to 25% combustibles (wooden filter frames) which are not incorporated in grout, therefore the fire hazard exists. Are the storage compartments divided by fire walls so that a fire will be confined at one compartment only?

7) Page F-12: item 1) addresses fuel-cladding surface temperature in an inert gas environment during storage. Has any analysis been performed to show that upon slow, gradual loss of the inert gas environment (due to diffusion or leaks), the fuel temperature has decreased sufficiently (in the range of 150°-200°C according to some reports/experience) to permit an air environment during storage without cladding degradation? Also, the fuel cladding temperatures expected when in air in the process cell lag storage, particularly during cell's operations shutdown for various postulated accidents/recovery; as consolidated pins in the canister prior to canister sealing, etc.

8) Page F-14: for the HVAC Supply System, there is no mention of the possibility of bypassing the fans in case of their shutdown during a power failure, while the exhaust fans will continue to operate (as noted on page F-15 and App. A-14). ?

9) Page F-19: in a), criticality evaluations should be limited to all credible potential configurations of fissionable material and potential moderators. In b), low-density water (a 4 to 10% water, air mixture) conditions also need to be considered (see, e.g., Appendix E to ANSI/ANS 57.9-1984). Kelaloch

10) Page F-25: effluent releases during DBA's are not related to ALARA principles. good

11) App. A-24: is there a redundant handling system provided for in-cell handling? o.k.

12) App. A-21: how will the single hatches be moved without use of a crane? o.k.

13) App. A-29: what will a gas sample of cask or drywell indicate, particularly in a concrete cask where the escaped inert gas will diffuse rather rapidly through concrete? Will this be continuous or periodic monitoring? what about liner?

14) App. A-32: water will be present in the dry well before the potential consequences occur; and a gas sample would not necessarily be indicative of the problem. Otherwise, the consequences could include radionuclide release from the drywell, and the potential for criticality as described on page A-60.

15) App. A-33: does the CHTRU facility have the capability of cleanup and decontamination? o.k.

16) App. A-34: water monitoring would be more appropriate than gas sampling. Does the CHTRU facility have drum overpacking capability? Would the drum pallet be replaced if corroded? Once corrosion begins, it is likely to continue in air.

17) App. A-35: where will the fuel removed from cells be placed? Also, the increase of temperature at "centerline" above permissible limits and not at the surface of a HLW canister is of significance (such that is does not reach the melting point of solidified waste). ?

18) App. A-36: a postevent action should also be the manual shutdown of area of operation. o.k.

19) App. A-52: it is stated that the disassembly method precludes Zircaloy fines. This statement should be qualified becuase it is not demonstrated at this time. o.k.

20) App. A-59: maintaining air moisture less than 1% does not appear feasible because a) the supply air to the cells is not treated (dehumidified) and b) the cask venting directly into the cells would bring sudden, uncontrolled increases in cells moisture level. Air at 100% humidity at 90°F contains about .03 pounds of water vapor per pound of dry air (i.e., 3% moisture) and air at 125°F contains about 10% moisture. Note that < 10% water density can pose a criticality problem, as indicated, e.g., in Appendix E to ANSI/ANS 57.9-1984). Kelaloch

21) App. A-60: is there the intent to have criticality monitors in each of the storage units? Also, should there be postevent cleanup actions?

22) App. A-74 and App. A-75: Although the difference in results will be minor, shouldn't 5 yr old PWR fuel be looked at instead of 10 yr old? Justification for the Event 3, 30% and 10% numbers need to be provided; however, it is probably better to assume 100% breach of 100% of the assemblies, as the site boundary dose results would still be quite tolerable. What about particulate release for Event 3?

The possibility of a common mode failure resulting in the drop of up to 4 open canisters (one from each of the process cells) should be addressed.

23) App. A-76: Bases for does rate calculations should be provided. Note that the Dose Rates and Dose columns should be interchanged.

App B

App C

TBF

Concept Design Report
Volume II
Regulatory Assessment Document
(Prepared by Ralph M. Parsons Co.)

APPENDIX D

CODES AND STANDARDS

The MRS Facility shall comply with the appropriate requirements of the regulations, codes, DOE Orders, and specifications listed below.

B.1 Code of Federal Regulations[1]

10 CFR 20, Standards for Protection Against Radiation

10 CFR 50, Domestic Licensing of Production and Utilization Facilities (Appendix B, Quality Assurance, and Appendix E, Emergency Planning)

10 CFR 51, Licensing and Regulatory Policy and Procedures for Environmental Protection

10 CFR 60, Disposal of High-Level Radioactive Wastes in Geologic Repositories

10 CFR 61, Licensing Requirements for Land Disposal of Radioactive Wastes

10 CFR 70, Domestic Licensing of Special Nuclear Material

10 CFR 71, Packaging of Radioactive Materials for Transport

10 CFR 72, Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation (ISFSI)

10 CFR 73, Physical Protection of Plants and Materials

10 CFR 100, Reactor Site Criteria (Appendix A, Seismic and Geologic Siting Criteria)

10 CFR 961, Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste

29 CFR 1910, Occupational Safety and Health Administration (Revised 1981)

36 CFR 1190, Architectural and Transportation Barriers Compliance Board - Minimum Guidelines and Requirements for Accessible Design (Amended 1982)

40 CFR 61, National Emission Standards for Hazardous Air Pollutants

40 CFR 191 (1983 draft), Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes

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[1] 1984 edition unless otherwise noted.

B.2 Nuclear Regulatory Commission (NRC) Regulations

NUREG 0700-1981, Guidelines for Control Room Design Reviews

NUREG 0800-1981, Rev. 4, Standard Review Plan (SRP) for the Review of Safety Analysis Reports for Nuclear Power Plants

Chapter 3, Design of Structures, Components, Equipment, and Systems
- Section 3.3.2 - Tornado Loadings, Rev. 2
- Section 3.7.2 - Seismic System Analysis, Rev. 1
- Section 3.7.4 - Seismic Instrumentation, Rev. 1
- Section 3.8.4 - Other Seismic Category I Structures

Chapter 7, Instrumentation and Controls

B.3 Nuclear Regulatory Commission (NRC) Regulatory Guides

1.3-1974, Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors

1.6-1971, Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution

1.9-1979, Selection, Design, and Qualification of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants

1.13-1981, Rev. 2, Spent Fuel Storage Facility Design Basis

1.17-1973, Protection of Nuclear Power Plants Against Industrial Sabotage

1.21-1974, Rev. 1, Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants

1.23-1980, Onsite Meteorological Programs

1.28-1979, Rev. 2, Quality Assurance Program Requirements (Design and Construction)

1.30-1972, Quality Assurance Requirements for the Installation, Inspection and Testing of Instrumentation

1.32-1976, Criteria for Safety-Related Electric Power systems for Nuclear Power Plants

1.38-1977, Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage, and Handling of Items for Water-Cooled Nuclear Power Plants

1.39-1977, Housekeeping Requirements for Water-Cooled Nuclear Power Plants

1.41-1973, Preoperational Testing of Redundant Onsite Electric Power systems to Verify Proper Load Grout Assignments

1.47-1973, Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems

1.53-1973, Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems

1.59-1977, Rev. 2, Design Basis Floods for Nuclear Power Plants

1.60-1973, Rev. 1, Design Response Spectra for Seismic Design of Nuclear Power Plants

1.61-1973, Damping Values for Seismic Design of Nuclear Power Plants

1.62-1973, Manual Initiation of Protective Actions

1.64-1976, Quality Assurance Requirements for the Design of Nuclear Power Plants

1.68.3-1980, Preoperational Testing of Instrument and Control Air Systems

1.74-1974, Quality Assurance Terms and Definitions

1.76-1974, Design Basis Tornado for Nuclear Power Plants

1.78-1974, Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release

1.86-1974, Termination of Operating Licenses for Nuclear Reactors

1.91-1978, Evaluation of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants

1.92-1976, Rev. 1, Combining Modal Responses and Spatial Components in Seismic Response Analysis

1.93-1974, Availability of Electric Power Sources

1.94-1975, Quality Assurance Requirements for Installation, Inspection, and Testing of Structural Concrete and Structural Steel During the Construction Phase of Nuclear Power Plants

1.97-1981, Rev. 2, Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident

1.105-1981, Instrument Setpoints

1.106-1977, Thermal Overload Protection for Electric Motors on Motor-Operated Valves

1.108-1977, Rev. 1, Periodic Testing of Diesel Generators Used as Onsite Electric Power Systems at Nuclear Power Plants

1.109-1977, Rev. 1, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I

1.110-1976, Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors

1.111-1977, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors

1.112-1977, Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors

1.113-1977, Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I

1.116-1977, Quality Assurance Requirements for Installation, Inspection, and Testing of Mechanical Equipment and Systems

1.117-1978, Tornado Design Classification

1.118-1978, Rev. 2, Periodic Testing of Electric Power and Protection Systems

1.122-1978, Rev. 1, Development of Floor Design Response Spectra for Seismic Design of Floor-Supported Equipment or Components

1.123-1977, Quality Assurance Requirements for Control of Procurement of Items and Services for Nuclear Power Plants

1.128-1977, Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants

1.129-1978, Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants

1.132-1979, Rev. 1, Site Investigations for Foundations of Nuclear Power Plants

1.134-1979, Medical Evaluation of Nuclear Power Plant Personnel Requiring Operator Licenses

1.136-1981, Material for Concrete Containments

1.137-1979, Fuel-Oil Systems for Standby Diesel Generators

1.138-1978, Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants

1.142-1981, Rev. 1, Safety-Related Concrete Structures for Nuclear Power Plants (Other Than Reactor Vessels and Containments)

1.143-1979, Rev. 1, Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants

1.144-1980, Auditing of Quality Assurance Programs for Nuclear Power Plants

1.145-1979, Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants

1.146-1981, Qualification of Quality Assurance Program Audit Personnel for Nuclear Power Plants

1.148-1981, Functional Specification for Active Valve Assemblies in Systems Important to Safety in Nuclear Power Plants

1.151-1983, Instrument Sensing Lines

3.2-1973, Efficiency Testing of Air-Cleaning Systems Containing Devices for Removal of Particles

3.4-1978, Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors

3.6-1973, Content of Technical Specificatins for Fuel Reprocessing Plants

3.7-1973, Monitoring of Combustible Gases and Vapors in Plutonium Processing and Fuel Fabrication Plants

3.9-1973, Concrete Radiation Shields

3.10-1973, Liquid Waste Treatment System Design Guide for Plutonium Processing and Fuel Fabrication Plants

3.12-1973, General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants

3.14-1973, Seismic Design Classification for Plutonium Processing and Fuel Fabrication Plants

3.16-1974, General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants

3.17-1974, Earthquake Instrumentation for Fuel Reprocessing Plants

3.18-1974, Confinement Barriers and Systems for Fuel Reprocessing Plants

3.19-1974, Reporting of Operating Information for Fuel Reprocessing Plants

.20-1974, Process Offgas Systems for Fuel Reprocessing Plants

3.21-1977, Quality Assurance Requirements for Protective Coatings Applied to Fuel Reprocessing and to Plutonium Processing and Fuel Fabrication Plants

3.22-1974, Periodic Testing of Fuel Reprocessing Plant Protection System Actuation Functions

3.27-1977, Rev. 1, Nondestructive Examination of Welds in the Liners of Concrete Barriers in Fuel Reprocessing Plants

3.28-1975, Welder Qualification for Welding in Areas of Limited Accessibility in Fuel Reprocessing Plants and in Plutonium Processing and Fuel Fabrication Plants

3.29-1975, Preheat and Interpass Temperature Control for the Welding of Low-Alloy Steel in Fuel Reprocessing Plants and in Plutonium Processing and Fuel Fabrication Plants

3.30-1977, Selection, Application, and Inspection of Protective Coatings

3.31-1977, Emergency Water Supply Systems for Fuel Reprocessing Plants

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LPI 175

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IMAGE EVALUATION TEST TARGET (MT-3)

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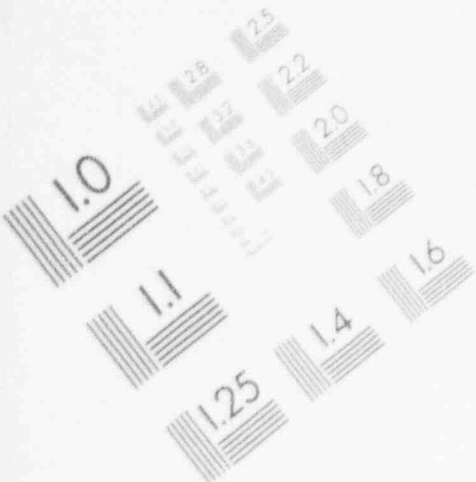

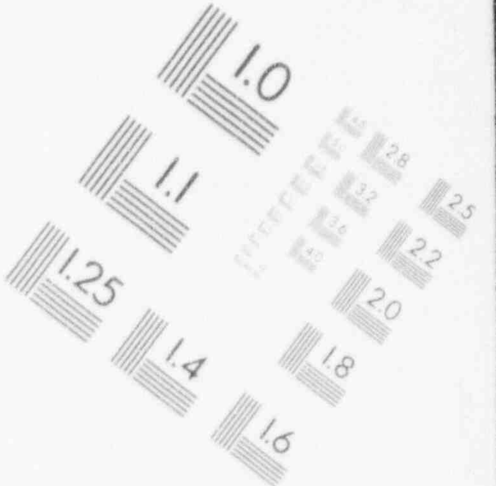

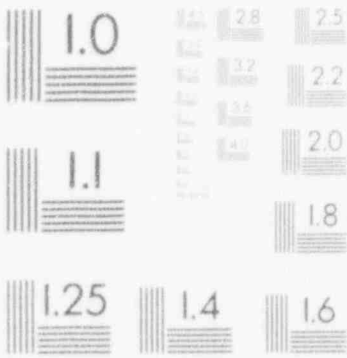

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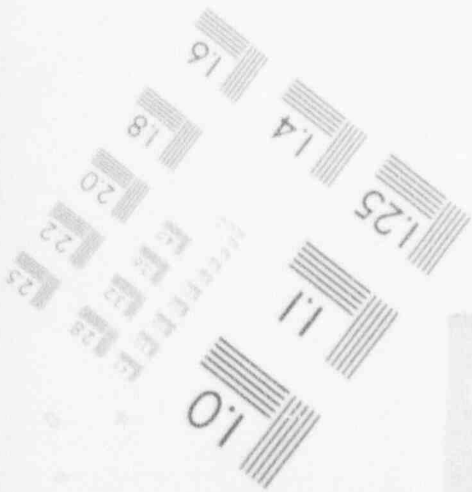

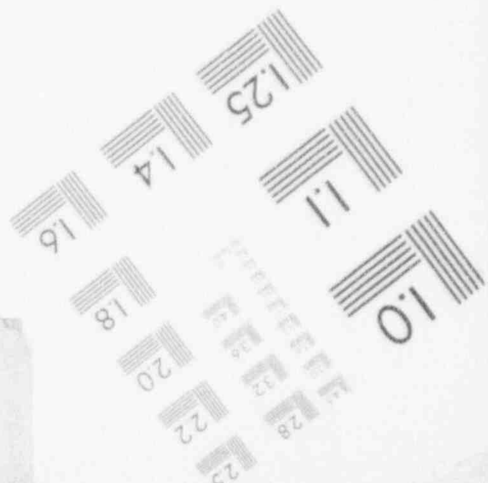

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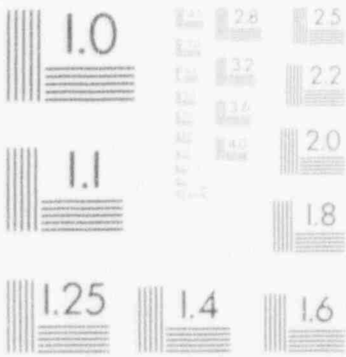

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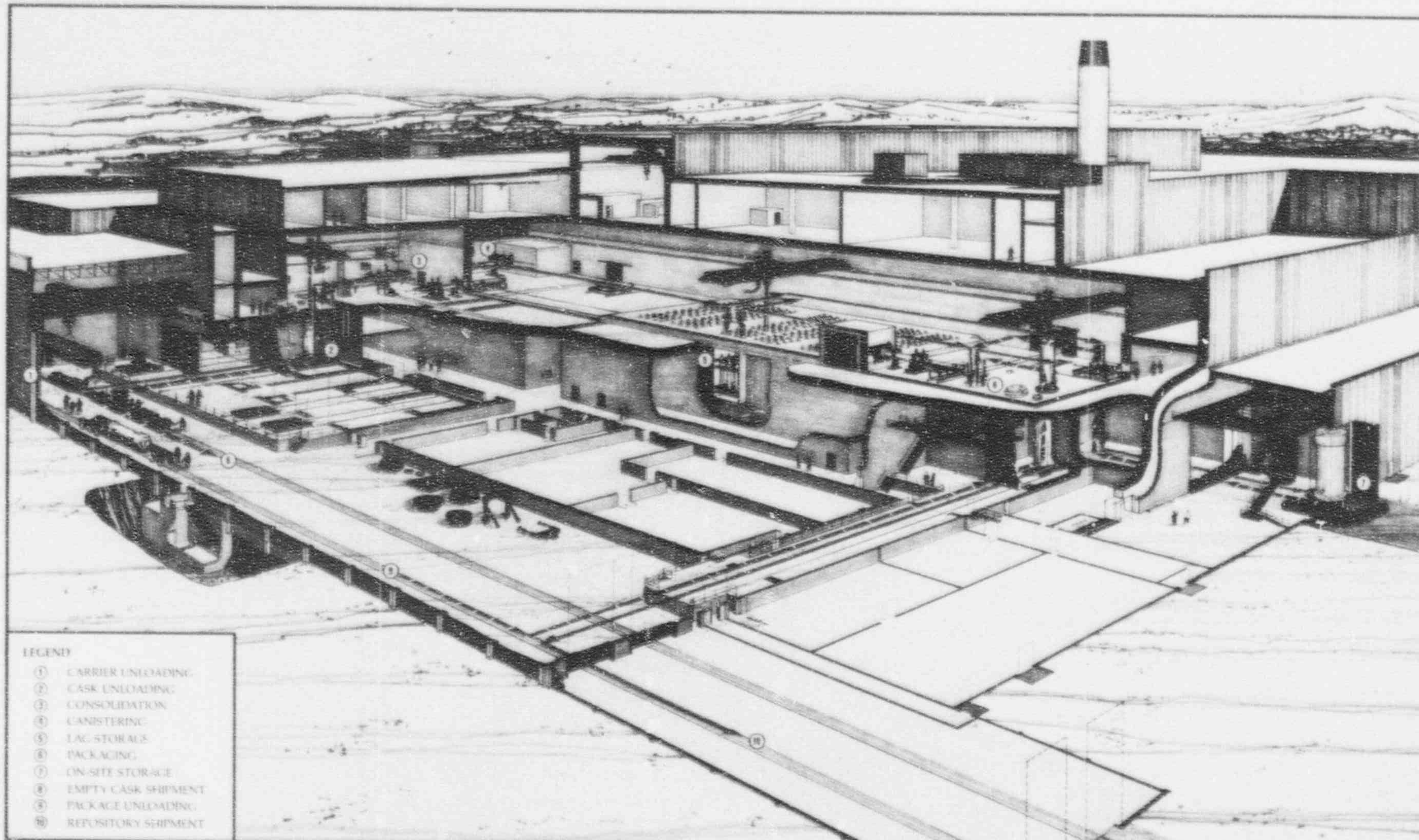

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DOE/RW-0018
Revised Reprint

Draft

Radioactive Waste Management System

Project Decision Schedule

July 1985

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

Draft

DOE/RW-0018
Revised Reprint

Radioactive Waste Management System

Project Decision Schedule

July 1985

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

RADIOACTIVE WASTE MANAGEMENT SYSTEM

DRAFT PROJECT DECISION SCHEDULE

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DRAFT PROJECT DECISION SCHEDULE

ABSTRACT

The Nuclear Waste Policy Act (NWPA) of 1982 (Pub. L. 97-425) requires that the Secretary of Energy prepare, in cooperation with affected Federal agencies, a Project Decision Schedule that portrays the optimum way to attain the operation of geologic repositories. The Draft Project Decision Schedule portrays the major milestones of the Radioactive Waste Management System. It also depicts the set of activities for which Federal agencies have responsibility and the deadlines for taking the required action that are associated with the activities.

The NWPA also requires that Federal agencies having determined that they: 1) cannot comply with a deadline for taking a required action; or 2) fail to comply with a deadline contained in the Project Decision Schedule; submit a comprehensive report to the Secretary of Energy and Congress to explain their failure or expected failure. The Secretary, in turn, is required to submit to Congress a response to the agency's report.

1. PROJECT DECISION SCHEDULE - SCOPE AND APPLICABILITY

The Nuclear Waste Policy Act (NWPA) of 1982 (Pub. L. 97-425), in Section 114(e) (the full text of Section 114(e) is found in Appendix A), requires the Secretary of Energy (the Secretary) to prepare, in cooperation with all affected Federal agencies, a Project Decision Schedule that is to portray the optimum way to attain the operation of a geologic repository by January 1998. The Project Decision Schedule provides for the following:

1) Portrayal of the optimum schedule for the attainment of operation of the geologic repository involved;

2) Identification of, on an agency-by-agency basis, the key activities, decision points, and deadlines for Federal agency actions to be taken throughout the course of the development and operation of the system;

3) A notification mechanism to alert the Secretary and Congress as to potential or actual delays in the program that may be caused by the failure of an agency to take a specified action within the time frame established by the Project Decision Schedule. The report to be submitted shall contain the following:

   o An explanation for the failure or expected failure of a Federal agency to perform a specified action;

   o The reason(s) why an agreement could not be reached with the Secretary regarding a modification to the Project Decision Schedule;

- o The estimated time for completion of the action(s) required;
- o The effect that this failure will have on its other deadlines in the Project Decision Schedule; and
- o Any recommendations or changes in either operations, organization, or statutory authority that would mitigate the delay(s).

The Secretary is then required to submit to Congress, within 30 days of receipt of such report by the agency, a response which shall include the reasons why the Project Decision Schedule could not be amended; and

4) Updating on either a periodic or on as needed basis.

1.1 Other NWPA Authorities Related to the Project Decision Schedule

The NWPA also provides, in Section 120, for expedited consideration of ancillary requirements (e.g., granting of rights-of-way, issuance of permits, leases, etc.) related to site characterization, construction, or operation of a repository as authorized by the NWPA. Section 120 requires any Federal agency, with the exception of the Nuclear Regulatory Commission (NRC), having jurisdiction over the issuance of any type of authorization, as noted above, to expedite its issuance and to give it priority consideration over other similar applications not related to the siting, construction, or operation of a repository.

The full text of Section 120 is found in Appendix B.

1.2 Federal Agency Reporting Requirements

The Project Decision Schedule addresses those components of the Radioactive Waste Management System that span all functions from acceptance of spent nuclear fuel and high-level radioactive waste to final disposal in a geologic repository. These components are:

1. First Geologic Repository;
2. Second Geologic Repository;
3. Transportation Subsystem; and
4. Monitored Retrievable Storage Program.

Tables 1-4 identify those specific activities that Federal agencies have responsibility for that are critical to the development and operation of the Radioactive Waste Management System. Only those activities so noted by an asterisk are subject to the reporting requirements contained in Section 114(e)(2) of the NWPA. Activities that are not so identified in the tables as being critical Federal agency activities are shown for completeness and as an aid to understanding the overall program schedule.

The Department believes that, in addition to the issuance of regulations, permits, standards, and licenses, it is also essential for affected Federal agencies to review and comment on major program documents as provided for in Tables 1-4. The Department is of the opinion that such interaction is of significant importance to the continued on-time development of the Radioactive

Waste Management System. The Department believes that the insights that affected Federal Agencies can provide to the Department during the course of a review and comment period for a program document with regard to their own programs or statutory responsibilities will be of considerable assistance as the program moves forward.

The Project Decision Schedule only applies to affected Federal agencies and is derived from the reference schedules contained in the Mission Plan.[1] The Department believes that the reference schedules contained in the Mission Plan have been optimized to the extent possible at this time.

As discussed above, Section 114(e)(2) requires that any Federal agency that determines that it cannot comply with any deadline in the Project Decision Schedule, or fails to so comply, to submit a report to the Secretary and Congress explaining the reason for such actual or potential failure.

However, before such a report is submitted, Section 114(e)(2) of the NWPA infers that the affected agency and the Department will have attempted to resolve the potential failure to comply with a deadline contained in the Project Decision Schedule. The Department believes that the activities for which Federal agencies have responsibility for taking action and the deadlines for such actions are explicit and provide adequate notice as to when Federal

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[1]<u>The Mission Plan for the Civilian Radioactive Waste Management Program</u> (Mission Plan). (DOE/RW 0005, June 1985). This document provides a comprehensive discussion of the Office of Civilian Radioactive Waste Management program strategy, a detailed discussion of program plans, and reference schedules for the development of geologic repositories, the transportation subsystem, and a Monitored Retrievable Storage facility.

agency actions are required. The Department would, therefore, anticipate receiving notice at an early date as to their potential failure to comply so that discussions leading to resolution or mitigation of the effects of the failure to take the required action can be initiated. Such discussions may lead to corrective actions that can be taken that may obviate the need for the formal report required by Section 114(e)(2).

1.3 Department of Energy Reporting Requirements

1.3.1 Departmental Reporting Required by Section 114(e)

The Secretary, after receiving a report from an affected Federal agency that has determined either that it cannot comply or has failed to comply with a deadline for taking action as specified in the Project Decision Schedule, is required to file a response to that report with Congress. Such response is to contain the reasons why the Project Decision Schedule could not be amended to accommodate the requirements of the Federal agency involved.

1.3.2 Other Departmental Reporting Requirements

The Department, while not required by Section 114(e)(2) to report to Congress in the same manner as the affected agencies, has its reporting responsibilities specified elsewhere in the NWPA.

The Civilian Radioactive Waste Management Program is required, for example, to prepare and submit to Congress a Mission Plan, an Annual Report on the activities and expenditures of the Radioactive Waste Management Program, and an Annual Fee Adequacy Report. The Department also is required to apprise Congress regarding the status and proposed plans of the program through a number of reports such as the Test and Evaluation Facility (TEF) Report, Monitored Retrievable Storage (MRS) Needs and Feasibility Study, Federal Interim Storage Fee Study, and the Alternative Means for Financing and Managing Radioactive Waste Facilities Report (AMFM Panel Report).

There is continuing interaction with Congress through the appropriation process and through the Department's transmittal to Congress of major program documents required to be developed by the NWPA not mentioned above such as the Siting Guidelines and the Draft Environmental Assessments (EAs) for the First Geologic Repository sites. Other major program documents, as they are developed, will be transmitted to Congress for their information. The Department will, through the Annual Report, report to Congress any significant changes in the schedule, and the reasons therefore, that could adversely affect critical, legislated milestones. The Department is also planning to submit the Project Decision Schedule and any modifications thereto to the appropriate Congressional committees.

1.4 Limitation of Applicability

1.4.1 General

The Project Decision Schedule will only display schedules associated with the "Authorized" plan as discussed in the Mission Plan. The Mission Plan recognizes the potential for the application of an "Improved Performance" plan and a number of contingency plans. Should any of these become the "Authorized" plan, the Project Decision Schedule will be so modified as provided for in Section 3 to reflect the change. Figure 1 displays the Radioactive Waste Management Program as discussed in the Mission Plan.

1.4.2 Monitored Retrievable Storage and Second Geologic Repository Program

At this time, the Department does not have Congressional authorization to proceed beyond the development and submission to Congress of a proposal, including an Environmental Assessment and "Needs and Feasibility Study" (Discussed further in Section 9.1) relating to an Monitored Retrievable Storage (MRS) facility.[1] Similarly, the Department does not have authority to construct a Second Geologic Repository. The Department can, however, carry out all functions related to the Second Geologic Repository up to the point of actual construction. In the case of the MRS Program, the proposal recommending the construction of an MRS facility will be submitted in January 1986. With regard to the Second Geologic Repository program, the request for Congressional authorization to construct is scheduled to be submitted in June 1993 with receipt of Construction Authorization from NRC not scheduled until August 2000. Therefore, at this time, the schedules for activities associated with the MRS Program and the Second Geologic Repository Program are carried

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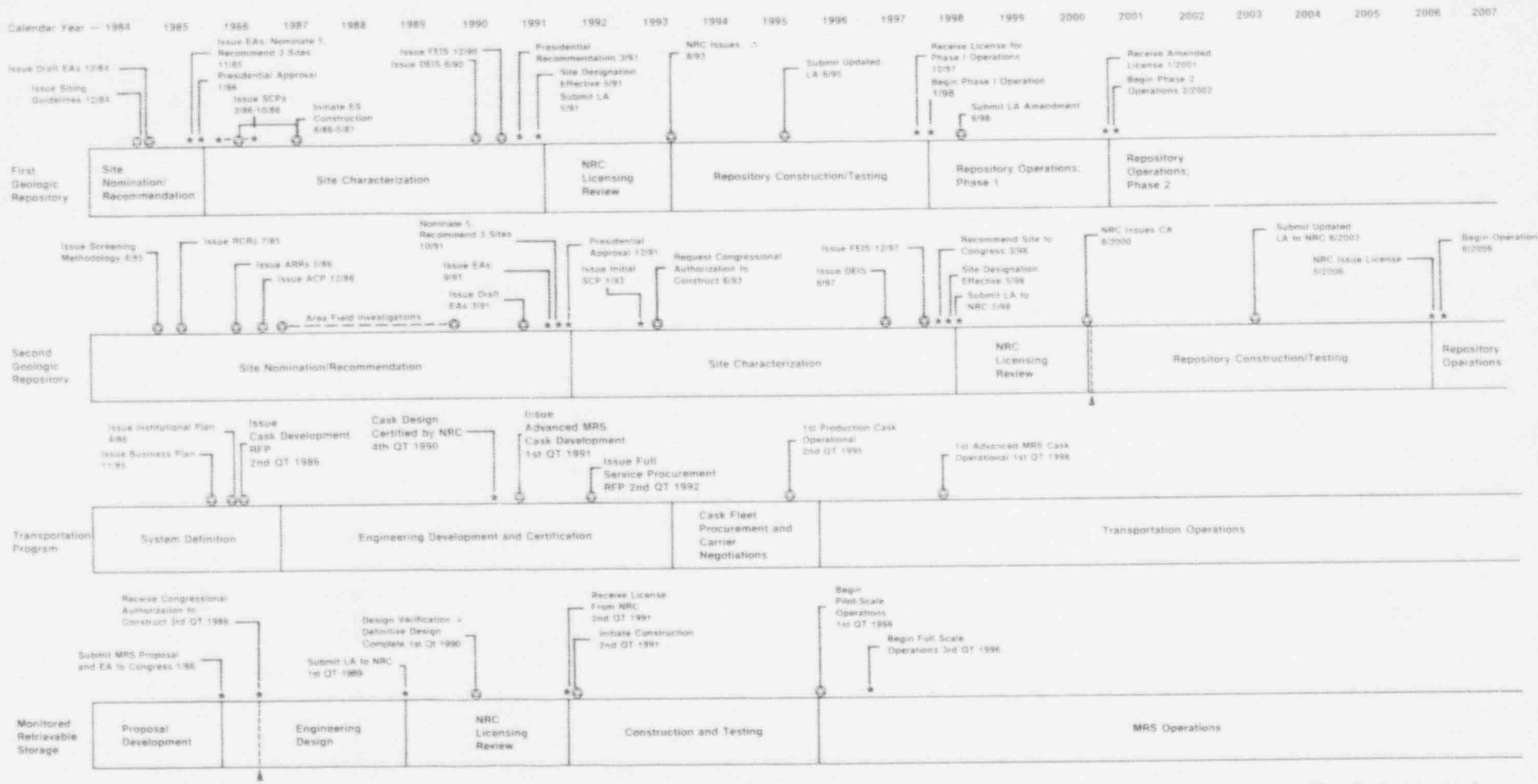
[1]The provisions of Section 114(e) of the NWPA do not apply to the MRS program at this time. It is, however, incorporated in the Project Decision Schedule for completeness. Should Congress authorize construction of an MRS facility that will perform the functions described in the Mission Plan, the MRS facility would then become an integral part of the Radioactive Waste Management System and will, therefore, be subject to the provisions of Section 114(e).

Figure 1

Office of Civilian Radioactive Waste Management Program Schedule



Footnote: Activities shown in this Program Schedule include those described in the "Improved Performance" plan discussed in the Mission Plan and are included here for completeness and context. The Symbol ▲ denotes points beyond which the Project Decision Schedule does not consider scheduled activities. In the Second Geologic Repository Program, the PDS does not address activities scheduled to take place subsequent to the issuance of NRC Construction Authorization. With regard to the Monitored Retrievable Storage Program, no activities are shown that are scheduled to take place subsequent to the receipt of Congressional Authorization to construct.

ACP - Area Characterization Plan
ARR - Area Recommendation Report
CA - Construction Authorization
DEIS - Draft Environmental Impact Statement
EA - Environmental Assessment
ES - Exploratory Shaft
FEIS - Final Environmental Impact Statement
LA - License Application
RCR - Regional Characterization Report
SCP - Site Characterization Plan
* - Key Milestone/Decision
⊙ - Major Milestone on Critical Path

only up to, in the case of the MRS Program, the submission of the proposal and EA to Congress in January 1986, and in the case of the Second Geologic Repository Program, the receipt of construction authorization from NRC in August 2000. Should Congress authorize further activity in either of the program areas, the Project Decision Schedule will be modified, in cooperation with the affected Federal agencies, to include schedules of MRS and Second Geologic Repository activities requiring Federal agency action.

1.4.3 Other Radioactive Waste Management Programs Not Considered in the Project Decision Schedule

In addition to the aforementioned aspects of the MRS and Second Geologic Repository Program, the Project Decision Schedule does not address a number of other activities provided for by the NWPA. Not included in the Project Decision Schedule are the research and development program, the Federal Interim Storage Program, the development of a Test and Evaluation Facility, and international activities. Although all of these activities are components of the Civilian Radioactive Waste Management Program, they are not included in the Project Decision Schedule because they do not, at this time, directly support the attainment of repository operations.

1.5 States and Affected Indian Tribes

Section 114(e) of the NWPA focuses only on Federal agency interactions. Accordingly, the Project Decision Schedule only incorporates schedules that specifically relate to Federal agency involvement in the Civilian Radioactive Waste Management Program.

2. PROJECT DECISION SCHEDULE - SCHEDULE DEVELOPMENT

The Federal agency activities and schedules depicted in the draft Project Decision Schedule are derived from the current reference schedule as identified in the Mission Plan. This reference schedule will become the schedule relating to the implementation of the "Authorized" plan for the Radioactive Waste Management Program and, in accordance with Section 301(b)(3) of the NWPA, ". . . shall be used by the Secretary at the end of the first period of 30 calendar days . . . following receipt of the Mission Plan by the Congress." The reference schedule was developed through analyses of the activities required to develop and operate the Radioactive Waste Management System.

The Department considered a number of elements during the course of the development of the reference schedule. Specifically, the Department:

- Recognized its commitment to the January 1998 requirement to initiate operations of the Radioactive Waste Management System and the acceptance of spent nuclear fuel and high-level radioactive waste;

- Examined the steps that lead to the beginning of repository operations, organizing these into major phases.

- Developed logic networks for each phase to identify sequential relationships of major activities and their interrelationships.

- Developed estimates of time durations for each phase and the critical activities within each phase.

- Considered and analyzed alternative cases, as discussed in the Mission Plan, that could potentially accelerate or delay activities, the schedule, and/or the date of initiation of operations;

- Selected a reference schedule which is consistent with the Department'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.

2.1 Planned Schedule Analysis

The Department will, in the future, make use of an integrated logic network to assist the program in the implementation of the requirements of the NWPA. A preliminary version of the program logic network, currently being developed further, is shown in Figure 2. It is the Department's intention to develop a program-wide activity and schedule network based on the logic network, that will:

1) determine activity durations, slack times, early and late start and finish dates;

2) identify the activities that are on the critical path of the program;

3) define programmatic interfaces; and

4) allow for revisions to be made in the schedule network that will permit the Department to analyze the schedule impacts of changes in the status of the program and/or the use of alternative cases or contingency plans.

The integrated logic network will form the basis for the further development of the overall program schedule which will be issued by the Office of Civilian Radioactive Waste Management as a separate document. Initially this schedule will be based on the reference schedules associated with the "Authorized" Plan contained in the recently issued Mission Plan and in this Project Decision Schedule.

3. PROJECT DECISION SCHEDULE-REVIEW AND MODIFICATION

3.1 General

In accordance with the provisions contained in Section 114(e) of the NWPA, the Department has developed the Project Decision Schedule in cooperation with affected Federal agencies. Any modification of the Project Decision Schedule will also be undertaken in cooperation with the Federal agencies.

3.2 Periodicity of Review

The Department will, on an annual basis, assess the need for modification of the Project Decision Schedule. The Department will conduct this assessment in cooperation with the affected Federal agencies.

FIGURE 2
RADIOACTIVE WASTE MANAGEMENT SYSTEM PROGRAM LEVEL LOGIC NETWORK

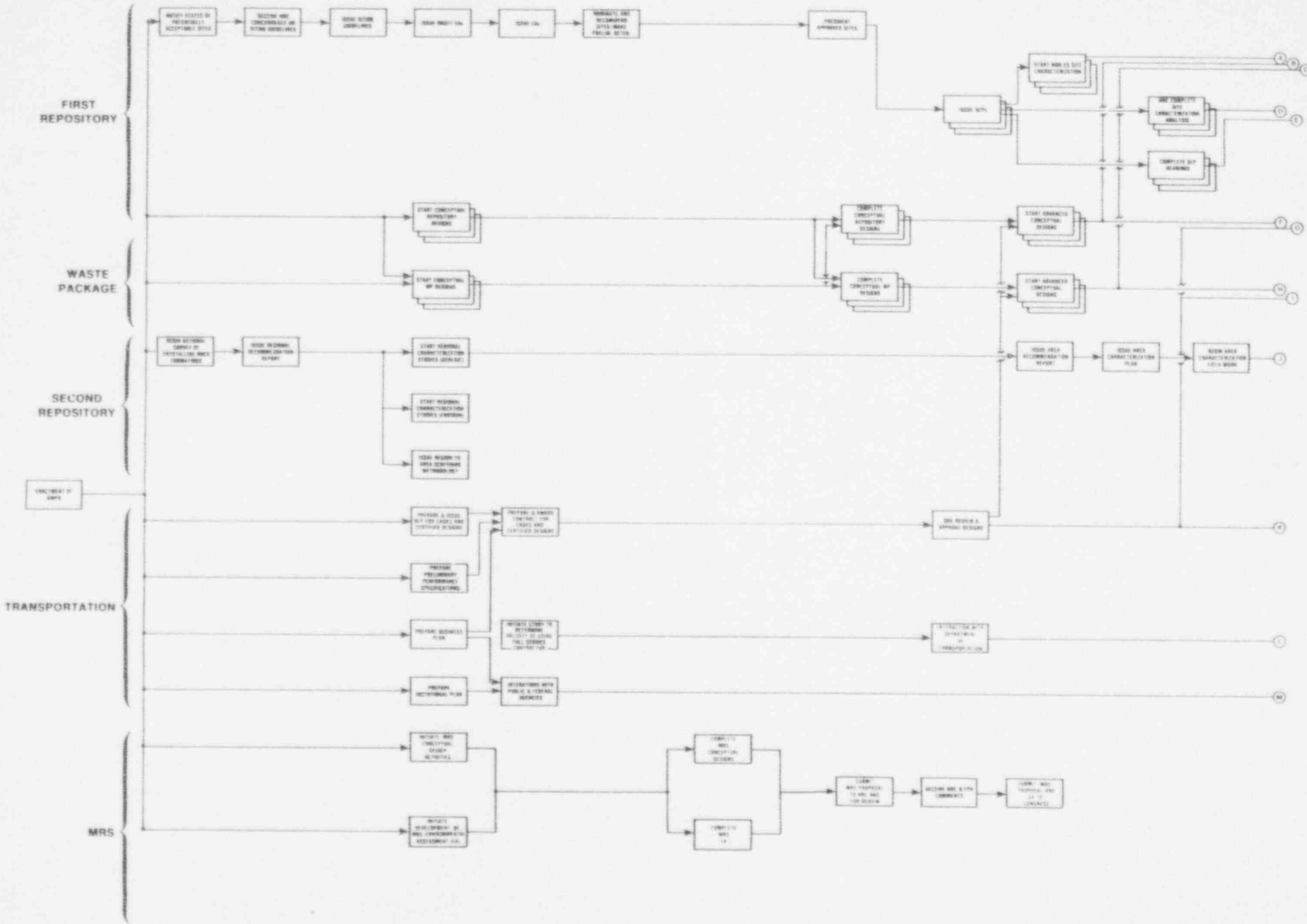


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FIGURE 2
RADIOACTIVE WASTE MANAGEMENT SYSTEM PROGRAM LEVEL LOGIC NETWORK (Continued)

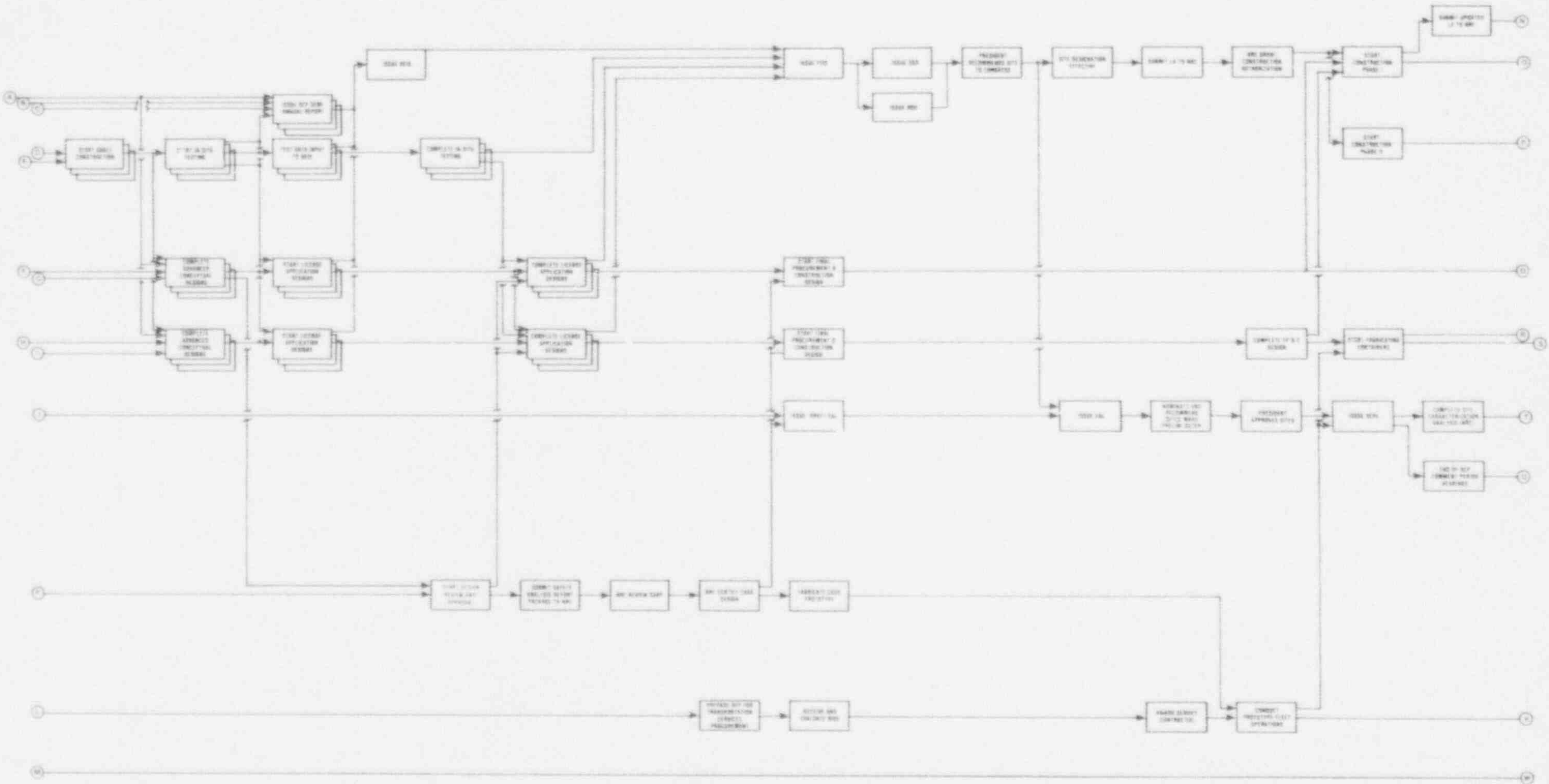
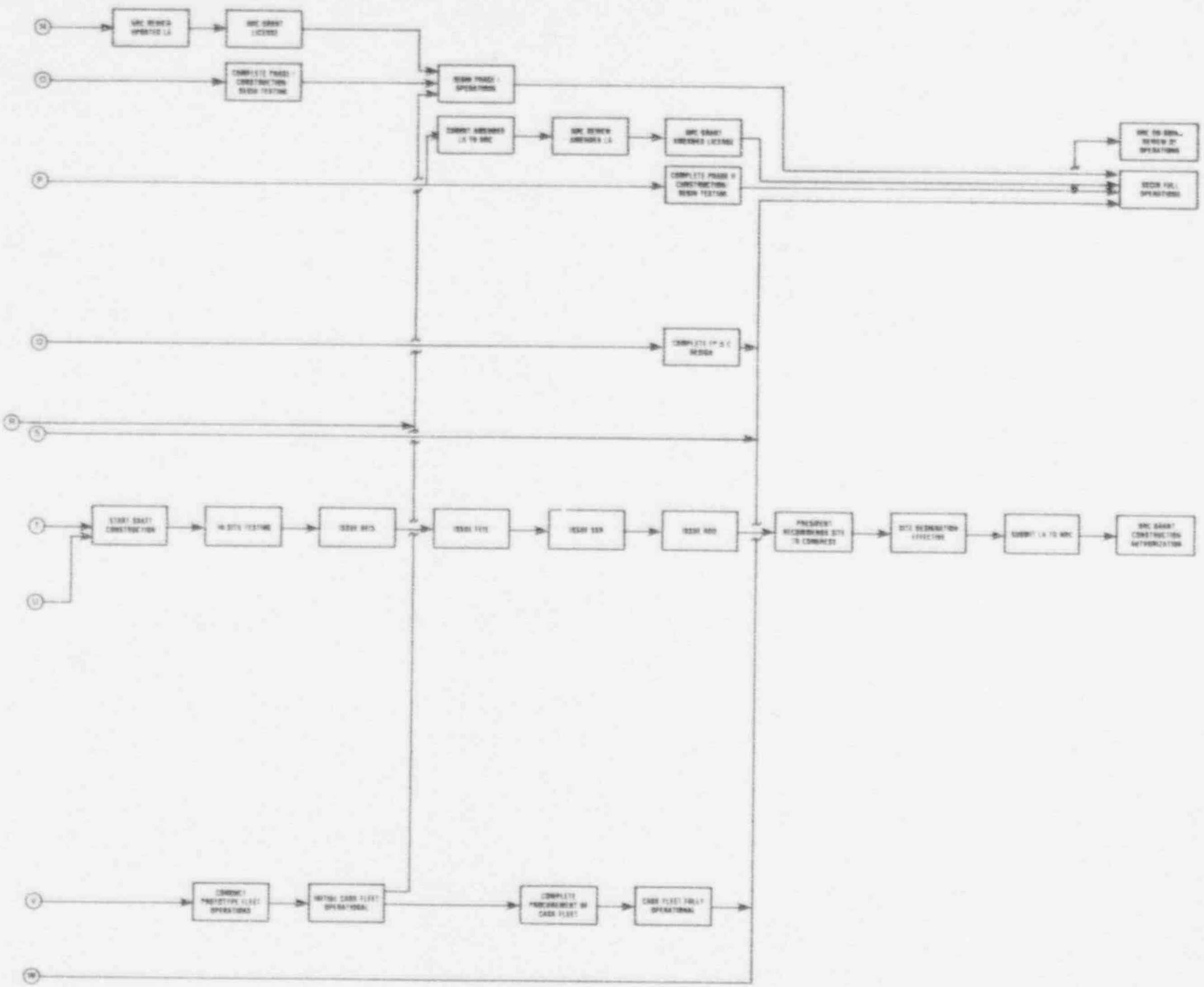


FIGURE 2
RADIOACTIVE WASTE MANAGEMENT SYSTEM PROGRAM LEVEL LOGIC NETWORK (Continued)



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3.3 Modification of the Project Decision Schedule

The Department, in cooperation with affected Federal agencies, intends to modify the Project Decision Schedule when one of the following occur:

1) The Department changes the scope and/or schedule of the Radioactive Waste Management Program;

2) An affected Federal agency notifies the Department that it cannot comply with a provision contained in the Project Decision Schedule. Should the Department and the affected Federal agency agree on a new milestone date, a letter amendment to the Project Decision Schedule will be issued to affected Federal agencies. Any letter amendment issued will be incorporated into the Project Decision Schedule when a major revision of the schedule is undertaken;

3) Federal statutes and/or regulations that may affect the Radioactive Waste Management System schedule are enacted or amended. Should this occur, affected Federal agencies should bring such changes and their possible effects to the attention of the Department;

4) Schedule extensions permitted by the NWPA occur (e.g., Presidential extension of time permitted for nomination, Congressional action upholding a notice of disapproval, etc.); or

5) the annual assessment indicates a need for a revision to the Project Decision Schedule.

4. FEDERAL AGENCY ACTIVITIES AND REQUIREMENTS

The Project Decision Schedule, in Tables 1-4, provides a detailed, sequential listing of all program activities, including those for which the Department has identified a specific role for the affected Federal agencies and the associated deadline for taking action. Table 1 provides a listing of the activities associated with the development and operation of the First and Second Geologic Repository. Table 2 relates to the Transportation Subsystem. Table 3 addresses the Monitored Retrievable Storage Program. Table 4 provides a cross-cutting view of the activities that Federal agencies are specifically responsible for on an agency-by-agency basis.

As discussed before in Section 1.2, only the activities that are identified in the tables as being a critical activity are subject to the reporting requirements of Section 114(e)(2) of the NWPA.

5. COMPONENTS OF THE RADIOACTIVE WASTE MANAGEMENT SYSTEM

As noted before, the Project Decision Schedule addresses those components of the Radioactive Waste Management System that span all functions from acceptance of spent nuclear fuel and high-level radioactive waste to final disposal in a geologic repository. These components are:

1. First Geologic Repository;
2. Second Geologic Repository;
3. Transportation Subsystem; and
4. Monitored Retrievable Storage Program.

6. FIRST GEOLOGIC REPOSITORY

6.1 First Geologic Repository Overview

The mission of the Department's geologic repository program is to develop geologic repositories for the permanent disposal of high-level radioactive waste and spent nuclear fuel in a manner that fully protects the health and safety of the public, the quality of the environment, and in a time frame responsive to national needs.

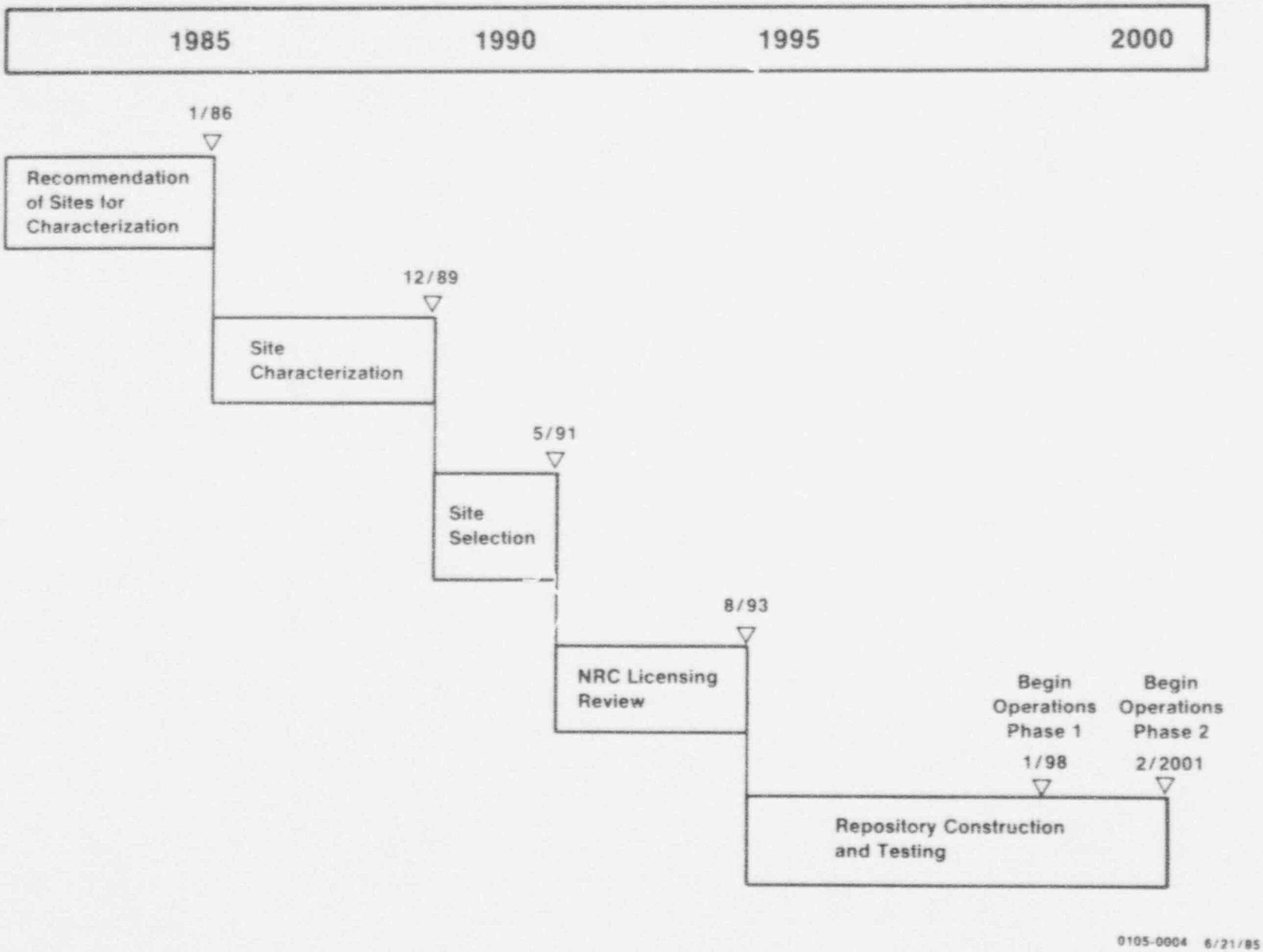
During the development of the Mission Plan, the Department examined the steps which lead to the initiation of operations of a geologic repository and analyzed various alternative schedules for accomplishing those steps. Based on that analysis, a reference schedule was selected for the First Geologic Repository Program and is shown in Figures 4 and 5 (also see Section 2, Project Decision Schedule-Schedule Development).

As shown in Figure 3, the Department has divided the First Geologic Repository program into five major phases:

1. Recommendation of Sites for Characterization;
2. Site Characterization;
3. Site Selection;
4. NRC Licensing Review; and
5. Repository Construction and Testing.

Each phase and associated major milestones are summarized below.

FIGURE 3
REFERENCE SCHEDULE FOR FIRST GEOLOGIC REPOSITORY



6.2 Phase 1 - Recommendation of Sites for Characterization

The Department is currently conducting those activities associated with the first phase of the repository program. As a first step in the process leading to the Presidential recommendation of sites to be characterized, the Department issued final siting guidelines in December 1984. These siting guidelines were utilized in developing the Environmental Assessments which addressed site specific issues. The EAs were issued in draft form for public comment in December 1984. The Department is currently in the process of reviewing and considering comments received during the public comment period and is planning on issuing the EAs in November 1985.

Using the EAs, the Secretary will nominate at least five and recommend three sites for site characterization in November 1985. At that time, the Secretary will make a Preliminary Decision as to site suitability as required by Section 114(b) of the NWPA.

Upon approval by the President of the sites for characterization, Phase 1 will be completed.

The specific milestones for Phase 1 are as follows:

- o Issuance of the Siting Guidelines: December 1984.
- o Issuance of the Draft EAs: December 1984.
- o Issuance of the EAs: November 1985.
- o Secretarial Nomination and Recommendation of candidate sites: November 1985.

- Secretarial Preliminary Determination as to site suitability: November 1985
- Presidential approval of the recommended sites: January 1986.

6.3 Phase 2 - Site Characterization

Site Characterization Plans describing the testing program for each site will be issued during Phase 2. After obtaining the required permits and following the procedures contained in Section 113 of the NWPA related to public comment, the Department will begin construction of the exploratory shafts. The work on the shafts includes drilling or mining followed by lining and outfitting of the shafts with utility and service lines. Subsurface drifts would then be excavated, and, finally, test equipment would be installed.

Both surface testing and in-situ testing will be conducted at each of the three sites approved for characterization to determine site suitability. This information will be used in the License Application (LA) along with any additional data that are gathered while the Draft Environmental Impact Statement (DEIS) is being prepared and issued. During Phase 2, the development of repository designs will continue and laboratory testing of site samples will be performed. In addition, laboratory testing to evaluate the performance of materials planned for use as engineered barriers will also be performed. Additional testing to support the LA will continue into Phase 3. Phase 2 will be completed when sufficient testing has been performed to support the DEIS.

The specific milestones for Phase 2 are as follows:

- o Site Characterization Plans are issued in March 1986 for Basalt, March 1986 for Tuff, and October 1986 for Salt.
- o The permitting process for any Salt site, which have the most extensive permitting requirements, is completed by July 1987.
- o Construction of the initial exploratory shaft begins in August 1986 for Basalt, August 1986 for Tuff, and July 1987 for Salt.
- o Testing to support the draft EIS is completed in December 1989.

6.4 Phase 3 - Site Selection

During Phase 3, the Department will prepare and issue a DEIS based on the data compiled during the in-situ testing period. Upon the close of the public comment period for the DEIS, the Department will review and consider all comments received from Federal agencies, States, affected Indian Tribes, other interested parties, and members of the public. The Final Environmental Impact Statement (FEIS) will then be issued along with a Site Selection Report (SSR) as required by the NWPA. No sooner than thirty days after the issuance of the FEIS, the Department will issue a Record of Decision (ROD) as required by 40 CFR Part 1505. Subsequent to the issuance of the ROD, the Secretary shall recommend one repository site to the President. The President shall then recommend the first repository site to Congress.

The NWPA provides that a State and/or affected Indian Tribe on whose land or reservation the recommended site is located, may submit to Congress, within sixty days, a notice of disapproval of the site recommended for repository development. If no notice of disapproval is filed, then the site designation takes effect sixty days after the site is recommended by the President to Congress. If a notice of disapproval is filed, Congress has ninety days of continuous session to act on the notice. If Congress overrides the notice of disapproval by a joint resolution, the site designation becomes effective. If Congress does not override the disapproval, the disapproval stands and the President must recommend another site not later than 1 year after the disapproval.

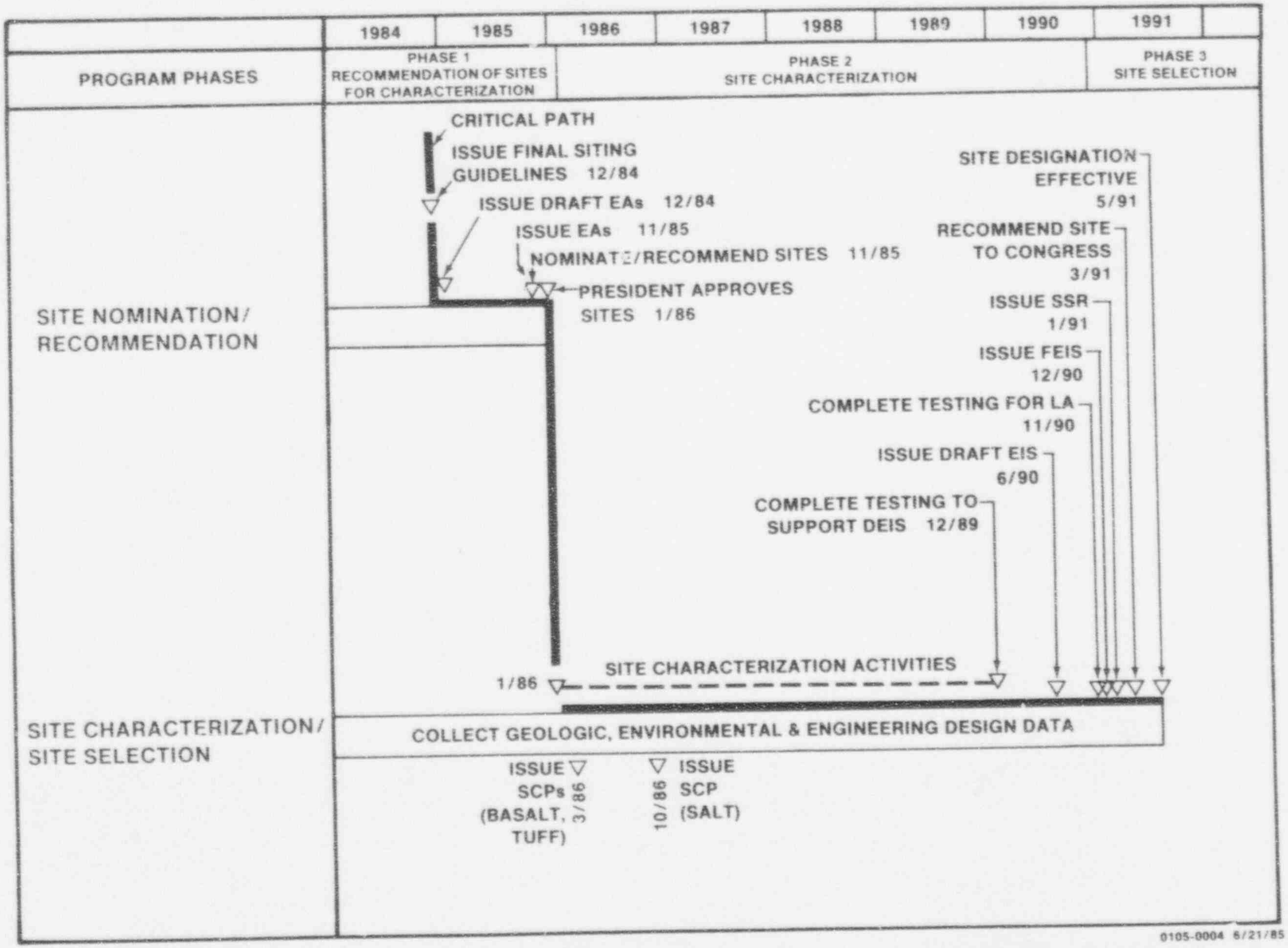
The reference schedule assumes that the site designation will take effect sixty days after the site is recommended to Congress by the President and that no notice of disapproval is filed by a State or affected Indian Tribe. The Department has not assumed a notice of disapproval in the reference schedule. Phase 3 will be completed when the site designation is effective.

The specific milestones for Phase 3 are as follows:

- o The DEIS is issued by June 1990.
- o The FEIS is issued by December 1990.
- o The Site Selection Report is issued in January 1991.
- o The President recommends the site by March 1991.
- o Site designation is effective May 1991.

The Reference Schedules for Phases 1, 2, and 3 are depicted in Figure 4.

FIGURE 4
FIRST GEOLOGIC REPOSITORY
SITE RECOMMENDATION, CHARACTERIZATION AND SELECTION PHASES



6.5 Phase 4 - NRC Licensing Review

Following site approval and site designation, the Department will submit an (LA) for the construction of a repository to NRC. The NWPA allows the NRC a three year review period. It also authorizes them to extend its review by one year, if needed.

The specific milestones for Phase 4 are as follows:

- The LA is submitted in May 1991;
- NRC review of the LA is completed by August 1993; and
- NRC issues a Construction Authorization in August 1993.

The reference schedule assumes that NRC will take twenty-seven months to issue the Construction Authorization.

It should also be noted that NRC licensing activities do not terminate at the end of this phase, rather they continue during the repository construction and testing phase.

6.6 Phase 5 - Construction

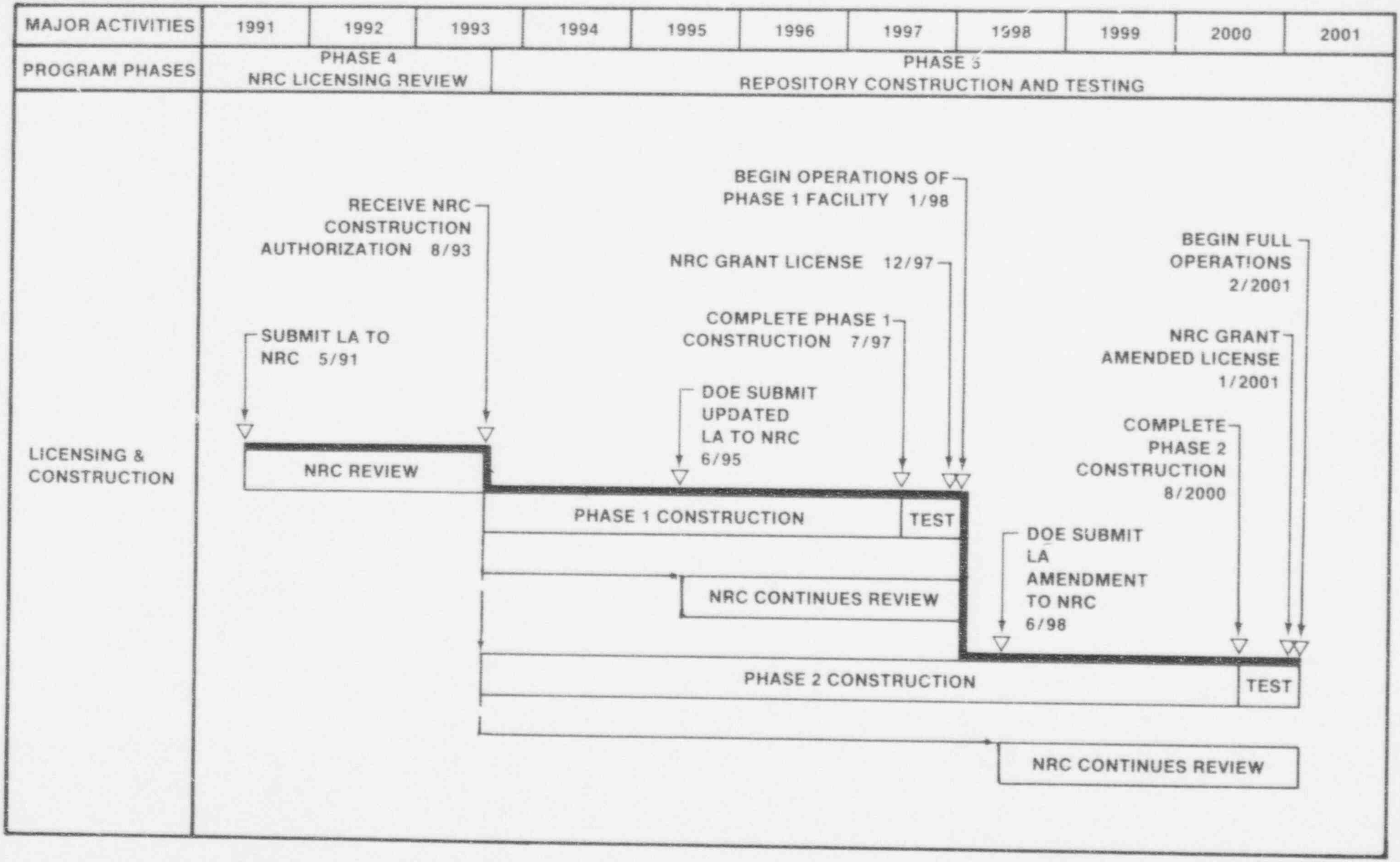
The reference schedule for Phase 5 assumes that the Department constructs the repository in two phases. Phase 1 construction consists of the construction of the surface and shaft facilities required to allow the Department to begin accepting up to 400 MTU/yr of spent fuel in 1998. Phase 2 construction consists of the construction of the remaining facilities needed to develop the repository to its full scale capacity. Phase 1 and Phase 2 construction and pre-operational testing would be completed in fifty-three and ninety months, respectively, after receipt of NRC's Construction Authorization.

The specific milestones for Phase 5 are as follows:

- o Begin repository construction: August 1993;
- o Submit updated License Application to NRC (to receive and possess radioactive waste for Phase 1: June 1995;
- o Complete Phase 1 construction and begin pre-operational testing: July 1997;
- o NRC completes review of updated LA: December 1997;
- o Receive license for Phase 1 operations: December 1997;
- o Complete phase 1 pre-operational testing and begin operation: January 1998;
- o Submit application to NRC for an amended license (to receive and possess radioactive waste for Phase 2): June 1998;
- o Complete Phase 2 construction and begin pre-operational testing: August 2000;
- o Receive amended license for Phase 2 operations: January 2001; and
- o Complete phase 2 pre-operational testing and begin operation: February 2001.

The reference schedule for phases 4 and 5 is shown in Figure 5.

FIGURE 5
FIRST GEOLOGIC REPOSITORY
LICENSING AND CONSTRUCTION PHASES



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7. SECOND GEOLOGIC REPOSITORY

7.1 Second Geologic Repository Overview

The Department anticipates that a Second Geologic Repository will be required and, therefore, is proceeding to conduct the siting of the second repository and will request approval in 1993 from Congress for its construction. The activities described in the preceding section for the first repository, with respect to site selection, site characterization, and NRC licensing will be essentially similar for the Second Geologic Repository. As discussed in Section 1.4.2, the Draft Project Decision Schedule does not address those elements of the Radioactive Waste Management System for which there are no authorizations provided by the NWPA. Consequently, the activities identified and deadlines for taking action for the Second Geologic Repository program extend only to the NRC issuance of the Construction Authorization. The process and the schedule associated with the Second Geologic Repository Program is discussed below.

7.2 Planned Second Geologic Repository Activities

The Department is currently conducting screening activities in seventeen States in the northeastern, southeastern, and North-Central regions of the Nation. The screening activities will continue until May 1986 when the Department plans to issue an Area Recommendation Report. This report will identify areas within the 17 States where the Department plans to conduct more detailed studies, including field investigations. Data collected during these investigations will allow the Department to evaluate sites that may be suitable for nomination and recommendation for site characterization. These area field investigations will be completed in January 1990. As noted, activities conducted subsequent to the completion of the area field investigations with respect to site characterization, site selection, and NRC licensing will be similar as to those conducted during the First Geologic Repository Program.

7.3 Relationship to First Geologic Repository Schedule

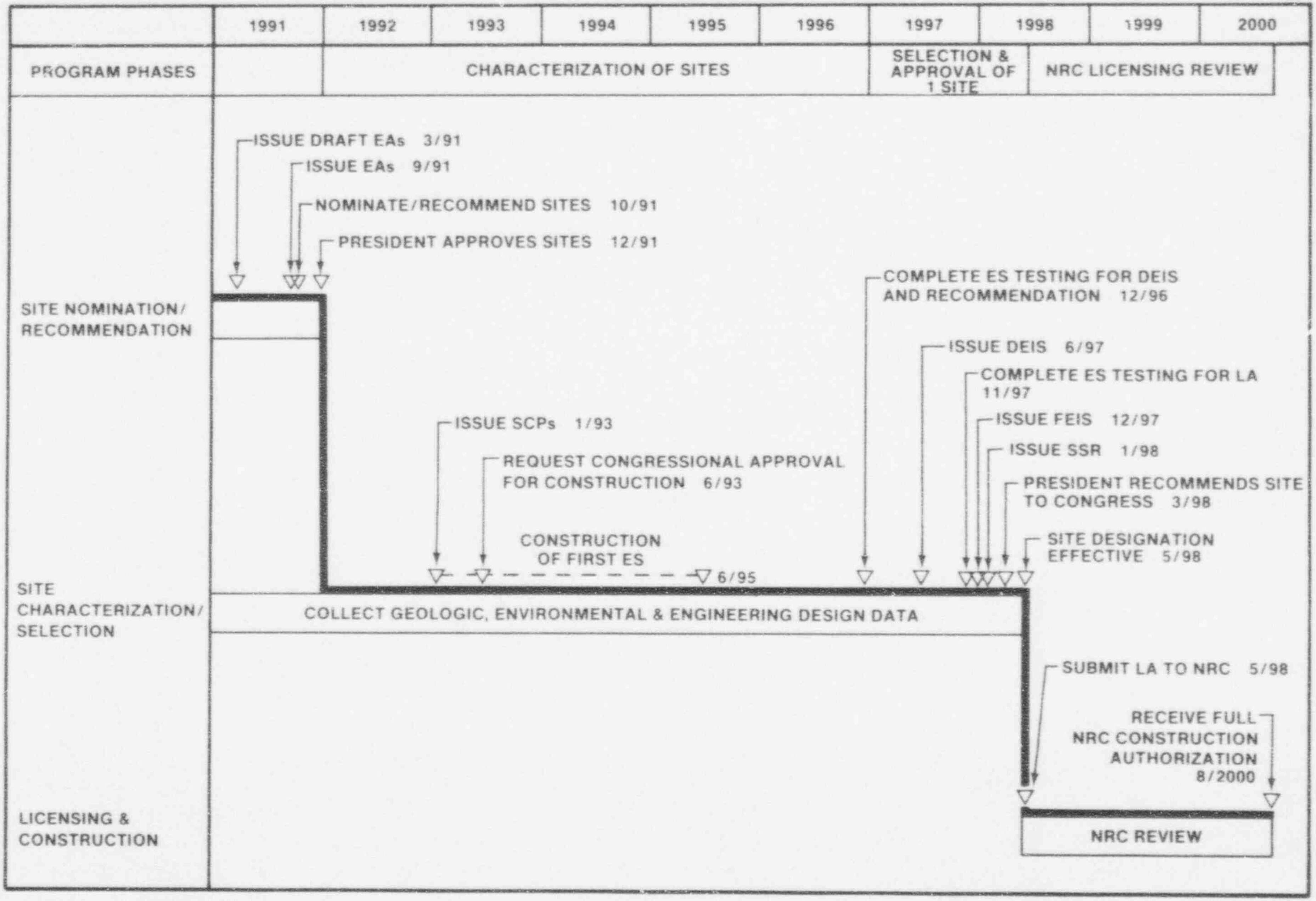
The schedules for the Second Geologic Repository recognizes the fact that some of the sites not selected for the First Geologic Repository are eligible for the Second Geologic Repository. This aspect of the Second Geologic Repository program is directly dependent on the First Geologic Repository program. Sites are nominated for site characterization for the Second Geologic Repository in October 1991, which is after the First Geologic Repository site is recommended to Congress in March 1991. This allows the Department to consider sites characterized, but not selected, for the First Geologic Repository for nomination for the Second Geologic Repository. This sequencing ensures that the Second Geologic Repository schedule will not converge with that of the First Geologic Repository.

7.4 Second Geologic Repository Schedule

Subsequent to site nomination, the process of siting and characterizing the Second Geologic Repository will be similar to that of the First Geologic Repository. The major milestones for the Second Geologic Repository are listed below and are also shown in Figure 6:

o Issue Area Recommendation Report:	May 1986
o Identify potentially acceptable sites for the second repository:	To Be Determined
o Issue EAs:	September 1991
o Nominate and recommend sites for characterization:	October 1991
o President approves recommended sites:	December 1991
o Issue initial Site Characterization Plan:	January 1993
o Request Congressional approval for construction:	June 1993
o President Recommends Site for Repository to Congress:	March 1998
o Submit LA to NRC	May 1998
o Receive Construction Authorization from NRC	August 2000

FIGURE 6
SECOND GEOLOGIC REPOSITORY
SITE CHARACTERIZATION, SELECTION, AND LICENSING PHASES



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8. TRANSPORTATION SUBSYSTEM

8.1 Transportation Subsystem Overview

The Department will take title to civilian spent nuclear fuel and high-level radioactive waste at reactor sites, or at other points of origin, and arrange for transportation to repositories or to related storage facilities. Although the Department has full responsibility for the management of transportation activities, Section 137 of the NWPA further directs that the private sector be utilized to the fullest extent possible in all aspects of developing and operating the Transportation Subsystem. Direct federal services for nuclear waste transportation would be considered only if the Secretary of Transportation, in consultation with the Secretary of Energy, determined that the private sector was unwilling or unable to provide the needed equipment or services at reasonable costs. In addition to the shipment of civilian spent nuclear fuel and high-level radioactive waste, the Department also has the responsibility for transporting high-level radioactive waste from Federal defense activities to repositories. These defense waste shipments will be made on a schedule designed not to interfere with civilian spent nuclear fuel or high-level radioactive waste shipments. All shipments to repositories will meet U.S. Department of Transportation and NRC regulatory requirements in effect at the time of transport, and, consistent with safety considerations, the number of shipments will be minimized to the extent practical. The Transportation Subsystem also may be called upon, as specified by Section 136 of the NWPA, to transport spent nuclear fuel to a federally owned and operated interim away-from-reactor storage facility.

8.2 Phasing and Schedule of the Transportation Subsystem

The current strategy for the development and operation of the Transportation Subsystem assumes that the Department would be an active participant with industry throughout the entire process. Technical development will follow a phased approach, a discussion of which will be included in the Transportation Business Plan. The Business Plan is scheduled to be issued in November 1985. In addition to information on the timing and the scope of major procurement actions, the plan will include plans for cask development, certification, procurement, ownership, and 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.

8.2.1 System Definition

During the system definition phase, requirements for the overall transportation system will be defined in terms of the needs, capabilities, schedules, costs, and operating constraints. The Department will develop information concerning long-term shipments, such as the size, weight, other characteristics of waste forms, quantities, timing, and destinations of shipments, and handling constraints at origin and destination points. It is also during this phase that the Department will develop performance specifications for transportation casks.

8.2.2 Cask Engineering Development, NRC Certification, Prototype Fabrication, and Testing

During engineering development, NRC certification, and testing, the establishment of feasibility of cask concepts will be established and the development specifications will be issued. The Department will invite industry proposals for the design, engineering development, certification, prototype fabrication, and testing of casks.

During this phase, contract(s) for cask development will be awarded, and Safety Analysis Reports (SARs) will be developed for submission to and review by the NRC. The NRC will also, during this phase, grant the certifications of the cask designs. NRC certifications are required before fabrication of the production cask units may begin.

8.2.3 Full Service Contractor Negotiations

During the Full Service Contractor Negotiations phase, a contract(s) will be awarded for the procurement of carrier services, transportation casks, training, maintenance, and operation of the Transportation Subsystem.

8.2.4 Transportation Operations

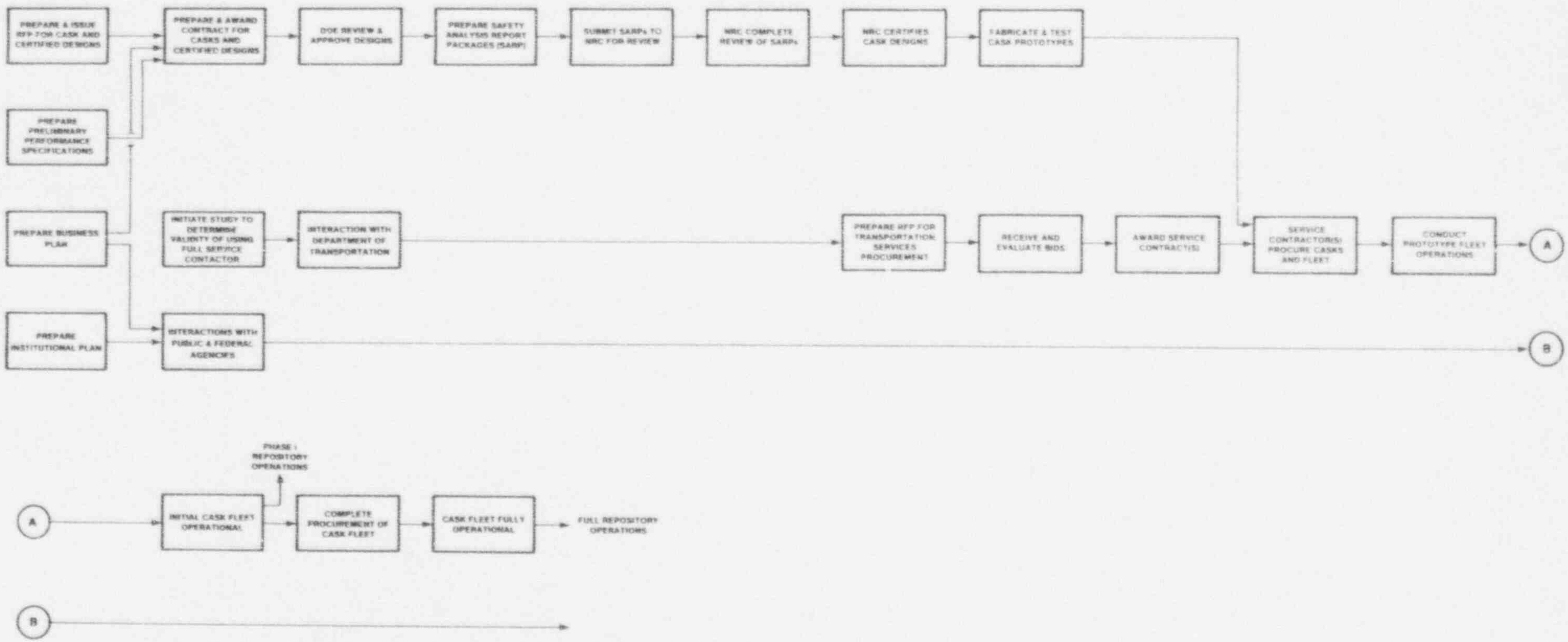
Subsequent to the award of the full service contract(s), transportation operations will commence. All tasks, as delineated above, that are required to complete shipments (e.g., cask procurement, personnel training, maintenance, transport operations, and traffic management) are components of this phase. In addition, planning for future development and improvement of transport capabilities will also continue during this phase.

8.2.5 Institutional Interactions

Throughout the development and subsequent operation of the Transportation Subsystem, the Department will interact with States, affected Indian Tribes, the transportation business community, and the public-at-large. The purpose of these interactions will be to surface issues that relate to the development and operation of the Transportation Subsystem and then, in a cooperative manner, make efforts to resolve them.

Figure 7 depicts the activities associated with the Transportation Subsystem.

FIGURE 7
TRANSPORTATION SUBSYSTEM NETWORK



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9. MONITORED RETRIEVABLE STORAGE

9.1 Monitored Retrievable Storage Overview

Congress found that long-term storage of spent nuclear fuel and high-level radioactive waste at a Monitored Retrievable Storage (MRS) facility was an option to be considered. The Nuclear Waste Policy Act, in addition to authorizing the Department to develop and operate a geologic repository, directed, in Section 141 of the NWPA, that the Department complete a study of the need for, and feasibility of, a Monitored Retrievable Storage Facility, and submit to the Congress a proposal for the construction of one or more MRS facilities.

The Department is considering proposing an MRS facility to be an integral component of the Radioactive Waste Management System. The role of an MRS facility as only a backup to a geologic repository has been redefined since the issuance of the Draft Mission Plan dated May 1984. A comprehensive discussion of the role of an MRS facility in the Radioactive Waste Management System is contained in the Mission Plan and in two recently issued documents related to the MRS program. The first document, The Need for and Feasibility of Monitored Retrievable Storage -- A Preliminary Analysis (DOE/RW-0022, April 1985), ("Needs and Feasibility Study") was issued as a preliminary study in compliance with Section 141 of the NWPA which requires the Secretary to complete a study of the need for, and feasibility of, an MRS facility. The study will form part of the basis for the proposal to Congress which will be made in January 1986. Issued concurrently with the "Needs and Feasibility Study" was a study entitled: Screening and Identification of Sites for a Proposed Monitored Retrievable Storage Facility (DOE/RW-0023, April 1985).

This study identified three sites for an MRS facility, one preferred and two alternates. Based on this identification, site-specific designs and an Environmental Assessment will be prepared based on the site and design combinations.

9.2 Near-Term Monitored Retrievable Storage Plans

The Department, as was noted, is currently in the process of developing the MRS proposal including the completion of the "Needs and Feasibility Study", and accompanying Environmental Assessment for Congress to review. The proposal and EA are scheduled for submission to Congress in January 1986. Section 141 of the NWPA also requires the Secretary to submit the comments of EPA and NRC along with the proposal. Consequently, the Department will transmit the MRS proposal to EPA and NRC in December 1985 for review.

Congress, after review of the proposal submitted by the Secretary, may authorize construction of a Monitored Retrievable Storage facility. However, the timing of such authorization is, at this time, uncertain. Therefore, the Project Decision Schedule does not identify Federal agency actions necessary for the licensing, construction, and operation of an MRS facility. The Project Decision Schedule will be modified to incorporate an MRS facility at such time Congress may authorize it.

10. COMPLIANCE WITH FEDERAL STATUTES, REGULATIONS, AND PERMITS

10.1 Overview

The following is, the Department believes, a comprehensive listing of Federal statutes, regulations, and permits that may apply to the development and operation of the Radioactive Waste Management System. They are categorized by subject area (i.e., Air, Land, Water Quality, Ecology and Wildlife Protection, Cultural Resources, and Environmental Compliance and Pollution Control).

The Department, as shown in Table 1, item 18a, is requesting Federal agency review of the statutes, regulations, and permits that are shown below. We have requested that, by January 1, 1986, affected Federal agencies report to the Department as to the specific applicability of those statutes, regulations, and permits shown below. Such a report should include the identification of the Federal agency action required by the statute, regulation, or permit and the amount of time which should be scheduled to permit agency action. In addition, any statute, regulation, or permit that has applicability to the Radioactive Waste Management Program not identified below should be included in the report.

10.2 Statutes/Regulations/Permits

10.2.1 Air Quality	Agency
o Clean Air Act (Prevention of Significant Deterioration and other Air Quality approvals) as amended 42 U.S.C. 57401, *et seq.*	EPA
- Requirements for Preparation, Adoption, and Submittal of Implementation Plans, 40 CFR 51	

- Approval and Promulgation of Implementation Plans, 40 CFR 52

- Procedures for Decision Making, 40 CFR 124

- National Primary and Secondary Ambient Air Quality Standards, 40 CFR 60

- Standards of Performance for New Stationary Sources, 40 CFR 60

o Noise Control Act of 1972 and the Quiet Communities Act of 1978, 42 U.S.C. 4901, *et seq.*	EPA

10.2.2 Land

o Farmland Protection Policy Act, 7 U.S.C. 4201-4209	USDA
- 7 CFR 658	
-- Soil Conservation Service Form AD 1006	
o Taylor Grazing Act, 43 U.S.C. 315-316	DOI
- 43 CFR 4100	
-- Right-of-Way Grant	
-- Withdrawal Land Order	
o Wild and Scenic Rivers Act, 16 U.S.C. 1271-1287	DOI
o Floodplain/Wetlands Executive Orders, E.O. 11988 and E.O. 11990	DOI
- 10 CFR 1022	
o National Forest Organic Legislation, 16 U.S.C. 475	USDA
o Multiple-Use Sustained-Yield Act, 16 U.S.C. 528-531	USDA
o Forest and Rangeland Renewable Resources Planning and Research Acts	USDA
o National Forest Management Act of 1972, 16 U.S.C. 472(a), 476	USDA
o Renewable Resource Extension Act, 16 U.S.C. 1600-1676	DOI
- 36 CFR 261	
o Objects Affecting Navigable Airspace	DOT
- 14 CFR 77	

- o Materials Act, 30 U.S.C. 601-604 — DOI
  - 43 CFR 3600 et seq.
- o Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Pub. L. 96-50. — EPA
- o Coastal Zone Management Act of 1972, 16 U.S.C. 1451-1464 — EPA, DOI DOC
  - 15 CFR 930
- o Federal Land Policy and Management Act of 1976, 43 U.S.C. 1701-1782 — DOI, USDA
  - 43 CFR 2300
    - -- Right-of-Way Grant (BLM or USFS)
- o Federal Land Policy and Management Act, 43 U.S.C. 155-158, — DOI, USDA
  - Withdrawal Land Order
- o Federal Land Policy and Management Act, 43 U.S.C. 103(f), 302(b), 501(a)(7), 504(a), and 507(a) — DOI
  - Temporary Use Permit
- o Coastal Barrier Resources Act, 16 U.S.C. 3501-3510 — DOI
- o National Trails System, 16 U.S.C. 1241-1249 — EPA, DOI
- o Fish & Wildlife Coordination Act, 16 U.S.C. 661, et seq., Section 4(f) — DOI
- o Department of Transportation Act of 1966, 80 Stat. 931, Pub. L. 89-670 — DOT
  - -- Right-of-Way Consultation
- o National Wildlife Refuge System Administration Act, Pub. L. 80-669 — DOI
- o General Bridge Act of 1946, 33 U.S.C. 401, 491-507, 523-524; 33 CFR 114-115

10.2.3 Water Quality

- o Federal Land Policy and Management Act, 43 U.S.C. 1767 — EPA, DOI
  - National Pollutant Discharge Elimination System, 40 CFR 122

- Criteria and Standards for the National Pollutant Discharge Elimination System, 40 CFR 125

- Water Quality Standards, 40 CFR 131

- Toxic Pollutant Effluent Standards, 40 CFR 129

- Underground Injection Control Program, 40 CFR 144

- Underground Injection Control Program, Criteria and Standards, 40 CFR 146

  -- Right-of-Way Grants

o Clean Water Act, 33 U.S.C. 1251, <u>et seq.</u>	EPA
- National Pollutant Discharge Elimination System (NPDES) Permit	
o Clean Water Act, 33 U.S.C. 1344, 404; E.O. 11988 and 11990	EPA
o Clean Water Act, Section 311 (j)(1)(c); 40 CFR 112	EPA
o Rivers and Harbors Act, 33 U.S.C. 401-413; 33 CFR 322	DOD(COE)
o Safe Drinking Water Act, 42 U.S.C. 300f-300g-10; 40 CFR 122, 146, and 149	EPA
-- Underground Injection Control Permit	
o Marine Protection Research and Sanctuaries Act of 1972, 16 U.S.C. 1431, <u>et seq.</u>, 33 U.S.C. 1401, <u>et seq.</u>	DOI

10.2.4 Waste Disposal

o Solid Water Disposal Act, Resource Conservation and Recovery Act of 1976, 42 U.S.C. 6901-6987; 40 CFR Parts 124, 260-265, 270; E.O. 12088	EPA

- Hazardous Waste Management System; General, 40 CFR 260

- Identification and Listing of Hazardous Waste, 40 CFR 261

- Standards Applicable to Transporters of Hazardous Waste, 40 CFR 263

- Public Participation Programs, 40 CFR 25

- Standards for Generators of Hazardous Waste, 40 CFR 262
- State Program Requirements, 40 CFR 123
- Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, 40 CFR 264
- Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, 40 CFR 265

o Solid Waste Disposal Act, as amended, 42 U.S.C. 3251, et seq.	EPA
o Hazardous Materials Transportation Act, 49 U.S.C. 1801, et seq.; 40 CFR 170 et seq.	DOT
o Resource Conservation and Recovery Act, U.S.C. 6901, et seq.	EPA
– Hazardous Waste TSD Permit	

10.2.5 Ecology and Wildlife Protection

o Endangered Species Act of 1973, 16 U.S.C. 1531-1543; 50 CFR 17.11 and 17.12	DOI
-- Biological Opinion on Threatened and Endangered Species	
o Fish and Wildlife Coordination Act, 16 U.S.C. 661-666	DOI
o Migratory Bird Treaty Act, 16 U.S.C. 703-711; 50 CFR 10.13	DOI
o National Wildlife Refuge System Act	DOI
-- Permit or Easement Required for Road or Powerline Corridors	
o National Wildlife Refuge Administration Act of 1966, 16 U.S.C. 668dd-668ee; 50 CFR Parts 25, 27, 28, and 29	DOI
o Bald and Golden Eagle Protection Act, 16 U.S.C. 668-668d	DOI
o Sikes Act, Pub. L. 93-452; 16 U.S.C. 679, et seq.	DOI
-- Consultation	

- o Federal Aviation Act, 49 U.S.C. 1347, et seq. — DOT
  - -- Airspace Permit
- o Wild, Free-Roaming Horses and Burros Act, 16 U.S.C. 1331-1340; 43 CFR 4700 — DOI
  - -- Project activities must avoid harm to wild, free-roaming horses and burros on Public Land
- o Wild and Rivers Act, 16 U.S.C. 1271-1287 — DOI

10.2.6 Cultural Resources

- o Archaeological Resources Protection Act of 1979, 16 U.S.C. 470(aa)-470(11) — DOI, USDA
  - - Historic Preservation Certifications Pursuant to the Tax Reform Act of 1976, the Revenue Act of 1978, the Tax Treatment Extension Act of 1980, and the Economic Recovery Act of 1981; 36 CFR 67
  - - Determination of Eligibility for Inclusion in the National Register of Historic Places; 36 CFR 63
  - - Protection of Archaeological Resources: Uniform Regulations; 36 CFR 296
  - - Procedures for Approved State and Local Government Historic Preservation Programs; 36 CFR 61
- o Historic Sites, Buildings, and Antiquities Act of 1935, 16 U.S.C. 461-467, as amended — DOI
- o American Antiquities Act, 16 U.S.C. 433 — DOI
- o American Indian Religious Freedom Act, 42, U.S.C. 1996 — DOI
  - -- Consultation
- o National Historic Preservation Act, 16 U.S.C. 470, et seq.; E.O. 11593; 35 CFR 800 — DOI
  - -- Determination of No Adverse Effect
  - -- Programmatic Memorandum Agreement
  - -- Avoidance and Mitigation for Land Withdrawal where no Excavations of Removal of Archaeological Resources are Anticipated
- o Archaeological Resources Preservation Act of 1979, 16 U.S.C. 470, et seq. — DOI
  - -- Permit to Excavate, Remove, or Alter Archaeological Resources

o Resource Salvage Act of 1960, 16 U.S.C. 469-469(c)	DOI
-- Survey for Recovery and Preservation of Archeologic Resource discovered in the course of Siting a Federal Project	
o National Trails System Act, 16 U.S.C. 1241, _et seq._	DOI
-- Cooperative Agreement for Construction and Operation on Historic Trails	
o Protection and Enhancement of Cultural Environment, E.O. 11593 (1971)	DOI

10.2.7 Environmental Compliance and Pollution Control

o National Environmental Policy Act, 42 U.S.C. 1321, _et seq._	EPA, DOI USDA, CEQ DOE, DOT NRC
o Federal Compliance with Pollution Control Standards, E.O. 12088 (1978)	EPA, DOE USDA, CEQ DOD, DOT NRC
o Organic Act of the National Park Service, 16 U.S.C. 1, 1901-1912; 3 CFR Part 9	DOI
o National Forests Act of 1972, Pub. L. 96-289	USDA

LIST OF TABLES - FOREWORD

The following four tables, as discussed in Section 4 of the Draft Project Decision Schedule, depict, in a sequential fashion, those activities and deadlines for action that Federal agencies have responsibility for in the development and operation of the Radioactive Waste Management System.

TABLE 1

ACTIVITIES ASSOCIATED WITH THE SITING, CONSTRUCTION, AND OPERATION OF THE RADIOACTIVE WASTE MANAGEMENT SYSTEM (FIRST AND SECOND GEOLOGIC REPOSITORIES)

TABLE 1
Activities Associated with the Siting, Construction, and Operation of the Radioactive Waste Management System (First and Second Geologic Repositories)

Provision and Required Action	Reference Schedule	Agency
*(1) State Notification (1st Repository) "The Secretary shall identify the States with one or more potentially acceptable sites for a repository within 90 days after the date of enactment of this Act." Section 116(a).		
(1a) State Notification of Potentially Acceptable Site by DOE	2/2/83 Actual	DOE
(2) Grants for Potentially Acceptable Sites (1st Repository) The Secretary shall make grants to each State (affected tribe) notified under Section 116(a) for the purpose of participating in activities required by Sections 116 and 117 or authorized by written agreement entered into pursuant to subsection 117(c). Sections 116(c)(1)(A) and 118(b)(1).		
(2a) Provide Grants to States and/or Affected Indian Tribes Having been notified as to their PAS status	Ongoing	DOE
(3) Memorandum of Understanding (MOU) with NRC		
(3a) Develop MOU between NRC and DOE concerning interaction during the Site Characterization Phase of Repository Deployment	6/27/83 Actual	DOE, NRC
(4) Memorandum of Understanding (MOU) with DOI		
(4a) Develop MOU between DOI and DOE concerning BLM reviewing Site Characterization Plans for the First and Second Repositories	6/83 Actual	DOE, DOI (BLM)
(5) Memorandum of Understanding (MOU) with DOI		
(5a) Develop MOU between DOI and DOE concerning USGS reviewing Site Characterization Plans for the First and Second repositories	3/29/84 Actual	DOE, DOI (USGS)
(6) Memorandum of Understanding (MOU) with DOI		
(6a) Develop MOU between DOI and DOE concerning NPS role for consultation and review of OCRWM documents	5/1/84 Actual	DOE, DOI (NPS)
(7) Interagency Agreement with DOI		
(7a) Sign Interagency Agreement between DOI and DOE concerning NPS role for reviewing EA's	9/14/84 Actual	DOE, DOI (NPS)

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and Operation of the Radioactive Waste Management System (First and Second Geologic Repositories)

Provision and Required Action	Reference Schedule	Agency
*(8) Siting Guidelines "Not later than 180 days after the date of the enactment of this Act, the Secretary, following consultation with the Council on Environmental Quality, the Administrator of the Environmental Protection Agency, the Director of the Geological Survey, and interested Governors, and the concurrence of the Commission, shall issue general guidelines for the recommendation of sites for repositories." Section 112(a).		
(8a) Complete Consultation on Siting Guidelines/Issue Draft to NRC for Concurrence	11/22/83 Actual	CEQ, EPA, DOI (USGS), DOE
(8b) Concurrence from NRC on Siting Guidelines	6/22/84 Actual	NRC
(8c) Issue Siting Guidelines	12/6/84 Actual	DOE
(9) Pre-nomination Notification (1st Repository) "Before nominating a site, the Secretary shall notify the Governor and legislature of the State in which such site is located, or the governing body of the affected Indian tribe where such site is located, as the case may be, of such nomination and the basis for such nomination. Before nominating any site, the Secretary shall hold public hearings in the vicinity of such site to inform the residents of the area in which such site is located of the proposed nomination of such site and to receive their comments. At such hearings, the Secretary shall also solicit and receive any recommendations of such residents with respect to issues that should be addressed in the environmental assessment described in paragraph (1) and the site characterization plan described in section 113(b)(1)." Section 112(b)(1)(H) and 112(b)(2).		
(9a) Notify States and Affected Indian Tribes of Nomination	12/19/84 Actual	DOE
(9b) Participate in Public Hearings	3/83-5/83 Actual	DOE
*(10) Environmental Assessments (1st Repository) Following the issuance of guidelines and consultation with the Governors of the affected States, the Secretary shall nominate at least five sites that he determines suitable for site characterization for selection of the first repository site. Each nomination shall be accompanied by an environmental assessment. Section 112(b)(1)(A) and (E).		
(10a) DOE Issue Draft EAs for Review	12/20/84 Actual	DOE
(10b) Review and Comment on Draft EAs	12/20/84 - 3/20/85 Actual	DOD, NRC, DOT, DOI, USDA, EPA

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

	Provision and Required Action	Reference Schedule	Agency
	(10c) Issue Final EAs	11/85	DOE
*(11)	NRC Requirements for SCP "(A) A general plan for site characterization activities to be conducted at such candidate site, which plan shall include--... (V) any other information required by the Commission." Section 113(b)(1)(A).		
	(11a) Issue Revised Draft of Regulatory Guide 4.17	3/85	NRC
	(11b) Issue Final Regulatory Guide 4.17	After 13b	NRC
	(11c) Identify Additional SCP Content Requirements	Continuing through 12/1/90	NRC
*(12)	Environmental Protection Agency Standards "Not later than 1 year after the date of the enactment of this Act, the Administrator, pursuant to authority under other provisions of law, shall, by rule, promulgate generally applicable standards for protection of the general environment from offsite releases from radioactive material in repositories. "Section 121(a).		
	(12a) EPA Develop Standards	8/85	EPA
*(13)	NRC Requirements and Criteria Not later than January 1, 1984, the Commission, pursuant to authority under other provisions of law, shall, by rule, promulgate technical requirements and criteria that it will apply, under the Atomic Energy Act of 1954 (42 U.S.C. 2011, et seq.) and the Energy Reorganization Act of 1974 (42 U.S.C. 5081, et seq.). Section 121(b).		
	(13a) NRC Develop Requirements and Criteria	6/21/83 Actual	NRC
	(13b) NRC Revise Requirements and Criteria, if Necessary, to be Consistent with the Provisions of the NWPA and EPA Standards	11/85	NRC
(14)	Define Affected Indian Tribes which have Treaty Rights (1st Repository)		
	(14a) Make Determination	Upon Application By Tribe	DOI

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

	Provision and Required Action	Reference Schedule	Agency
*(15)	Nominate and Recommend Sites for Characterization (1st Repository) "Subsequent to such nomination, the Secretary shall recommend to the President three of the nominated sites not later than January 1, 1985, for characterization as candidate sites." Section 112(b)(1)(B).		
	(15a) Secretary Nominate at least Five and Recommend Three Sites for Characterization	11/85	DOE
*(16)	Preliminary Determination (1st Repository) "...the Secretary shall consider as alternate sites for the first repository to be developed under this subtitle three candidate sites with respect to which (1) site characterization has been completed under section 113; and (2) the Secretary has made a preliminary determination, that such sites are suitable for development as repositories..." Section 114(f).		
	(16a) Secretary Makes Preliminary Determination That Sites Are Suitable for Development as Repositories	Concurrent with 15a	DOE
(17)	Presidential Review of Recommendation (1st Repository) "The President shall review each candidate site recommendation made by the Secretary under Subsection (b Not later than 60 days after the submission by the Secretary of a recommendation of a candidate site, the President, in his discretion, may either approve or disapprove such candidate site." Section 112(c)(1).		
	(17a) Transmit Decision on Approval or Disapproval of Site Recommendation to the DOE and the Affected States and/or Indian Tribes.	1/86	President
*(18)	Affected Federal Agencies Report to DOE as to Departmental Compliance with Regulations and Permit Requirements		
	(18a) Review Regulations and Requirements and Submit Report (See Sec. 10, PDS)	1/1/86	USDA, DOC, DOD DOI, DOJ, DOT EPA, NRC, CEQ
(19)	Grants for Candidate Sites (1st Repository) The Secretary shall make grants to each State (affected Indian tribe) in which a candidate site for a repository is approved under section 112(c). Section 116(c)(1)(B) and (118(b)(2)(A)).		
	(19a) Provide Grants to States and/or Affected Indian Tribes Having a Candidate Site	Negotiated Upon Request	DOE

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

	Provision and Required Action	Reference Schedule	Agency
(20)	Payment Equal to Taxes (1st Repository) The Secretary shall also grant to each State (affected Indian tribe) and unit of general local government in which a site for a repository is approved under section 112(c) an amount each fiscal year equal to the amount such State (Indian tribe) and unit of general local government, respectively, would receive were they authorized to tax site characterization activities at such site, and the development and operation of such repository... Section 116(c)(3) and (118(b)(4)).		
	(20a) Provide Payment Equal to Taxes	Candidate Site Designation thru completion of Operations at site	DOE
*(21)	Site Characterization Plan (1st Repository) Before proceeding to sink shafts at any candidate site, the Secretary shall submit to the NRC and the affected States or Indian tribes a general plan for site characterization activities, a waste form or packaging description and a conceptual repository design. Section 113(b)(1).		
	(21a) Issue SCP for Review	Basalt 3/86 Tuff 3/86 Salt 10/86	DOE
	(21b) Review and Comment on SCP	Basalt 6/86 Tuff 6/86 Salt 1/87	DOI, DOD, EPA, NRC, DOT, USDA
*(22)	Site Characterization Analysis (10 CFR 60)(1) (1st Repository)		
	(22a) Issue Draft SCA	Basalt 8/86 Tuff 8/86 Salt 3/87	NRC
	(22b) Issue Final SCA	Basalt 1/87 Tuff 1/87 Salt 8/87	NRC

(1) According to the Current Procedural Rule (10 CFR Part 60), the NRC will issue a draft and Final Site Characterization Analysis (SCA). The final would be completed ten months after issuance of the initial SCP. A change to this rule has been proposed that would require the NRC to issue only a final SCA. The final SCA would be issued for comment five months after receipt of the initial SCP. NRC comments contained in their final SCA would then be incorporated into the next SCP report issued by the Department. The Schedule pertaining to the Current Procedural Rule is Depicted above.

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and
Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

	Provision and Required Action	Reference Schedule	Agency
(23)	Radioactive Material Use (1st Repository) "In conducting site characterization activities-- (A) the Secretary may not use any radioactive material at a candidate site unless the Commission concurs that such use is necessary to provide data for the preparation of the required environmental reports and an application for construction authorization for a repository at such candidate site. Section 113(c)(2)(A)		
	(23a) NRC Concurrence on Use of Radioactive Materials for Characterization	Basalt 1/87 Tuff 1/87 Salt 8/87	NRC
*(24)	SCP Public Hearings (1st Repository) "Before proceeding to sink shafts at any candidate site, the Secretary shall (A) make available to the public the site characterization plan described in paragraph (1); and (B) hold public hearings in the vicinity of such candidate site to inform the residents of the area in which such candidate site is located of such plan, and to receive their comments." Section 113(b)(2).		
	(24a) Conduct Public Hearings on SCP	Basalt 6/86 Tuff 6/86 Salt 1/87	DOE
*(25)	Provide Detailed Guidance for License Application		
	(25a) Provide Draft Guidance as to Format and Content of LA that is Similar in Style and Scope Regulatory Guide 1.70 Rev. 3	5/87	NRC
	(25b) Provide Final Guidance	5/88	NRC
(26)	Written Agreements (1st Repository) "Not later than 60 days after (1) the approval of a site for site characterization for such a repository under Section 112(c), or (2) the written request of the State or Indian tribe in any affected State notified under Section 116(a) to the Secretary, whichever first occurs, the Secretary shall seek to enter into a binding written agreement, and shall begin negotiations, with such State and, where appropriate, to enter into a separate binding agreement with the governing body of any affected Indian tribe, setting forth (but not limited to) the procedures under which the requirements of subsections (a) and (b), and the provisions of such written agreement, shall be carried out.... Each such written agreement shall, to the maximum extent feasible, be completed not later than six months after such notification. If such written agreement is not completed within such period, the Secretary shall report to the Congress in writing within 30 days on the status of negotiations to develop such agreement..." Section 117 (c).		

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and
Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

	Provision and Required Action	Reference Schedule	Agency
	(26a) DOE Negotiate Written Agreements with States and/or Affected Indian Tribes	Ongoing	DOE
	(26b) If No Agreement is Reached, DOE Submit Written Explanation to Congress	7 Months After Request	DOE
*(27)	Land Acquisition Procedures for Tuff Site (If President Approves Site) (1st Repository)		
	(27a) Renew Land Use Permit	1/86	DOE, DOD (AF)
	(27b) Extend Cooperative Agreement	4/86	DOE, DOI (BLM)
	(27c) Renew Permits and Agreements as Needed	1/86-5/93	DOE, DOD (AF), DOI (BLM)
	(27d) Begin Pre-Application Consultation	1/91	DOE, DOI (BLM)
	(27e) Apply for Withdrawal of Public Land	11/91	DOE
	(27f) Begin Preparation of Case File Reports	11/91	DOE
	(27g) Publish Notice in Federal Register for Withdrawal Application, Invitation to Comment, and Public Meeting	12/91	DOI (BLM)
	(27h) Public Comment Period Closes	2/92	DOI (BLM)
	(27i) Hold Public Meeting	5/92	DOE
	(27j) Submit Case File Reports	5/92	DOE
	(27k) Issue Public Land Order	5/93	DOI
	(27l) Provide Congress with Withdrawal Information	5/93	DOI
	(27m) Discharge from Further Consideration unless Disapproval Resolution Reported	6/93	Congressional Committees
	(27n) Withdrawal takes effect, unless vetoed	8/93	Congress
*(28)	Land Acquisition Procedures for Salt Sites (If President Approves Site)[1] (1st Repository)		
	(28a) Sign Interagency Agreement on Land Acquisition Support for Site Characterization	7/85	DOE, DOD (COE)

[1] Land Acquisition procedures for Second Repository sites have not been developed at this time, but are expected to be similar to those for the First Repository. These procedures will be included in future updates of the Project Decision Schedule.

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

Provision and Required Action	Reference Schedule	Agency
(28b) Prepare and Submit Land Acquisition Plan for ES, Site Characterization, and Site Protection	10/85	DOD (COE)
(28c) Approve Land Acquisition Plan	11/85	DOE
(28d) Initiate Land Acquisition	12/85	DOD (COE), DOJ
(28e) Complete Negotiations, Acquisition of Land, and File Condemnation Proceedings, if necessary	8/86	DOD (COE), DOJ
(28f) Complete Relocation, if necessary/take possession of Site	10/86	DOD (COE), DOJ
(28g) Prepare and Submit Land Acquisition Plan for Repository Acquisition	6/90	DOD (COE)
(*** Steps for Acquiring Federal land at Davis and Lavender Canyons, Utah and Cypress Creek, Mississippi are Different from this step on. (Refer to (27l)***)		
(28h) Approve Land Acquisition Plan	8/90	DOD (COE)
(28i) Initiate Land Acquisition	8/90	DOD (COE), DOJ
(28j) Complete Negotiations, Acquisition of Land, and File Condemnation Proceedings, if necessary	6/93	DOD (COE), DOJ
(28k) Complete Relocation, if necessary/take possession of Land	8/93	DOD (COE), DOJ
(*** Steps for Acquiring Land at Davis and Lavender Canyons, Utah, and Cypress Creek, MS ***)[1]		
(28l) Begin Pre-Application Consultation	8/90	DOE, DOI (BLM), USDA, DOD(COE), DOI (NPS)
(28m) Apply for Withdrawal of Public Land	5/91	DOE, DOI (BLM), USDA, DOD(COE), DOI (NPS)
(28n) Begin Preparation of Case File Reports	5/91	DOD (COE)
(28o) Publish Notice in Federal Register for Withdrawal Application, Invitation to Comment, and Public Meeting	6/91	DOI (BLM), USDA, DOI(NPS)

[1] Depending on Site Selected, either DOI (BLM) (NPS) or USDA will be the Affected Agency.

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

	Provision and Required Action	Reference Schedule	Agency
	(28p) Public Comment Period Closes	8/91	DOI (BLM), USDA, DOI(NPS)
	(28q) Hold Public Meeting	11/91	DOI (BLM), USDA, DOI(NPS)
	(28r) Submit Case File Reports	5/92	DOD (COE)
	(28s) Issue Public Land Order	5/93	DOI(NPS), USDA, DOI (BLM)
	(28t) Provide Congress with Withdrawal Information	5/93	DOI(NPS), USDA, DOI (BLM)
	(28u) Discharge from further consideration unless disapproval resolution reported	6/93	Congressional Committees
	(28v) Withdrawal takes effect, unless vetoed	8/93	Congress
*(29)	Site Characterization (1st Repository) "The Secretary shall carry out, in accordance with the provisions of this section, appropriate site characterization activities..." Section 113(a).		
	(29a) DOE Perform Site Characterization Activities	12/86 - 11/90	DOE
*(30)	State Notification (2nd Repository) Section 116(a)		
	(30a) State Notification of Potentially Acceptable Sites by DOE	TBD	DOE
(31)	Grants to Potentially Acceptable Sites (2nd Repository) Sections 116(c)(1)(A) and 118(b)(1)		
	(31a) Provide Grants to States and/or Affected Indian Tribes Having a PAS	After (33a)	DOE
(32)	Semi-annual SCP Report (1st Repository) "During the conduct of site characterization activities at a candidate site, the Secretary shall report not less than once every 6 months to the Commission and to either the Governor and legislature of the State in which such candidate site is located, or the governing body of the affected Indian tribe where such candidate site is located, as the case may be, on the nature and extent of such activities and the information developed from such activities." Section 113(b)(3).		
	(32a) Issue Semi-Annual SCP Reports	9/86- 3/91	DOE

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

	Provision and Required Action	Reference Schedule	Agency
(33)	Site Recommendation Public Hearing (1st Repository) "The Secretary shall hold public hearings in the vicinity of each site under consideration for recommendation to the President under this paragraph as a site for the development of a repository, for the purposes of informing the residents of the area in which such site is located of such consideration and receiving their comments regarding the possible recommendation of such site." Section 114(a).		
	(33a) DOE Hold Public Hearings on Site Recommendation	6/90	DOE
*(34)	Environmental Impact Statement (1st Repository) "...A final environmental impact statement prepared pursuant to subsection (f) and the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.), including an analysis of the consideration given by the Secretary to not less than three candidate sites for the first proposed repository or to all of the characterized sites for the development of subsequent repositories..." Section 114(a)(1)(D).		
	(34a) Pursuant to Section 1501.6 of the CEQ NEPA regulations, 40 CFR Parts 1500-1508, DOE as the lead agency will request certain other affected Federal agencies to serve as cooperating agencies.	2/86	DOE
	(34b) DOE Issue Draft EIS for Review	6/90	DOE
	(34c) Review and Comment on Draft EIS	6/90-9/90	DOT, DOD, CEQ NRC, DOI, EPA, USDA
	(34d) Issue FEIS, Incorporating Above Comments	12/90	DOE
*(35)	NRC Preliminary Sufficiency Comments (1st Repository) "Preliminary comments of the Commission concerning the extent to which the at-depth site characterization analysis and the waste form proposal for such site seem to be sufficient for inclusion in any application to be submitted by the Secretary for licensing of such site as a repository." Section 114(a)(1)(E).		
	(35a) NRC Comment on Characterization Analysis	6/90-1/91	NRC

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

	Provision and Required Action	Reference Schedule	Agency
*(36)	Site Selection Report (1st Repository) "...the Secretary shall notify the Governor and legislature of the State in which such site is located, or the governing body of the affected Indian tribe where such site is located, as the case may be, of such decision....Together with any recommendation of a site under this paragraph, the Secretary shall make available to the public, and submit to the President, a comprehensive statement of the basis of such recommendation." Section 114(a)(1)(A)(B)(C)(F)(G)(H).		
	(36a) Notify Affected States and/or Indian Tribes of Proposed Site Selection	6/90	DOE
	(36b) Issue Site Selection Report to President	1/91	DOE
(37)	Record of Decision (ROD) (40 CFR Part 1505) (1st Repository)		
	(37a) DOE prepare and issue ROD	1/91	DOE
*(38)	Site Recommendation (1st Repository) "Not later than March 31, 1987, the President shall submit to the Congress a recommendation of one site from the three sites initially characterized that the President considers qualified for application for a construction authorization for a repository." Section 114(a)(2)(A).		
	(38a) President Recommend Site to Congress	3/91	President
(39)	Pre-Nomination Notification (2nd Repository) Section 112(b)(1)(H) and 112(b)(2)		
	(39a) Notify States and Affected Indian Tribes of Nomination	5/91	DOE
	(39b) Conduct Public Hearings	5/91	DOE
*(40)	Environmental Assessments (2nd Repository) Section 112(b)		
	(40a) DOE Issue Draft EAs for Review	3/91	DOE
	(40b) Review and Comment on Draft EAs	3/91- 6/91	DOT, DOI, EPA, NRC, USDA, DOD
	(40c) DOE Issue EAs	9/91	DOE

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and
Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

	Provision and Required Action	Reference Schedule	Agency
(41)	Nominate and Recommend Sites for Characterization (2nd Repository) Section 112(b)		
	(41a) Secretary Nominate Five (5) and Recommend Three (3) Sites for Characterization	10/91	DOE
(42)	Assistance for Repository State (1st Repository) The Secretary shall provide financial and technical assistance to any State (affected Indian tribe) requesting such assistance in which there is a site with respect to which the Commission has authorized construction of a repository. Section 116(c)(2)(A) and 118(b)(3)(A).		
	(42a) Prepare and Submit to DOE an Impact Description Report	After site characterization and before 37a	States Indian tribes
	(42b) Enter into a Binding Agreement Defining Assistance	10/93	DOE
	(42c) Provide Financial and Technical Assistance to Mitigate Impact of Repository Development	2/94	DOE
*(43)	License Application (1st Repository) "If the President recommends to the Congress a site for a repository under subsection (a) and the site designation is permitted to take effect under section 115, the Secretary shall submit to the Commission an application for a construction authorization for a repository at such site not later than 90 days after the date on which the recommendation of the site designation is effective..." Section 114(b).		
	(43a) Submit LA (License Application per 10 CFR Part 60)	5/91	DOE
	(43b) Review LA	5/91-8/93	NRC
	(43c) Issue Construction Authorization	8/93	NRC
(44)	Adoption of FEIS (1st Repository) "...Any environmental impact statement prepared in connection with a repository proposed to be constructed by the Secretary under this subtitle shall, to the extent practicable, be adopted by the Commission in connection with the issuance by the Commission of a construction authorization and license for such repository." Section 114(f).		
	(44a) NRC Adoption of DOE FEIS, to Extent Practicable	6/91	NRC

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and Operation of the Radioactive Waste Management System (First and Second Geologic Repositories)

	Provision and Required Action	Reference Schedule	Agency
*(45)	Preliminary Determination (2nd Repository) Section 114(f)		
	(45a) Secretary makes Preliminary Determination that Sites are Suitable for Development As Repositories	10/91	DOE
(46)	Grants to Candidates Sites (2nd Repository) Section 112(c) and 116(c)(1)(B) and 118(b)(2)(A)		
	(46a) Provide Grants to States and/or Affected Indian Tribes Having a Candidate Site	Negotiated by Request	DOE
(47)	Presidential Review of Recommendation (2nd Repository) Section 112(c)		
	(47a) Transmit Decision on Approval or Disapproval of Site Recommendation to the DOE and the Affected States and/or Indian Tribes	12/91	President
(48)	Payment Equal to Taxes (2nd Repository) Sections 116(c)(3) and 118(b)(4)		
	(48a) Provide Payment Equal to Taxes	Candidate Site Design -ation thru Completion of Operations at Site, if Site is Authorized	DOE
(49)	NRC Status Report (1st Repository) "Not later than 1 year after the date on which an application for a construction authorization is submitted under subsection (b), and annually thereafter until the date on which such authorization is granted, the Commission shall submit a report to the Congress describing the proceedings undertaken through the date of such report with regard to such application..." Section 114(c).		
	(49a) NRC's Status Report on LA Review to Congress	5/92, 5/93	NRC
*(50)	Site Characterization Plan (2nd Repository) Section 113(b)		
	(50a) DOE Issue SCP for Review	1/93	DOE
	(50b) Review and Comment on SCP	1/93-4/93	DOI, EPA, DOD, DOT, USDA, NRC

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and
Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

Provision and Required Action	Reference Schedule	Agency
*(51) Site Characterization Analysis (10 CFR 60)[1] (2nd Repository)		
(51a) Issue Draft SCA	6/93	NRC
(51b) Issue SCA	11/93	NRC
(52) Radioactive Material Use (2nd Repository) Section 113(c)(2)(A)		
(52a) NRC Concurrence on Use of Radioactive Materials for Characterization	11/93	NRC
*(53) Update License Application in Accordance with 10 CFR Part 60.24 (1st Repository)		
(53a) Submit Updated LA to NRC-Authority to Receive and Possess HLW for Phase 1 operations of First Repository	8/95	DOE
(53b) NRC Review of Updated LA	6/95-12/97	NRC
(53c) Issue License to Receive and Possess HLW for Phase 1 operations for First Repository	12/97	NRC
(54) NRC Requirements for SCP (2nd Repository) Section 113(b)(1)(A)		
(54a) Identify Additional SCP Content Requirements	Continuing thru 1/98	NRC
*(55) SCP Public Hearings (2nd Repository) Section 113(b)(2)		
(55a) Conduct Public Hearings	4/93	DOE
(55) Written Agreements (2nd Repository) Section 117(c)		
(55a) DOE Negotiate Written Agreements with States and/or Indian Tribes	Within 6 mos after request	DOE
(55b) If no Agreement is reached, DOE Submit Written Explanation to Congress	7 months after request	DOE

[1] According to the Current Procedural Rule (10 CFR Part 60), the NRC will issue a draft and final Site Characterization Analysis (SCA). The final would be completed ten months after receipt of the initial SCP. A change to this rule has been proposed that would require the NRC to issue only a final SCA. The final SCA would be issued for comment five months after receipt of the initial SCP. Comments would then be incorporated into the next SCP report.

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

	Provision and Required Action	Reference Schedule	Agency
*(57)	Request for Authorization to Construct Second Repository		
	(57a) DOE Request Authorization from Congress to Proceed with Development and Construction of a Second Repository	6/93	DOE
(58)	Semi-Annual SCP Report (2nd Repository) Section 113(b)(3)		
	(58a) Issue Semi-Annual SCP Report	7/93-1/97	DOE
(59)	Site Recommendation Public Hearing (2nd Repository) Section 114(a)		
	(59a) DOE Hold Public Hearings on Site Recommendation	6/97	DOE
*(60)	Environmental Impact Statement (2nd Repository) Section 114(a)(1)(D)		
	(60a) Pursuant to Section 1501.6 of the CEQ NEPA Regulations 40 CFR Parts 1500-1508, DOE as the lead agency will request certain other affected Federal agencies to serve as cooperating agencies.	1/92	DOE
	(60b) DOE Issue DEIS	6/97	DOE
	(60c) Review and Comment on DEIS	6/97-9/97	DOT, DOD, CEQ, NRC, DOI, EPA, USDA
	(60d) Issue FEIS, Incorporating Above Comments	12/97	DOE
(61)	NRC Preliminary Sufficiency Comments (2nd Repository) Section 114(a)(1)(E)		
	(61a) NRC Comment on Characterization Analysis	6/97	NRC
*(62)	Site Selection Report (2nd Repository) Section 114(a)		
	(62a) Notify Affected States and/or Indian Tribes of Proposed Site Selection	6/97	DOE
	(62b) Issue Site Selection Report	1/98	DOE

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and
r - ion of the Radioactive Waste Management Sys em
First and Second Geologic Repositories)

	Provision and Required Action	Reference Schedule	Agency
(63)	Record of Decision (ROD) (40 CFR Part 1505) (2nd Repository)		
	(63a) DOE prepare and issue ROD	2/98	DOE
*(64)	Site Recommendation (2nd Repository) Section 114(a)(2)(A)		
	(64a) President Recommend Site to Congress	3/98	DOE
*(65)	Submittal of Amended License Application (1st Repository)		
	(65a) Submit Application to Amend License to NRC - Authority to receive and possess HLW for Phase 2 operations of First Repository	6/98	DOE
	(65b) NRC Review of Amended LA	6/98-1/2001	NRC
	(65c) Issue Amended License to receive and possess HLW for Phase 2 operations of First Repository	1/2001	NRC
(66)	Assistance for Repository States (2nd Repository) Section 116(c)(2)(A) and 118(b)(3)(A)		
	(66a) Prepare and Submit to DOE an Impact Description Report	After Site Characterizaiton and Before (61a)	States, Indian tribes
	(66b) Enter into a Binding Agreement Defining Assistance	10/2000	States, Indian tribes, DOE
	(66c) Provide Financial and Technical Assistance to Mitigate the Impact of Repository Development	2/2001	DOE
*(67)	License Application (2nd Repository) Section 114(b)		
	(67a) Submit LA (License Application per 10 CFR Part 60)	5/98	DOE
	(67b) Review LA	5/98-8/2000	NRC
	(67c) Issue Construction Authorization	8/2000	NRC
(68)	Adoption of FEIS (2nd Repository) Section 114(f)		
	(68a) NRC adoption of DOE FEIS, to Extent Practicable	6/98	NRC

*CRITICAL ACTIVITY

TABLE 1 (Continued)
Activities Associated with the Siting, Construction, and
Operation of the Radioactive Waste Management System
(First and Second Geologic Repositories)

Provision and Required Action	Reference Schedule	Agency
*(69) License Amendments (10 CFR Part 60) (1st Repository)		
(69a) Apply for License Amendment for Permanent Closure of Repository	Prior to Permanent Closure	DOE
(69b) Review License Amendment for Closure	Prior to Permanent Closure	NRC
(69c) Issue License Amendment for Closure	Prior to Permanent Closure	NRC
(69d) Apply for License Amendment for License Termination	After Closure and Decontamination of Surface facilities	DOE
(69e) Review License Amendment for License Termination	After Closure and Decontamination of Surface Facilities	NRC
(69f) Issue License Amendment for License Termination	After Closure and Decontamination of Surface Facilities	NRC

*CRITICAL ACTIVITY

TABLE 2

ACTIVITIES ASSOCIATED WITH THE DEVELOPMENT AND OPERATION OF THE RADIOACTIVE WASTE MANAGEMENT TRANSPORTATION SUBSYSTEM

TABLE 2
Activities Associated With The Development and
Operation of the Radioactive Waste Management Transportation Subsystem

Provision and Required Action		Reference Schedule	Agency
(1)	Transportation Program Milestones Engineering and Procurement		
(1a)	Sign procedural Agreement with NRC to Address Certification Process for Transportation Casks	11/3/83 Actual	DOE, NRC
(1b)	Issue Business Plan	11/85	DOE
(1c)	Develop Transportation Cask Performance Spec for RFP	11/85	DOE
(1d)	Issue RFPs to Private Industry for Cask Development	2/86	DOE
*(1e)	Award Cask Development Contracts	9/86	DOE
*(1f)	NRC Review Safety Analysis Report Packages (SARPs) & Grant Certifications	12/88-12/90	NRC
(1g)	Issue Full Service Contract Procurement RFP	6/90	DOE
	DOE/DOT Interaction		
(1h)	Sign M.O.U. with DOT to Cover Transportation Aspects of the Nuclear Waste Policy Act	8/85	DOE, DOT
(1i)	Initiate Procurement of Transportation Casks	1/93	DOE(1)
(1j)	DOT Determine Transportation Services, if Required	6/91	DOT
	Intergovernmental/Public Interactions		
(1k)	Issue Institutional Plan	4/86	DOE
(1l)	Interact with Public and Intergovernmental Agencies to Identify Fuel Acceptance Scheduling, Routing, and Impacts	2/85-1/98	DOE, DOT

(1) DOT could become involved in determination of cask procurement decision process if private industry is unable or unwilling to provide transportation services at a reasonable cost.

*CRITICAL ACTIVITY

TABLE 3

ACTIVITIES ASSOCIATED WITH THE DEVELOPMENT AND SUBMITTAL OF MRS PROPOSAL AND EA TO CONGRESS

TABLE 3
Activities Associated With The Development and Submittal of MRS Proposal and EA to Congress

	Provision and Required Action	Reference Schedule	Agency
(1)	Monitored Retreivable Storage (MRS) Proposal "On or before June 1, 1985, the Secretary shall complete a detailed study of the need for and feasibility of, and shall submit to the Congress a proposal for, the construction of one or more Monitored Retrievable Storage facilities for high-level radioactive waste and spent nuclear fuel. . . . The Secretary shall prepare, in accordance with regulations issued by the Secretary implementing such Act, an environmental assessment with respect to such proposal." Section 141(b), 141(c).		
	(1a) Consultation with EPA and NRC for the Development of an MRS Proposal	11/85	NRC, EPA
	(1b) Issue draft MRS Proposal	11/85	DOE
	(1c) Review and comment on draft MRS Proposal	12/2/85- 1/15/86	NRC, EPA
	(1d) Submit MRS Proposal and EA to Congress	1/15/86	DOE

TABLE 4

Activities Associated with the Siting, Construction and Operation of the Radioactive Waste Management System (Agency-By-Agency Cross-Cut)

NOTE: The following tables list activities by agency. The numbers in the far left column correspond to the activity numbers on Table 1, 2, and 3. For example, the number I-2a is an activity associated with the siting, construction, and operation of the Radioactive Waste Management System (First and Second Mined Geologic Repositories) listed in Table 1; the number II-1b is an activity associated with the Transportation Subsystem and is listed in Table 2; and the number III-1a relates to an activity associated with the development of the MRS proposal listed in Table 3.

4.1 U.S. Department of Agriculture
4.2 U.S. Department of Commerce
4.3 U.S. Department of Defense
4.4 U.S. Department of Interior
4.5 U.S. Department of Justice
4.6 U.S. Department of Transportation
4.7 Council on Environmental Quality
4.8 Environmental Protection Agency
4.9 Nuclear Regulatory Commission

TABLE 4.1

AGENCY: U.S. DEPARTMENT OF AGRICULTURE (USDA)

		Task	Action Required	Date
I-10b	*	Environmental Assessments	Review and Comment	12/84 - 3/85
I-18a	*	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86
I-21b	*	Site Characterization Plan	Review and Comment	(Basalt) 6/87 (Tuff) 6/87 (Salt) 1/87
I-28		Land Acquisition for Salt Sites	Negotiate Land Use Permits or Agreements, As Needed; Review and Approve Land Withdrawal, if Necessary	8/90 - 5/93
I-34c	*	Environmental Impact Statement	Review and Comment	6/90 - 9/90
I-40b	*	Environmental Assessments For Second Repository	Review and Comment	3/91 - 6/91
I-50b	*	Site Characterization Plan For Second Repository	Review and Comment	1/93 - 4/93
I-60c	*	Environmental Impact Statement For Second Repository	Review and Comment	6/97- 9/97

*CRITICAL ACTIVITY

TABLE 4.2

AGENCY: U.S. DEPARTMENT OF COMMERCE (DOC)

	Task	Action Required	Date
I-18a *	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86

*CRITICAL ACTIVITY

TABLE 4.3

AGENCY: U.S. DEPARTMENT OF DEFENSE (DOD)

	Task	Action Required	Date
Air Force (AF)			
I-10b *	Environmental Assessments	Review and Comment	12/84 - 3/85
I-18a *	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86
I-21b *	Site Characterization Plan	Review and Comment	(Basalt) 6/86 (Tuff) 6/86 (Salt) 1/87
I-27 *	Land Acquisition for Tuff Site	Review Permits and Agreements; Review and Approve Land Withdrawal, if Necessary	1/86 - 5/93
I-34c *	Environmental Impact Statement	Review and Comment	6/90 - 9/90
I-40b *	Environmental Assessments(1) For Second Repository	Review and Comment	3/91 - 6/91
I-50b *	Site Characterization (1) Plan For Second Repository	Review and Comment	1/93 - 4/93
I-60c *	Environmental Impact State-(1) ment For Second Repository	Review and Comment	6/97- 9/97

(1) Only required if the Nevada Tuff site is included in those being considered for the second repository.

*CRITICAL ACTIVITY

TABLE 4.3 (Continued)

AGENCY: U.S. DEPARTMENT OF DEFENSE (DOD)

		Task	Action Required	Date
Army Corps of Engineers (COE)				
I-10b	*	Environmental Assessments	Review and Comment	12/84 - 3/85
I-18a	*	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86
I-21b	*	Site Characterization Plan	Review and Comment	(Basalt) 6/86 (Tuff) 6/86 (Salt) 1/87
I-28	*	Land Acquisition for Salt Sites	Acquire Necessary Real Property	7/85 - 8/93
I-34c	*	Environmental Impact Statement	Review and Comment	6/90 - 9/90
I-40b	*	Environmental Assessments For Second Repository	Review and Comment	3/91 - 6/91
I-50b	*	Site Characterization Plan For Second Repository	Review and Comment	1/93 - 4/93
I-60c	*	Environmental Impact Statement For Second Repository	Review and Comment	6/97- 9/97

*CRITICAL ACTIVITY

TABLE 4.4

AGENCY: U.S. DEPARTMENT OF THE INTERIOR (DOI)

		Task	Action Required	Date
I-10b	*	Environmental Assessments	Review and Comment	12/84 - 3/85
I-14a		Define Affected Indian Tribes	Make a Determination	Upon Appli-cation By Tribe
I-18a	*	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86
I-21b	*	Site Characterization Plans	Review and Comment	(Basalt) 6/86 (Tuff) 6/86 (Salt) 1/87
I-34c	*	Environmental Impact Statement	Review and Comment	6/90 - 9/90
I-40b	*	Environmental Assessments For Second Repository	Review and Comment	3/91 - 6/91
I-50b	*	Site Characterization Plans For Second Repository	Review and Comment	1/93 - 4/93
I-60c	*	Environmental Impact Statement For Second Repository	Review and Comment	6/97-9/97

*CRITICAL ACTIVITY

TABLE 4.4 (Continued)

AGENCY: U.S. DEPARTMENT OF THE INTERIOR (DOI)

Bureau of Land Management (BLM)(1)

	Task	Action Required	Date
I-4a	MOU Concerning Environmental Reviews for Site Characterization Activities	Develop MOU	6/83 Actual
I-10b *	Environmental Assessments	Review and Comment	12/84 - 3/85
I-18a *	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86
I-21b *	Site Characterization Plans	Review and Comment	(Basalt) 6/86 (Tuff) 6/86 (Salt) 1/87
I-27 *	Land Acquisition for Tuff Site	Review and Approve Land Withdrawal	1/86 - 5/93
I-28 *	Land Acquisition for Salt Sites	Review and Approve Land Withdrawal	8/90- 5/93
I-34c *	Environmental Impact Statement	Review and Comment	6/90 - 9/90
I-40b *	Environmental Assessments(2) For Second Repository	Review and Comment	3/91 - 6/91
I-50b *	Site Characterization Plans(2) For Second Repository	Review and Comment	1/93 - 4/93
I-60c *	Environmental Impact State-(2) ment for Second Repository	Review and Comment	6/97- 9/97

(1) BLM's involvement will be principally limited to salt sites

(2) Only required if the Nevada Tuff site is included in those being considered for the second repository.

*CRITICAL ACTIVITY

TABLE 4.4 (Continued)

AGENCY: U.S. DEPARTMENT OF THE INTERIOR (DOI)

National Park Service (NPS)

		Task	Action Required	Date
I-6a		MOU Concerning NPS Role in OCRWM Program	Develop MOU	5/1/84 Actual
I-7a		Interagency Agreement Concerning NPS Review of EA's	Sign Interagency Agreement	9/14/84 Actual
I-18a	*	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86
I-28	*	Land Acquisition For Salt Sites	Review and Approve Land Withdrawal	8/90 - 5/93

*CRITICAL ACTIVITY

TABLE 4.4 (Continued)

AGENCY: U.S. DEPARTMENT OF THE INTERIOR (DOI)

U.S. Geological Survey (USGS)

		Task	Action Required	Date
I-5a		MOU on Site Characterization Plans	Develop MOU with DOE	3/29/84 Actual
I-8a	*	Siting Guidelines	Consultation	11/22/83 Actual
I-10b	*	Environmental Assessments	Review and Comment	12/84 - 3/85
I-18a	*	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86
I-21b	*	Site Characterization Plans	Review and Comment	(Basalt) 6/86 (Tuff) 6/86 (Salt) 1/87
I-34c	*	Environmental Impact Statement	Review and Comment	6/90 - 9/90
I-40b	*	Environmental Assessments For Second Repository	Review and Comment	3/91 - 6/91
I-50b	*	Site Characterization Plans For Second Repository	Review and Comment	1/93- 4/93
I-60c	*	Environmental Impact Statement For Second Repository	Review and Comment	6/97- 9/97

*CRITICAL ACTIVITY

TABLE 4.5

AGENCY: U.S. DEPARTMENT OF JUSTICE (DOJ)

	Task	Action Required	Date
I-18a *	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86
I-28 *	Land Acquisition for Salt Sites	Provide Legal Assistance re. Land Acquisition	12/85-8/93

*CRITICAL ACTIVITY

TABLE 4.6

AGENCY: U.S. DEPARTMENT OF TRANSPORTATION (DOT)

		Task	Action Required	Date
I-10b	*	Environmental Assessments	Review and Comment	12/84 - 3/85
I-18a	*	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86
I-21b	*	Site Characterization Plan	Review and Comment	(Basalt) 6/86 (Tuff) 6/86 (Salt) 1/87
I-34c	*	Environmental Impact Statement	Review and Comment	6/90 - 9/90
I-40b	*	Environmental Assessments For Second Repository	Review and Comment	3/91 - 6/91
I-50b	*	Site Characterization Plan For Second Repository	Review and Comment	1/93 - 4/93
I-60c	*	Environmental Impact Statement For Second Repository	Review and Comment	6/97- 9/97
II-1i		MOU on Transportation aspects of NWPA	Develop MOU with DOE	8/85
II-1j		Determination of Transportation Services, if required	Determine who will provide Transportation Services	6/91
II-1l		Interaction of Public and Intergovernmental agencies during Transportation Program	Consultation	2/85 - 1/98

*CRITICAL ACTIVITY

TABLE 4.7

AGENCY: COUNCIL ON ENVIRONMENTAL QUALITY (CEQ)

		Task	Action Required	Date
I-8a	*	Siting Guidelines	Consultation	11/22/83 Actual
I-18a	*	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86
I-34c	*	Environmental Impact Statement	Review and Comment pursuant to Sec. 309 of the Clean Air Act, if referred by EPA	6/90 - 9/90
I-60c	*	Environmental Impact Statement For Second Repository	Review and Comment pursuant to Sec. 309 of the Clean Air Act, if referred by EPA	6/97- 9/97

*CRITICAL ACTIVITY

TABLE 4.8

AGENCY: ENVIRONMENTAL PROTECTION AGENCY (EPA)

		Task	Action Required	Date
I-8a	*	Siting Guidelines	Consultation	11/22/83 Actual
I-10b	*	Environmental Assessments	Review and Comment	12/84 - 3/85
I-12a	*	EPA Standards	Develop Standards under Applicable statutes	8/85
I-18a	*	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86
I-21b	*	Site Characterization Plan	Review and Comment	(Basalt) 6/86 (Tuff) 6/86 (Salt) 1/87
I-34c	*	Environmental Impact Statement	Review and Comment pursuant to Sec. 309 of the Clean Air Act	6/90 - 9/90
I-40b	*	Environmental Assessments For Second Repository	Review and Comment	3/91 - 6/91
I-50b	*	Site Characterization Plan For Second Repository	Review and Comment	1/93 - 4/93
I-60c	*	Environmental Impact Statement For Second Repository	Review and Comment	6/97-9/97
III-1a		Development of MRS Proposal	Consultation	11/85
III-1c		Draft MRS Proposal	Review and Comment	12/2/85-1/15/86

*CRITICAL ACTIVITY

TABLE 4.9

AGENCY: NUCLEAR REGULATORY COMMISSION (NRC)

		Task	Action Required	Date
I-3a		MOU on Site Characterization Activities	Develop MOU with DOE	6/27/83 Actual
I-8a	*	Siting Guidelines	Concurrence	6/22/84 Actual
I-10b	*	Environmental Assessments	Review and Comment	12/84 - 3/85
I-11a	*	Draft Regulatory Guide 4.17	Update RG 4.17 on SCP Contents	3/85
I-11b	*	Final Regulatory Guide 4.17	Issue Final RG 4.17	After 13b
I-11c	*	SCP Content	Identify Information Requirements	Through 12/1/90
I-13a	*	NRC Requirements and Criteria	Develop Criteria	6/21/83 Actual
I-13b	*	Revise Criteria	Revise Criteria Based on EPA Standards	11/85
I-18a	*	Report to DOE on Regulations and Permit Requirements	Review and Submit Report	1/1/86
I-21b	*	Site Characterization Plan	Review and Comment	(Basalt) 6/86 (Tuff) 6/86 (Salt) 1/87
I-22a	*	Draft Site Characterization Analysis	Issue Draft SCA	(Basalt) 8/86 (Tuff) 8/86 (Salt) 3/87
I-22b	*	Site Characterization Analysis	Issue SCA	(Basalt) 1/87 (Tuff) 1/87 (Salt) 8/87
I-23a		Radioactive Material Use	Concur on use	(Basalt) 1/87 (Tuff) 1/87 (Salt) 8/87
I-25a	*	License Application Guidance	Provide Draft Detailed Guidance on LA Content	5/87
I-25b	*	License Application Guidance	Provide Final Guidance on LA Content	5/88

*CRITICAL ACTIVITY

TABLE 4.9 (Continued)

AGENCY: NRC

		Task	Action Required	Date
I-34c	*	Environmental Impact Statement	Review and Comment	6/90 - 9/90
I-35a		NRC Preliminary Sufficiency Comments	Review and Comment	6/90 - 1/91
I-40b	*	Environmental Assessments For Second Repository	Review and Comment	3/91 - 6/91
I-43b	*	License Application	Review	5/91 - 8/93
I-43c	*	License Application	Issue Construction Authorization (CA)	8/93
I-44a		Adoption of FEIS	Adopt FEIS, to Extent Practicable	6/91
I-49a		NRC Status Report	Report to Congress	5/92, 5/93
I-50b	*	Site Characterization Plan For Second Repository	Review and Comment	1/93 - 4/93
I-51a	*	Draft Site Characterization Analysis for Second Repository	Issue Draft SCA	6/93
I-51b	*	Site Characterization Analysis For Second Repository	Issue SCA	11/93
I-52a		Radioactive Material Use For Second Repository	Concur on Use	11/93
I-53b	*	Update License Application in Accordance With 10 CFR Part 60.24	Review and Update LA License to receive and possess HLW	6/95 - 12/97
I-53c	*	Issue License to Receive and Possess HLW	Issue License for Phase 1 Operations of First Repository	12/97
I-54a	*	Requirements for SCPs for Second Repository	Identify Information Requirements	Continuing thru 1/98
I-60c	*	Environmental Impact Statement For Second Repository	Review and Comment	6/97- 9/97

*CRITICAL ACTIVITY

TABLE 4.9 (Continued)

AGENCY: NRC

	Task	Action Required	Date
I-61a	Preliminary Sufficiency Comments For Second Repository	Review and Comment	6/97
I-65b *	Amended License Application	Review Amended LA for Phase 2 Operations for First Repository	6/98-1/2001
I-65c *	Amended License Application	Issue Amended License for Phase 2 Operations for First Repository	1/2001
I-67b *	License Application For Second Repository	Review LA	5/98-8/2000
I-67c *	License Application For Second Repository	Issue Construction Authorization	8/2000
I-68a	Adoption of FEIS for Second Repository	Adopt FEIS, to Extent Practicable	6/98
I-69b,c	License Amendment	Review and Issue License Amendment for Repository Closure	Prior to Permanent Closure
I-69e,f	License Amendment	Review and Issue License Amendment for License Termination	After Closure and Decontamination of Surface Facilities
II-1a	Develop Procedural Agreements with DOE	Sign Procedural Agreement	11/3/83 Actual
II-1f *	Review Safety Analysis Report Packages (SARPs) and Grant Cask Design Certifications	Review and Comment; Grant Certification of Designs	12/88 - 12/90
III-1a	Development of MRS Proposal	Consultation	11/85
III-1c	Draft MRS Proposal	Review and Comment	12/2/85-1/15/86

*CRITICAL ACTIVITY

APPENDIX A

NUCLEAR WASTE POLICY ACT OF 1982, SECTION 114(e)

(e) PROJECT DECISION SCHEDULE

(1) The Secretary shall prepare and update, as appropriate, in cooperation with all affected Federal agencies, a project decision schedule that portrays the optimum way to attain the operation of the repository involved, within the time periods specified in this subtitle. Such schedule shall include a description of objectives and a sequence of deadlines for all Federal agencies required to take action, including an identification of the activities in which a delay in the start, or completion, of such activities will cause a delay in beginning repository operation.

(2) Any Federal agency that determines that it cannot comply with any deadline in the project decision schedule, or fails to so comply, shall submit to the Secretary and to the Congress a written report explaining the reason for its failure or expected failure to meet such deadline, the reason why such agency could not reach an agreement with the Secretary, the estimated time for completion of the activity or activities involved, the associated effect on its other deadlines in the project decision schedule, and any recommendations it may have or actions it intends to take regarding any improvements in its operation or organization, or changes to its statutory directives or authority, so that it will be able to

mitigate the delay involved. The Secretary, within 30 days after receiving any such report, shall file with the Congress his response to such report, including the reasons why the Secretary could not amend the project decision schedule to accommodate the Federal agency involved.

APPENDIX B

NUCLEAR WASTE POLICY ACT OF 1982, SECTION 120

EXPEDITED AUTHORIZATIONS

Section 120(a) ISSUANCE OF AUTHORIZATIONS

(1) To the extent that the taking of any action related to the site characterization of a site or the construction or initial operation of a repository under this subtitle requires a certificate, right-of-way, permit, lease, or other authorization from a Federal agency or officer, such agency or officer shall issue or grant any such authorization at the earliest practicable date, to the extent permitted by the applicable provisions of law administered by such agency or officer. All actions of a Federal agency or officer with respect to consideration of applications or requests for the issuance or grant of any such authorization shall be expedited, and any such application or request shall take precedence over any similar applications or requests not related to such repositories.

(2) The provisions of paragraph (1) shall not apply to any certificate, right-of-way, permit, lease, or other authorization issued or granted by, or requested from, the Commission.

(b) TERMS OF AUTHORIZATION--Any authorization issued or granted pursuant to subsection (a) shall include such terms and conditions as may be required by law, and may include terms and conditions permitted by law.

APPENDIX C

DEPARTMENT OF ENERGY RESPONSES TO COMMENTS ON THE PRELIMINARY DRAFT PROJECT DECISION SCHEDULE (DOE/RW-0018; January 1985)

C.1. Comment Response Overview

The Preliminary Draft Project Decision Schedule (PDPDS: DOE/RW-0018; January 1985) was issued by the Department of Energy, Office of Civilian Radioactive Waste Management (OCRWM) on January 4, 1985. A notice announcing its issuance was published in the Federal Register on January 11, 1985 (50 FR 1616). Copies of the PDPDS were distributed to Federal agencies affected by the Radioactive Waste Management Program for their review and comment. Approximately 1000 additional copies were distributed to Governors, designated State Executive Branch contacts, affected Indian Tribe representatives, national organizations, and other interested parties for their information.

The Department received approximately 80 comments on the PDPDS from eight Federal agencies (see C.1.1). The comments were categorized (see C.1.2) and individual responses were prepared. It should be noted that individual responses for editorial or non-substantive comments were not prepared. These comments were considered and, as appropriate, incorporated into the Draft Project Decision Schedule (DOE/RW-0018; July 1985).

The PDPDS Comment Response Document (CRD) presents individual Departmental responses to each non-editorial or substantive comment submitted by the affected Federal agencies. These responses are reflected in the Draft Project Decision Schedule. Within the CRD, comments are grouped by category and presented in their entirety in the left-hand column of each page. The corresponding Departmental responses are depicted in the right-hand column along with the alphanumeric identification code that facilitated comment categorization and response production procedures. The code allows for identification of the specific PDS to which the comment applies (i.e., PDS0185 is the preliminary Draft PDS issued in January 1985). The abbreviation that follows permits the identification of the organization originating the comment (see C.1.1; i.e., NRC is the Nuclear Regulatory Commission: See C.1.1 for a complete list of agency abbreviations). Following the agency abbreviation is a unique sequential numeric identifier (i.e., 001 is the first comment from an agency).

C.1.1 Commenting Agencies; Number of Comments Received; and Identification Code Abbreviations:

Agency/Organization	Number of Comments	Identification Code Abbreviation
U.S. Council on Environmental Quality	2	CEQ
U.S. Department of Agriculture	1	USDA
U.S. Department of the Interior	37	DOI
U.S. Department of Justice	1	DOJ
U.S. Department of Labor	1	DOL
U.S. Environmental Protection Agency	2	EPA
Nuclear Regulatory Commission	35	NRC
U.S. Department of Defense U.S. Air Force	1	USAF

C.1.2 Number of Comments Received by Comment Category

Section	Comment Category	Number of Comments
C.2.1	Comments Related to the Mission Plan	2
C.2.2	Contingency Planning	2
C.2.3	Editorial Comments	3
C.2.4	Federal Agency Roles-Actions/Compliance	29
C.2.5	General Comments	1
C.2.6	Licensing Process	9
C.2.7	MRS Program	2
C.2.8	Other	4
C.2.9	Schedule Milestones/Sequence of Events	13
C.2.10	Schedule/Review-Period Durations	12
C.2.11	Transportation Program	3

COMMENT	RESPONSE

** C.2.1: <u>COMMENTS RELATED TO THE MISSION PLAN</u>

* COMMENT I.D.: PDS0185/NRC-026

We reiterate comments provided to DOE on the Draft Mission Plan (July 31, 1984, Enclosure 3, Comment #1), regarding the need for additional information on the two-stage construction plan for the first repository. The Final Mission Plan should include such information as the basis for the Project Decision Schedule.

RESPONSE: NRC's comments on the Draft Mission Plan were considered and reflected in the recently issued Mission Plan.

* COMMENT I.D.: PDS0185/NRC-027

Like the Draft Mission Plan, the preliminary Draft Project Decision Schedule divides the repository program into five major phases (p. 8). The same terminology is used to distinguish between the initial 400 metric ton per year capacity facility (Phase 1) and the full-scale 3000 metric ton per year capacity facility (Phase 2) planned by Doe for the first repository. It would be helpful to use different terminology for these two purposes (such as by calling the two first repository facilities "Stage 1" and "Stage 2").

RESPONSE: The Department does not believe that the likelihood for confusion between the five phases of repository development and the two-phased construction approach is great and, therefore, no change in the terminology is being made.

** C.2.2: <u>CONTINGENCY PLANNING</u>

* COMMENT I.D.: PDS0185/DOI-008

Figure 1 - KEY ACTIVITIES AND DECISION POINTS should me modified to address the following issues:

D. Figure 1 identifies no process to select another site for characterization if one (or more) site(s) of the original group identified for characterization are found unsuitable. This is consistent with statements made by the Department of Energy (DOE) in recent briefings on the EAs. However, block 21a indicates "Notify States of 3 to 1 Selection." This may not be the case since one (or more) site(s) of the original three may have been found unsuitable. Therefore, the phrase in this block should be clarified. In addition, if it is possible that additional sites (nominated but not recommended for characterization) may be selected for characterization, this process should be identified as a key activity and included in Figure 1. (also see comments PDS0185/DOI-005; PDS0185/DOI-006; PDS0185/DOI-007)

RESPONSE: The PDS identifies only those specific Federal agency actions associated with the Department's "Authorized" plan. It is not feasible, nor would it be productive, to identify all contingency schedules and associated Federal agency actions. The Department does not believe that it could expect an agency to commit itself to take an action based on a contingency schedule. The PDS will be modified to reflect programmatic changes when it becomes necessary to do so.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/DOI-##9 In the discussion of Phases 1 and 2 (i.e., issuance of siting guidelines through completion of site characterization), the decision schedule should address courses of action to be taken if one, two, or all three of the sites recommended for characterization are found unsuitable and/or disqualified due to technical, legal, or timing constraints.	The Mission Plan discusses various contingency plans that may be utilized if all sites are found to be unsuitable. The Department believes that, subsequent to the preliminary determination being made regarding site suitability, there will be no requirement to characterize additional sites should one or two be found unsuitable.
** C.2.3: EDITORIAL COMMENTS	
* COMMENT I.D.: PDS#185/NRC-#3# The preliminary draft states that DOE must comply with both NRC's technical criteria and EPA's standards for high-level waste repositories (p. 24, third paragraph). It would be more accurate to state that DOE is required to comply with NRC's criteria alone (and DOE would thereby meet EPA's high-level waste standards as they are implemented by NRC).	The narrative portion of the Preliminary Draft PDS to which this comment is directed has been eliminated from the Draft PDS. The Department, however, takes note of the comment.
* COMMENT I.D.: PDS#185/DOI-#17 The MOU signed by OCRWM and USGS does not state the USGS will furnish "as requested by the Department." It states: "1. Upon mutual agreement between DOE and USGS, the USGS shall:" Since these are not synonymous, we ask that the wording be changed to reflect the MOU.	The narrative portion of the Preliminary Draft PDS to which this comment is directed has been eliminated from the Draft PDS.
* COMMENT I.D.: PDS#185/DOI-##7 Figure 1 - KEY ACTIVITIES AND DECISION POINTS should be modified to address the following issues: C. If a site is determined to be unsuitable, Figure 1 includes a block which indicates "Decommission and Decontaminate." Given the importance of reclamation at such a site, we recommend that this block be revised to indicate "Decommission, Decontaminate, and Reclaim." (also see comments PDS#185/DOI-##5; PDS#185/DOI-##6; PDS#185/DOI-##8)	Decommissioning and Decontamination are generally accepted terms that describe the process for returning a site to its original condition before site characterization, and includes reclamation of the site. This is consistent with NRC's Regulatory Guide 4.17 and DOE's Annotated Outline for the SCP.

COMMENT	RESPONSE
** C.2.4: FEDERAL AGENCY ROLES-ACTIONS/COMPLIANCE	
* COMMENT I.D.: PDS#185/NRC-007 CONCURRENCE IN USE OF RADIOACTIVE MATERIAL - The preliminary draft proposes for NRC to concur in the use of radioactive material at candidate sites undergoing characterization by May 1987 for first repository sites and by June 1991 for second repository sites (pp. 39, 51 and 80). Under proposed procedural amendments to 10 CFR Part 60 (See enclosure 2), NRC's site characterization analysis would include a determination on the proposed use of radioactive material, if DOE's planned site characterization activities include onsite testing with such material (proposed 10 CFR 60.18(e)). NRC recommends separate listings for this milestone for each candidate repository site undergoing characterization, and that these schedules coincide with the proposed deadlines for completing site characterization analyses for each site.	The Department agrees and the Draft PDS reflects this suggestion.
* COMMENT I.D.: PDS#185/NRC-010 REVISION OF 10 CFR PART 60 - Table 5.11 proposes for NRC to revise its criteria in 1985 based on EPA's high-level waste standards (p. 80). This should be revised consistent with Table 1 (p. 45), where it is stated that NRC's revision will occur after EPA completes its final HLW standard.	The Department agrees with this comment and the modification is reflected in the Draft PDS.
* COMMENT I.D.: PDS#185/NRC-031 The procedures for updating the Project Decision Schedule, described on pp. 6 and 7, appear to be acceptable with one exception. In case of the second type of update, described at the end of p. 7, the discussion does not indicate whether or not other agencies would be given an opportunity to assess their ability to comply with updates initiated by DOE. Such provisions should be added to the discussion on p. 7.	The provisions for modifying the PDS have been changed from the Preliminary Draft PDS. A provision for modifying the PDS in cooperation with the affected Federal agencies has been incorporated.
* COMMENT I.D.: PDS#185/NRC-032 Figure 1 (p. 4) should be revised to reflect the possibility that NRC could deny the construction authorization or the license to receive and possess waste.	The Mission Plan recognizes this possibility and a contingency plan has been developed that reflects this. The PDS, however, only recognizes the Mission Plan's "Authorized" plan. Should changes be required, the PDS will be modified in cooperation with Federal agencies to reflect those changes.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/DOI-##2 We note that under present laws and regulations, the Bureau of Land Management can comply with the proposed schedule for the first repository in the PDS should Bureau-administered lands be involved. Given the long lead time on this project, however, changes in the laws and regulations which might affect the Bureau's ability to meet this schedule cannot be precluded.	The Department takes note of the comment and has incorporated provisions for modifying the PDS should statutes or regulations change.
* COMMENT I.D.: PDS#185/DOI-##4 Another major concern involves Item 7 in Table 3 (page 57). As clearly footnoted by DOE "These activities...are outside the scope of the Project Decision Schedule." The work commitments to DOE by the USGS at the Nevada Test Site are dependent on circumstances totally outside the control of this agency, such as level of DOE funding, and results of basic research. Also, site investigations in support of DOE's program clearly are not the type of Federal agency responsibilities envisioned by Congress when the Act was passed. Therefore, we do not believe that Item 7 in Table 3 is appropriate for inclusion in a Project Decision Schedule. This item should be deleted, as should III-7 in Table 5.6, which is a repeat of the same information tabulated by the agency.	The Department agrees and is eliminating the DOI/USGS efforts in support of site-specific investigations from the Draft PDS.
* COMMENT I.D.: PDS#185/DOI-##5 Figure 1 - KEY ACTIVITIES AND DECISION POINTS should be modified to address the following issues: A. Block 11b should indicate review of Site Characterization Plans (SCPs) by NRC, States, Indian Tribes, and other Federal agencies. (also see comments PDS#185/DOI-##6; PDS#185/DOI-##7; PDS#185/DOI-##8)	The Department agrees with this comment. The SCPs will be made available to other Federal agencies, States, and Indian Tribes. This is reflected in the Draft PDS.
* COMMENT I.D.: PDS#185/DOI-#12 In accordance with the text on pages 3# and 31, Figure 9 should be modified to include review of the SCP (Salt) by the Department of the Interior (DOI).	The Department agrees. Although Figure 9 is no longer included in the Draft PDS, DOI's review of the SCP's is called for in Table 1.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/DOI-#16 The USGS is to be requested to comment on the Site Characterization Plans "to assess the technical credibility of the site characterization testing program." This request can only be accommodated within the constraints of available manpower and within the areas of expertise of the USGS.	The Department recognizes the validity of the comment. However, one of the purposes of the PDS is to provide affected Federal agencies with sufficient notification as to when they will be required to take action(s) to assist the Department in the development of the Program so that they will be able to appropriately staff their agency to handle the expected increased workload or, in the alternative, in accordance with the provisions of Section 114(e)(2), notify the Secretary of Energy and Congress of their projected failure to meet a deadline contained in the PDS for taking action.
* COMMENT I.D.: PDS#185/DOI-#18 Table 1 should be modified to include DOI in Review and Comment on SCP.	See response to comment PDS#185/DOI-#05 (page C-8).
* COMMENT I.D.: PDS#185/DOI-#19 An item (16b) should be added to include: review and comment on the semi-annual SCP Reports, as is shown in Figure 9.	The Department will make the SCP Reports available to all interested parties, including Federal agencies, but no formal comment period is provided for.
* COMMENT I.D.: PDS#185/DOI-#21 An item (14b) should be added to address: review and comment on the semiannual SCP Reports as is included in the first repository program.	The Department will make the SCP Reports available to all interested parties, including Federal agencies, but no formal comment period is provided for.
* COMMENT I.D.: PDS#185/DOI-#23 Table 3 should include DOI in Review and Comment on SCA for 1st Repository.	NRC has proposed a revision to 10 CFR Part 60 that would change their procedures with regard to the issuance of SCAs. The proposed change would eliminate the requirement to issue a Draft SCA. A number of reasons were cited by the NRC for this change. Among them were the extensiveness of the interaction between NRC and the Department, their ability to become fully informed about the Program, and the public involvement in the process. The NRC, in addition will be reviewing public comments on the SCPs. Therefore, DOI's comments on SCPs will serve the same purpose as would have been served by comments to NRC's Draft SCA.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/DOI-#25 Table 3 should reflect the existing Memorandum of Understanding (MOU) approved May 1, 1984, between the Rocky Mountain Regional Office, National Park Service (NPS), and the Salt Repository Project Office, DOE. This MOU formalizes an active and timely consultation and review role for NPS in the Civilian Radioactive Waste Management Program in the vicinity of Canyonlands National Park. Table 3 should also recognize the subsequent Interagency Agreement between NPS and DOE, approved September 14, 1984, which provides for NPS participation in preparing, reviewing, and commenting on EAs; taking part in workshops and meetings;	The Department agrees with the comment and has incorporated a reference to the MOU and IAG in the Draft PDS.
* COMMENT I.D.: PDS#185/DOI-#26 DOI should be added to the list of agencies involved in review of the Semiannual SCP Reports.	The Department will make the SCP Reports available to all interested parties, including Federal agencies, but no formal comment period is provided for.
* COMMENT I.D.: PDS#185/DOI-#27 Item (4a) - Dates are again questionable. It is unclear whether the USGS is expected to be reviewer.	The Department will make the SCP Reports available to all interested parties, including Federal agencies, but no formal comment period is provided for.
* COMMENT I.D.: PDS#185/DOI-#28 In the listing of Air Quality regulatory activities, the Decision Schedule should be amended to include a role for the Assistant Secretary for Fish and Wildlife and Parks of DOI. More specifically, this individual is the Federal Land Manager (FLM) for Canyonlands National Park (adjacent to the proposed repository sites at Davis Canyon and Lavender Canyon). In this case, the State of Utah provides for review by the FLM of the air quality related impacts of new air pollution sources (regardless of whether the source is subject to the Prevention of Significant Deterioration Regulations). Under the Utah Air Conservation Regulations, the FLM has an opportunity to determine whether the air quality related values (AQRVs) in the Class I area would be adversely affected. This review would presumably occur before shaft construction commences at the repository site.	The PDS does not identify specific individuals within an organization as having responsibility for taking action. The PDS will, however, identify components within Federal agencies that have the lead role for taking actions.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/DOI-#29 Table 5.4 which lists the actions of DOI should be modified to include reviews of SCPs, Semiannual SCP Reports, and SCAs. In addition, the role of the Assistant Secretary for Fish and Wildlife and Parks of DOI as FLM in determining whether repository construction and operation would cause adverse impacts on AQRVs of Canyonlands National Park should be included in this table.	See response to comments PDS#185/DOI-#05, DOI-#19, and DOI-#23 (pages C-8 and C-9). With regard to impacts of repository construction in Canyonlands National Park, they are considered in the Environmental Assessment and, should a Utah site be selected as the repository, those impacts will be considered further in an Environmental Impact Statement. It should be noted that the Preliminary Draft PDS, in Table 5.4, identified DOI as being a reviewer of the EAs. The Department is of the opinion that the level of detail suggested to be presented in the PDS, in terms of the identification of the specific reviewer, is not appropriate.
* COMMENT I.D.: PDS#185/DOI-#30 The regulations to be reviewed as noted in items IV-1 and IV-2 should be identified, at least by reference to the appropriate sections of Table 4.	The Department is requesting, in Table 1, item 18, that affected Federal agencies specifically identify, on a site-by-site basis, those regulations and permits that are applicable and the time frame for compliance with the regulations and permits.
* COMMENT I.D.: PDS#185/DOI-#31 Table 5.5 on page 74 should be modified to indicate that the Bureau (BLM) will be involved with salt sites in Utah only.	The Department agrees and has modified the Preliminary Draft PDS accordingly.
* COMMENT I.D.: PDS#185/DOI-#35 III-2a - The interagency MOU between the Office of Geologic Repository Deployment, DOE, and the U.S. Geological Survey does not specifically address the review of Site Characterization Plans, although items I.B. and II.B.1.(e) are applicable to such review.	The Department agrees that those items contained in the MOU would cover review of the SCPs.
* COMMENT I.D.: PDS#185/DOI-#36 III-7 - As is discussed in our general comments this item is not appropriate for inclusion in the PDS.	The Department agrees and is eliminating the DOI/USGS efforts in support of site-specific investigations from the Draft PDS.
* COMMENT I.D.: PDS#185/DOI-#37 IV-1 - The appropriate sections of Table 4 should be identified. A time commitment for response covering a period of 16 years needs much better definition.	The Department is requesting, in Table 1, item 18, that affected Federal agencies specifically identify, on a site-by-site basis, those regulations and permits and the time frame for compliance with the regulations and permits. The Department is requesting that this identification be made by January 1, 1986.

COMMENT	RESPONSE
* COMMENT I.D.: PDS0185/CEQ-002 The role that the Council will take in reviewing the applicability of federal regulations and statutes is more limited than that set forth in Table 4. CEQ is responsible for oversight of the environmental assessment process, but not of the specific requirements of environmental statutes. The various program agencies provide interpretations of laws in their particular functional areas. To more accurately represent CEQ's role, Table 4 should be revised to insert a category for "environmental assessment with reference to the National Environmental Policy Act, 42 U.S.C. 4321 et. seq., and to delete the references under the categories for Cultural Resources Hydrology and Water Quality, and Land Use.	Table 4 of the Preliminary Draft PDS has been eliminated in the Draft PDS. The substance of Table 4, however, has been incorporated in Table 1 of the Draft PDS. The comment regarding "Environmental Assessment" and its relation to NEPA, the Department believes, is addressed in the listing of Federal agencies responsible for reviewing the Draft EIS (Table 1, item 34).
* COMMENT I.D.: PDS0185/DOJ-001 With regard to Justice, the report notes that it must provide legal review of land acquisition procedures for sites; the report states that the dates for such consideration by Justice would be during the period of July 1986-93. Page 76, table 5.7. We have conferred with the Chief, Land Acquisition Section, and he told us that this is fine with him.	No response necessary.
* COMMENT I.D.: PDS0185/USDA-001 The involvement of the Department of Agriculture in the selection and construction of the first repository appears to be limited. The schedule in table 5.1 is acceptable. However, it should be recognized that there are some intermediate steps to obtaining a special use authorization from the Forest Service for site characterization tests and studies at the Cypress Creek Dome site. The Department of Energy (DOE) would be expected to provide the Forest Supervisor of the National Forests in Mississippi plans of proposed activities and an Environmental Analysis (EA). This involves consultation with the Forest Supervisor early in the process to determine what studies and plans will be needed to complete an application. Current legislative authority for the management of National Forest System (NFS) lands limits the uses that can be made of the land. The Forest Service has authority to permit the drill holes, shafts, etc., for site investigation, but lacks Congressional authority to authorize the permanent storage of radioactive waste materials.	The Department takes note of the comment. With regard to the development and submission of an Environmental Analysis, a Draft Environmental Assessment was issued on December 20, 1984 for the Cypress Creek Dome site in Mississippi. The Draft EA is currently being finalized taking into account public comments, including those of the Department of Agriculture. The Department recognizes the limitations of USDA's statutory authority. Congressional action would be sought to permanently withdraw non-DOE lands associated with a site selected as a repository.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/DOI-#13 a. The USGS should be included in the review and comment category for the DEIS.	The Department agrees and has incorporated the change into the Draft PDS.
* COMMENT I.D.: PDS#185/DOI-#14 b. DOI should also be included in the review and comment category for the DEIS.	The Department agrees and has incorporated the change in the Draft PDS.
* COMMENT I.D.: PDS#185/DOL-#01 As you are aware, the development of Nuclear Waste Repositories under the NWPA are not mines or mining activities. Therefore, MSHA does not have a role in support of the development of the Radioactive Waste Management System since we lack authority under the Federal Mine Safety and Health Act. It is also my understanding that this has been discussed with the Department of Energy and has been reflected in the development of your overall system design and the finalization of your Mission Plan.	The Department recognizes that, at this time, Geologic Repositories have not been designated as mines, as defined by MSHA. Therefore, the Department of Labor does not have jurisdiction over them. The Department plans, however, in the near future, to enter into discussions with the Department of Labor regarding their possible involvement in support of the development of the Radioactive Waste Management System.

** C.2.5: GENERAL COMMENTS

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/CEQ-#01 The Council appreciates the opportunity to comment upon the siting guidelines, the draft environmental assessments, the draft and final environmental impact statement, the Project Decision Schedule, and the Mission Plan. The Project Decision Schedule is accurate, clear, and complete with respect to the Council's responsibility for providing comments. The time durations of the comment periods for the environmental review documents are adequate for public scrutiny and appropriate given the Congressionally imposed completion deadline. CEQ commends the Department of Energy for providing for public comments upon the draft environmental assessments, which is not required under the law. Overall, the site selection process encourages public participation and openness.	No response is necessary.

COMMENT	RESPONSE
** C.2.6: LICENSING PROCESS	
* COMMENT I.D.: PDS#185/NRC-#13 GUIDANCE ON LA CONTENT - The preliminary draft proposes for NRC to update 1# CFR 6#.21 on the content of license applications by October 1986, along with a Reg. Guide that is similar to Reg. Guide 1.7# Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants" (milestone III-12a, pp. 61 and 82). NRC is currently considering whether revisions to 1# CFR 6#.21 are necessary. The Reg. Guide planned will primarily provide guidance on the format for a license application, as the content will be established through the prelicensing consultation process. NRC will take action on development of this Reg. Guide in FY87.	The Department agrees that the preliminary consultation process will be helpful in providing information regarding the content of the license application. However, given the crucial importance of ensuring that the license application is complete at the time of submission, and considering the time and effort that will be needed to prepare it, the Department believes that NRC should issue formal guidance, in the form of a Regulatory Guide that includes not only the acceptable format but also the acceptable content of a license application. The Regulatory Guide should be similar in scope and style to Reg. Guide 1.7#. It should be issued as a draft no later than May 1987, and in final form no later than May 1988.
* COMMENT I.D.: PDS#185/NRC-#17 Six major licensing activities need to be depicted in any description of the NRC repository licensing process: 1) DOE submits license application; 2) NRC performs licensing review; 3) NRC authorizes repository construction; 4) DOE submits updated license application; 5) NRC licensing review; and 6) NRC grants license to possess HLW. In several locations the preliminary draft inaccurately describes this process and must be revised to accurately describe these steps: pp. 4, 9, 16, 19, 21, and 27. Figures 2 and 5 (pp. 9 and 19) should be revised to show that the "NRC License Review" continues on parallel track with "Construction and Testing" until the beginning of repository operations. Further clarification of NRC's licensing process can be found in our July 31, 1984 comments on the Draft Mission Plan (Enclosure 2 of Mission Plan comments, p. 11).	The Draft PDS will reflect, to the extent possible, the suggestions made.
* COMMENT I.D.: PDS#185/NRC-#18 Figures 4 and 7 (pp. 17 and 23) indicate that DOE will "submit LA to NRC" in 6/95 for the first repository and in 3/2##3 for the second repository. These milestones should be revised in accordance with 1# CFR 6#.24 to read "submit updated application to NRC."	The Department agrees and the Draft PDS reflects the change for the first repository schedule. The milestone associated with the second repository is not shown at this time. See response to comment PDS#185/DOI-#22 (page C-26).

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/NRC-#19 With the change recommended in comment 2, Figures 4 and 7 (pp. 17 and 23) indicate that DOE intends to update its license application to NRC approximately half-way through the Phase 1 construction period for the first repository and approximately half-way through the full facility construction period for the second repository. NRC notes that although such timing is not inconsistent with current licensing requirements, 10 CFR 60.41 requires NRC to reach a finding that construction has been "substantially completed in conformity with the application as amended" in order for a license to be issued to DOE. Such a stage will have to be reached by the time the hearing process for the repository license begins. Furthermore, DOE's update of the license application must demonstrate that the facility has been constructed according to the design provided in the initial license application (10 CFR 60.24(b)(2)). Due to these requirements, an update to the license application will be necessary when construction of the facility is substantially complete. Before requesting a commitment to the milestones in the Project Decision Schedule, DOE should clarify in the Final Mission Plan what construction activities will precede license application updates(s) and what construction will remain to be completed after the update(s) is/are filed.	The terminology used for licensing has been updated in the Mission Plan in accordance with NRC comments. The Draft PDS will be modified to be consistent with the Mission Plan. As noted by NRC, the timing for submittal of the updated license application is consistent with the current licensing requirements. DOE recognizes that the update to the license application must contain sufficient information to show that the facility has been constructed to the design in the initial license application. However, detailed construction schedules are not available at this time. This should not, however, prevent NRC from evaluating the overall licensing schedule presented in the PDS. The Department is committed to provide this information to NRC in a timely fashion. At such time as this information is available, a modification to the PDS will be developed in cooperation with the NRC. The absence of such detailed, albeit critical, information should not, in the Department's view, prevent NRC from evaluating the schedules in the Draft PDS.
* COMMENT I.D.: PDS#185/NRC-#20 NRC recommends adding two sentences to the footnote on p. 15: "The term "Construction Authorization Application" is used throughout the Project Design Schedule and should be considered synonymous with License Application" as defined in 10 CFR 60.21. This application will be reviewed under 10 CFR Parts 2 and 60." Similarly, a sixth sentence should be added to the footnote on p. 55 regarding the proposed procedural amendments to 10 CFR Part 60: "The dates shown throughout the Project Design Schedule for NRC's preparation of SCAs are based on the current procedural rule."	The Draft PDS utilizes the term "License Application" rather than "Construction Authorization Application". The dates shown in the Draft PDS reflect NRC's current procedural rule.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/NRC-#21 The preliminary draft lists Federal activities required under NWPA in Tables 1 and 2, and other Federal technical activities in Table 3. Since the licensing of geologic repositories is required under Section 121(b) of NWPA, it would be useful to transfer milestones 5 and 6 of Table 3 (pp. 56-57) to Tables 1 and 2, where construction authorization milestones are also listed.	The tables in the Draft PDS have been recast and no longer reflect the distinctions made in the Preliminary Draft PDS.
* COMMENT I.D.: PDS#185/NRC-#22 Figure 4 indicates that DOE will "submit LA amendment to NRC" in 6/98 for Phase 2 of the first repository. This milestone should be revised to read "submit application to amend license to NRC," since a license for Phase 1 would have already been granted at that time.	The Department agrees and the Draft PDS reflects the change.
* COMMENT I.D.: PDS#185/NRC-#23 Proposed procedural amendments to 10 CFR Part 60 were published in the Federal Register on January 17, 1985 (Enclosure 2). NRC recommends that in the first complete paragraph on p. 28, the last four sentences be replaced with: NRC published proposed revisions to the procedural rules on January 17, 1985 to make the rules consistent with the Act. The proposed revisions have not been reflected in the reference schedule. It is assumed, however, that any changes made by NRC will not have significant adverse schedule impacts.	The narrative portion of the Preliminary Draft PDS to which this comment is directed has been eliminated from the Draft PDS. The Department, however, takes note of the comment.
* COMMENT I.D.: PDS#185/NRC-#24 Furthermore, we suggest substituting the following statement for the first two sentences in the second complete paragraph on p. 28: In addition to the procedural requirements of 10 CFR Part 60, the licensing of a geologic repository is subject to NRC regulations in 10 CFR Part 2, "Rules of Practice for Domestic Licensing Proceedings." These regulations establish the procedures for the conduct of the licensing review by the Commission, including adjudicatory hearings before the Atomic Safety and Licensing Board.	The narrative portion of the Preliminary Draft PDS to which this comment is directed has been eliminated from the Draft PDS. The Department, however, takes note of the comment.

COMMENT	RESPONSE
**** C.2.7: MRS PROGRAM**	
* COMMENT I.D.: PDS0185/NRC-008 REVIEW OF MRS PROPOSAL - Milestone 34c of Table 1 (p. 46) proposes for NRC to review and comment on DOE's draft Monitored Retrievable Storage (MRS) proposal within a one month time period, prior to DOE's submittal of the proposal to Congress. We recommend that a period of 6-8 weeks be projected for the NRC review to provide sufficient time for coordination of staff comments and review with the Commission prior to submittal to DOE.	The Department agrees and has extended the review period to six weeks. The Draft PDS has been modified to reflect this.
* COMMENT I.D.: PDS0185/NRC-009 Furthermore, we note media reports of comments by DOE that submittal of the proposal may be delayed as further consideration is given to the role of MRS as part of an integrated waste management system. We suggest that the Project Decision Schedule should reflect this potential delay, perhaps in the discussion of MRS on page 18.	The Draft PDS has been modified to reflect a January 1986 submittal of the MRS proposal and EA to Congress.
**** C.2.8: OTHER**	
* COMMENT I.D.: PDS0185/NRC-001 Since the licensing process under 10 CFR Part 60 is central to the NRC schedules and time requirements, we believe all the key steps in this process should be identified in the Project Decision Schedule.	The Department agrees and has incorporated, to the extent possible, the major licensing activities identified by NRC in the Draft PDS.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/NRC-#29 The preliminary draft describes the procedures for interaction and preliminary consultation between DOE and NRC through the site characterization period, and the procedural agreement between DOE and NRC that outlines such activities (p. 30, paragraph 2). We recommend adding the following passage at the end of that paragraph: Prior to SCP submission, DOE will be making decisions on long lead-time items related to exploratory shaft construction and sealing, in-situ testing, hydrogeologic testing and other site investigations. As described in the procedural agreement, DOE will meet with NRC to describe its plans for developing the information necessary for satisfying NRC licensing requirements, and to obtain NRC's views on the sufficiency of these plans. This interaction should allow timely NRC guidance before decisions on long lead-time items are made and major resources are committed in order to avoid errors which could result in delays in the licensing phase.	The narrative section that this comment is directed to has been eliminated from the Draft PDS. The Department and NRC have, however, met to discuss exploratory shaft construction, testing, and other site characterization activities. Additional interactions are planned in these areas with NRC over the next several months. These interactions have provided invaluable input to the Department's overall program planning. This input, along with other available information has been used to initiate certain long lead-time items for the exploratory shaft which, in order to meet the January 1998 deadline for initiation of operations and acceptance of spent fuel, had to be initiated before SCP issuance and before NRC's views on the sufficiency of those plans were received. However, the Department believes that the site characterization program is flexible enough to accomodate additional comments received during the continued interactions with NRC, before and after SCP issuance.
* COMMENT I.D.: PDS#185/DOI-#01 It is current Departmental policy that land for hazardous waste disposal can only be acquired through fee transfer or permanent congressional withdrawal. Therefore before DOE takes occupancy of any Federal lands administered by this Department, Congress must enact a transfer giving DOE irrevocable responsibility for the property. Time for this congressional action to occur must be factored into the Project Decision Schedule.	This policy would apply to the three sites that are located, in part, on BLM land. These sites are the Yucca Mountain and Davis and Lavender Canyon sites. The Department has developed a schedule for land withdrawal that is shown in Table 1, items 27 and 28, of the Draft PDS.
* COMMENT I.D.: PDS#185/USAF-#01 We have reviewed the proposed Project Decision Schedule (PDS) and have no recommended modifications. We appreciate your coordination efforts and look forward to working with your staff as this important project continues to develop.	No response required.

COMMENT	RESPONSE

** C.2.9: SCHEDULE MILESTONES/SEQUENCE OF EVENTS

* COMMENT I.D.: PDS#185/NRC-003

One of the matters requiring our attention is timely issue resolution. We addressed this previously in our July 31, 1984 comments on the Draft Mission Plan (Enclosure 3 of Mission Plan comments, p. 5). We are considering issue resolution through rulemaking in advance of the hearings required by 10 CFR Part 60. If such resolution is planned, it may be appropriate in future modifications to the Project Decision Schedule to include milestones for the resolution of identified issues. We will be discussing this approach to issue resolution with your staff.

RESPONSE: The Department agrees that such rulemaking activities would be appropriate for inclusion in the PDS.

* COMMENT I.D.: PDS#185/NRC-004

Review of SCPs - It is not clear what is intended by the dates "7/86-8/87" for milestone I-11c in Table 5-11 (p. 80), Review and Comment on Site Characterization Plans and how they relate to the dates shown on p. 12 for issuance of Site Characterization Plans. This item should be separated into individual milestones for each of the sites to be characterized for the first repository. As specified in Table 3 (p. 55), NRC's final SCA's for these sites would each be issued within ten months of the date of issuance of each SCP, under existing regulations. Note that under existing procedural requirements, NRC's comments on the SCPs will include either an opinion that there is no objection to DOE's site characterization program, or specific objections to DOE's proceeding with characterization (10 CFR 60.11(e)).

RESPONSE: In the Preliminary Draft, the dates "7/86-8/87" for milestone I-11c in Table 5-11 (page 80) indicate the time when NRC's final SCAs will be issued for the first repository (Basalt: 7/86; Tuff: 7/86; Salt: 8/87). These individual dates were shown as Milestone 3c in Table 3 (page 55). We agree with the NRC suggestion that the table should show these individual milestones.

In the PDPDS, Table 3 (Milestone 3) also illustrates NRC's process for review of the SCPs. As shown on page 55, NRC would issue a final SCA ten months after receipt of each SCP. If ten months is subtracted from the milestones listed above (Milestone 3c), the resulting dates would be 9/85 for Basalt, 9/85 for Tuff, and 10/86 for Salt. These are the issuance dates for the SCPs, which are listed in Table 1, Item 21a of the Draft PDS.

COMMENT	RESPONSE
* COMMENT I.D.: PDS0185/NRC-006 Revision to Reg. Guide 4.17 - The preliminary draft states that a revision of Reg. Guide 4.17 on the format and content of site characterization plans will be issued in draft form in either December 1984 or January 1985 and in final form in March 1985 (pp. 25, 30, 37, and 80). As stated in letters dated December 19, 1983 and April 20, 1984 from H. J. Miller, NRC, to J. W. Bennett, DOE, this revision involves only minor changes which principally serve to conform the July 1982 final version of Reg. guide 4.17 with the slightly modified scope and terminology called for in NWPA. Therefore, NRC believes that the existing guidance provides adequate direction for DOE in preparing SCPs. We recommend that in the second paragraph on p. 30, the fourth sentence be replaced by the following: "The revision involves minor changes, and the current Reg. Guide 4.17 provides sufficient guidance for DOE's present purposes. NRC plans to publish a draft revision of Reg. Guide 4.17 in March 1985, and issue its final revision after the final rulemaking is completed to amend 10 CFR Part 60 procedural requirements to conform with NWPA. This final rulemaking is now scheduled for November 1985."	The Department agrees and the Draft PDS reflects the NRC's proposed milestone dates for Reg. Guide 4.17 and 10 CFR Part 60.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/NRC-#14 FEIS ADOPTION - The preliminary draft proposes for NRC to adopt DOE's final environmental impact statements for the first and second repository site selections by September 1990 and July 1997, respectively (pp. 42, 54, 80, and 81). These dates are both only one month after DOE's scheduled submittal of license applications to NRC. NRC is currently developing proposed amendments to 10 CFR Part 51 which will establish the procedures for carrying out the Commission's NEPA responsibilities, including adoption of the DOE EIS and the timing of this action within the license review period. We recommend deletion of this milestone from the Project Decision Schedule until such requirements are promulgated. If DOE feels the EIS adoption should still be included in the Project Design Schedule, we suggest modifying milestones I-24a (pp. 42 and 80) and II-23b (pp. 54 and 81) so that the action required reads "review license application, including adoption of EIS to extent practicable." DOE should recognize that early interaction to discuss the intended scope and content of the EIS may be necessary to facilitate NRC's later adoption of the EIS. Such discussions should be completed well in advance of the planned issue date of the first DEIS.	The Department believes that milestones that provide for NRC's adoption of the FEIS should remain in the Draft PDS as they appeared in the PDPDS.
* COMMENT I.D.: PDS#185/NRC-#25 The preliminary draft should be revised in several locations to reflect the agreement between the Commission and the Director of DOE's Office of Civilian Radioactive Waste Management on June 22, 1984 that the preliminary determination of site suitability required under Section 114(f) of NWPA will be made after site characterization has been completed. Revisions are required on pp. 4, 36, and 52, and a milestone for this action should be added on pp. 12 and 26. Also, it should not be indicated that Site Characterization Plans will be issued after this preliminary determination is made (p. 37).	At the June 22, 1984 meeting on the Commission's concurrence decision on the Department's siting guidelines, the Department agreed to delete language from paragraph 960.3-2-3 related to the timing of the preliminary determination under Section 114(f) of the NWPA. This action was carried out, and the final siting guidelines do not mention anything about the timing of the preliminary determination of site suitability. The Department is planning to make a preliminary determination of site suitability at the time the Secretary recommends three sites to the President for site characterization. This is discussed in the Mission Plan and its accompanying Comment Response Document. THe Mission Plan, in Volume II, contains a more extensive discussion of the timing of the preliminary determination of site suitability.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/NRC-#28 The preliminary draft provides a brief outline of the major activities planned during Phase 2, the site characterization phase (p. 11, second and third paragraphs). The discussion should be expanded to state that: 1) development of repository designs will also occur during this phase; and 2) laboratory testing of site samples will occur during this phase, as well as laboratory testing to evaluate the performance of materials planned for use as engineered barriers.	The Department agrees and the Draft PDS reflects this suggestion.
* COMMENT I.D.: PDS#185/NRC-#33 On p. 29, the second sentence of the first paragraph should be revised to read, "Amendments for specific technical criteria related to HLW disposal in the unsaturated zone were proposed in February 1984 and final amendments are expected to be published in the spring of 1985."	The narrative section of the PDPDS that the comment refers to has been eliminated and is, therefore, not included in the Draft PDS.
* COMMENT I.D.: PDS#185/NRC-#35 The preliminary draft proposes f[illegible] to report to Congress and the President on "analysis of activities undertaken to support a TEF" (pp. 45 and 81). We assume this milestone refers to the requirements for such reports under Section 217(f)(3)(B), "as the Commission considers appropriate."	As discussed in Section 1.4.3 of the Draft PDS, references to Federal agency actions related to the Test and Evaluation Facility are not considered in the Draft PDS.
* COMMENT I.D.: PDS#185/DOI-#18 The Decision Schedule notes that the SCP for the salt site will lag behind the SCPs for the basalt and tuff sites by approximately 1 year. The reason for this timing should be explained in the Decision Schedule, and Figure 3 should be appropriately modified.	An explanation as to the timing of the issuance of the SCPs is found in the Mission Plan.
* COMMENT I.D.: PDS#185/EPA-#01 EPA anticipates the promulgation of its high-level radioactive waste standards in June 1985. This matter is discussed on page 24 and is listed on pages 45 and 79. We recommend the text be changed to reflect EPA's current schedule.	The tables in the Draft PDS have been modified to reflect EPA's current schedule.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/EPA-002 The schedule text indicates that exploratory shaft sinking would begin in March 1987 for a salt site. Based on the Draft Environmental Assessment for the Davis Canyon Site (Utah) it appears that such activities at salt sites would involve two phases of characterization activities. The first phase is principally borehole drilling and geological studies. The second phase of characterization involves the construction of the exploratory shaft as well as continued surface-based geotechnical studies. If these two phases of characterization are anticipated to be followed, we suggest that the phases be reflected in the schedule.	The Department did not intend to suggest that there are two distinct "phases" for site characterization at the Salt sites. The EAs describe "field studies" separate from "exploratory shaft facility" to distinguish between surface-based investigations from those that will be conducted underground. Although borehole drilling and geological studies are expected to begin before exploratory shaft construction, these two types of activities will overlap in time and do not represent separate phases of site characterization.
* COMMENT I.D.: PDS#185/DOI-006 Figure 1 - KEY ACTIVITIES AND DECISION POINTS should be modified to address the following issues: B. The "Sink Exploratory Shafts" block proceeds block 15a "Site Characterization Activities." This is inconsistent with the recently released draft Environmental Assessments (EAs) which include shaft sinking as an integral part of site characterization activities. In addition, according to these EAs, shaft sinking follows certain site characterization activities (e.g., geotechnical and environmental investigations) this should be resolved. (also see comments PDS#185/DOI-005; PDS#185/DOI-007; PDS#185/DOI-008)	The Department agrees with this comment. Shaft sinking is an integral part of the site characterization process. In some cases, shaft sinking may follow the initiation of other site characterization activities.
* COMMENT I.D.: PDS#185/DOI-011 In addition, the Decision Schedule indicates that the permitting process for the salt site is to be completed by March 1987, by concurrently seeking permits for drilling boreholes and constructing exploratory shafts. The Decision Schedule goes on to indicate that construction of the initial exploratory shaft will begin in March 1987. As a result, the potential exists for simultaneous commencement of borehole drilling and shaft construction at the salt site. This timing of characterization activities does not appear consistent with scheduling information presented in the EAs. We believe that is important to carry out borehole drilling (and other environmental evaluations) prior to shaft construction in order to gather important, site-specific data so that more comprehensive assessments may be made of potential adverse or disqualifying conditions (thus avoiding unnecessary shaft construction with its associated capital commitments and environmental impacts).	Although the Department will concurrently seek permits for drilling boreholes and constructing exploratory shafts, it is planned that borehole permits will be obtained prior to the shaft permit and that borehole drilling will begin before shaft construction. Information from certain boreholes (e.g., the boreholes at the shaft locations) is needed before the shaft design can be finalized and shaft construction can begin.

COMMENT	RESPONSE
** C.2.10: SCHEDULE/REVIEW-PERIOD DURATIONS	
* COMMENT I.D.: PDS0185/NRC-002 The schedules presented in the preliminary draft assume a 10-month period for NRC's preparation of final Site Characterization Analyses, in accordance with the current procedural requirements of 10 CFR Part 60. Proposed amendments to these requirements were published by NRC on January 17, 1985 and are provided in Enclosure 2. We have estimated that these amendments would reduce the time period for preparation of SCA's to 5 months. However, the 10-month schedule should continue to be used for planning purposes until the schedular impact of the final version of these amendments has been assessed.	The Draft PDS reflects the 10 month schedule for the preparation of NRC's SCAs.
* COMMENT I.D.: PDS0185/NRC-011 IN-SITU TESTING IN SALT - The schedule for in-situ testing which shows the start of exploratory shaft construction in March 1987 in salt leaves only a short period of testing to support the Draft EIS. The Draft Mission Plan stated that 30 months would be available for exploratory shaft construction and in-situ testing in salt: September 1986 to March 1989 (Vol. I, p. 3-A-39, and Vol. II, p. 2-20). The first 19 months was for shaft construction and the last 8 months was available for in-situ testing (Vol. II, p. 2-21). The Project Decision Schedule would narrow the total time for exploratory shaft construction and in-situ testing to 24 months: March 1987 to March 1989 (pp. 12, 37, and 40). Assuming the same 19 months for shaft construction as in the Draft Mission Plan, only 5 months would remain for in-situ testing with no time for breakout, drift mining, and equipment installation. This would appear to be an insufficient time period to perform important in-situ tests in salt, such as heater testing to investigate the repository-induced thermomechanical loadings on the host rock and surrounding strata. The in-situ testing schedules should be addressed in the Final Mission Plan, including a discussion of what DOE considers to be a sufficient time period for testing, before DOE requests commitments to the Project Decision Schedule.	The in-situ test durations to support the DEISs that are presented in the Mission Plan are: 24 months for Basalt; 26 months for Tuff; and, 8 months for Salt. The Mission Plan addresses the site characterization considerations that led the Department to select the reference schedules.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/NRC-#12 DEIS REVIEW - DOE proposes for NRC to submit comments on the Draft Environmental Impact Statements for the first and second repository site selections within 2 months of publication of each DEIS, and for NRC to submit its preliminary comments on the sufficiency of site characterization and the waste form proposal within 7 months of publication of each DEIS (pp. 40, 52, 80, and 81). The NRC staff does not believe 2 months will be adequate for the completion of the DEIS review. However, the staff currently intends to provide the preliminary sufficiency comments at the same time as its comments on the DEIS and believes both actions can be completed within four months of publication of the DEIS, provided there is a thorough review and consultation process throughout the site characterization phase.	See response to comment PDS#185/DOI-#20 (page C-26).
* COMMENT I.D.: PDS#185/DOI-#03 We are seriously concerned about the time available for the research and testing which are necessary to accomplish site characterization. This is especially evident when the first and second repository schedules are compared. For the first repository the maximum time available for site characterization is 42 months, yet for the second repository 52 months are scheduled. It appears to us that the first round of repository testing will be a learning process which will require more time than for subsequent repositories. In addition, much of the geohydrologic testing which must be done is on the frontier of the science and sufficient time must be available to develop that science. We are not confident that 42 months is adequate for that purpose.	The Department believes that the current estimated durations for in-situ testing are adequate to accomplish site characterization. As the site characterization program proceeds, it may be necessary to change these estimates. The differences between the time for site characterization for the first and second repositories are the result of the assumptions made about land acquisition and permitting, in addition to the estimates for in-situ testing. The first repository candidate sites have either relatively long land acquisition and State permitting processes (Salt), or relatively long in-situ testing durations (Basalt and Tuff). The second repository schedule assumes both conditions: namely the land acquisition and permitting process, like a Salt site; and the relatively long in-situ testing period, like a hard-rock medium (Basalt and Tuff). The result of these assumptions is that the site characterization phase of the second repository's schedule is about one year longer than for the first repository.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/DOI-#15 The USGS is included with those agencies which will be requested to provide comments on the DEIS. No time period for the review of the DEIS is specified, but the graph on page 26 indicates only about 4 months lapsed time between the issuance of the DEIS and FEIS. We believe at least 90 days should be made available for review of this complex technical document. Obviously this would leave very little time for preparation of the FEIS.	See response to comment PDS#185/DOI-#20 (below). Additionally, the issuance date for the FEIS has been changed to December 1990 to reflect this additional review time.
* COMMENT I.D.: PDS#185/DOI-#20 The 60-day comment period on the DEIS does not appear to be adequate, as per our comment on page 29.	The Department is planning to provide a three month review period for the DEIS.
* COMMENT I.D.: PDS#185/DOI-#22 Item (17b) - We believe the 60-day comment period is not adequate because of the expected technical complexity of the document.	The Department is planning to provide a three month review period for the DEIS.
* COMMENT I.D.: PDS#185/DOI-#24 Item (2b) - The reference schedule dates appear to be in error. The first two SCP's (according to Figure 8) will be issued in late September 1985 and the final one about October 1986 (Figure 9). Unless the time frame covers only the time from first issuance of the original SCP's through completion of review of the original salt SCP, semiannual reviews continue into early 1989. Some clarification would be appropriate. In addition, these very complex documents will require a minimum of 90 days for adequate review.	The reference schedule calls for the issuance of SCPs in December 1985 for Tuff and Basalt, and in October 1986 for Salt. The semi-annual reports would continue through early 1991. The NWPA, in Section 113(b)(3), requires the Department to report, on a semi-annual basis, to the NRC and a State or Indian Tribe as to the nature and extent of site characterization activities and information developed from such activities. The Department will make these semi-annual reports available to interested parties for their information. The Department, however is not providing for a formal review period for these reports.
* COMMENT I.D.: PDS#185/DOI-#32 Item I-11a does not adequately define the comment period. The dates shown appear to be release dates only. A 90-day comment period is probably a minimum.	Item I-11a in the preliminary draft was the date of issuance. Item I-11b displayed the date that the comments on the SCPs were expected by the Department. The public comment period will be 90 days.
* COMMENT I.D.: PDS#185/DOI-#33 Item I-19b - Again, the review period of 60 days is probably not adequate.	The Department is planning on providing a 90 day review period for the DEIS.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/DOI-#34 Item II-17b - The review period of 6# days is probably not adequate.	The Department is planning to provide a 9#-day review period for the second repository DEIS.
* COMMENT I.D.: PDS#185/NRC-##5 Review of SCPs - The reference schedules for milestones 3d, e, and f in Table 3 (p. 55) and Table 5-11 (p. 82) should each be moved one month earlier for consistency with the current 1# CFR Part 6#. Milestone 9C in Table 2 (p. 49) correctly shows that NRC's review and comment would be complete ten months after DOE issues the SCP. Furthermore, the entries of milestones III-3a, c, d, and f in Table 5-11 are not clear. We recommend separate entries for the first and second repositories, or deletion of these milestones since they repeat information in milestones I-IIc and II-9c.	The Department, in the Draft PDS, has used the NRC's existing rule as the basis for establishing the milestones related to this activity. The Department provides ten months for NRC issuance of the final SCA subsequent to the issuance of the SCP. The Draft PDS displays separate milestones for the first and second repository.
** C.2.11: TRANSPORTATION PROGRAM	
* COMMENT I.D.: PDS#185/NRC-#15 TRANSPORTATION - The transportation related activities diagrammed at the bottom of Figure 1 (p. 4) should be explained in the text accompanying Figure 1. In particular, the meaning of "performance specifications for transportable casks" and "NRC issue design criteria" should be clarified. Furthermore, Figure 1 contains transportation actions and decisions which do not appear in the transportation program milestones (Table 3, p. 61), and therefore have no reference schedule. A schedule for these items should be provided. Finally, the dates for milestone III-13e, "NRC review Safety Analysis Report Package," do not agree between Table 3 (p. 61) and Table 5.11 (p. 83).	The transportation activities have been revised in the Draft PDS. The Department believes that the revisions clarify the meaning of the milestones in question. The milestones have been made consistent and schedules provided.
* COMMENT I.D.: PDS#185/NRC-#16 TRANSPORTATION PROCEDURAL AGREEMENT - The task title for milestone III-13a on page 82 should be modified to clarify that this procedural agreement deals with the certification process for transportation casks, as stated on p. 61. The date of this agreement was 11/3/83, not 11/3/84 as suggested on p. 82.	Appropriate changes have been incorporated into the Draft PDS.

COMMENT	RESPONSE
* COMMENT I.D.: PDS#185/NRC-#34 It would be useful to explain the relationship between the Project Decision Schedule and DOE's Transportation Business Plan listed on p. 61 (milestone 13b). Also, Figure 1 (p. 4) should indicate how the timeline for transportation activities is integrated with the repository development timeline.	The Department believes that the narrative relating to the Transportation Subsystem in Section 8 of the Draft PDS, and in the recently issued Mission Plan, provides the desired clarification.

APPENDIX D

ACRONYMS AND DEFINITIONS

ACP	Area Characterization Plan
AF	Air Force
ARR	Area Recommendation Report
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
CA	Construction Authorization
CEQ	Council on Environmental Quality
COE	Army Corps of Engineers
DEIS	Draft Environmental Impact Statement
Department	Department of Energy
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DOJ	Department of Justice
DOL	Department of Labor
DOT	Department of Transportation
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ES	Exploratory Shaft
FEIS	Final Environmental Impact Statement
FWS	Fish and Wildlife Service
LA	License Application
Mission Plan	Mission Plan for the Civilian Radioactive Waste Management Program (DOE/RW 0005, June 1985)
MOU	Memorandum of Understanding
N/A	Not Applicable
NLT	No Later Than
NRC	Nuclear Regulatory Commission
NWPA	The Nuclear Waste Policy Act of 1982--Pub. L. 97-425
OCRWM	Office of Civilian Radioactive Waste Management
OMB	Office of Management and Budget
PAS	Potentially Acceptable Sites
PDS	Project Decision Schedule
PDPDS	Preliminary Draft Project Decision Schedule
RCR	Regional Characterization Report
Regulatory Guide 4.17	Standard Format and Content of Site Characterization Report for High-Level-Waste Geologic Repositories
SCA	Site Characterization Analysis
SCP	Site Characterization Plan
Secretary	Secretary of Energy
SSR	Site Selection Report
TEF	Test and Evaluation Facility
USDA	United States Department of Agriculture
USGS	United States Geological Survey

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