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Preliminary Estimates of the Total-System Cost for the Restructured Program:

An Addendum to the May 1989 Analysis of the Total-System Life Cycle Cost for the Civilian Radioactive Waste Management Program

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ABSTRACT

The total-system life-cycle cost (TSLCC) analysis for the Department of Energy's (DOE) Civilian Radioactive Waste Management Program is an ongoing activity that helps determine whether the revenue-producing mechanism established by the Nuclear Waste Policy Act of 1982--a fee levied on electricity generated and sold by commercial nuclear power plants--is sufficient to cover the cost of the program. This report provides cost estimates for the sixth annual evaluation of the adequacy of the fee. The costs contained in this report represent a preliminary analysis of the cost impacts associated with the Secretary of Energy's Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program issued in November 1989. The major elements of the restructured program announced in this report which pertain to the program's life-cycle costs are: a prioritization of the scientific investigations program at the Yucca Mountain candidate site to focus on identification of potentially adverse conditions, a delay in the start of repository operations until 2010, the start of limited waste acceptance at the monitored retrievable storage (MRS) facility in 1998, and the start of waste acceptance at the full-capability MRS facility in 2000. The cost estimates presented in this TSLCC report are updates to the estimates contained in the May 1989 TSLCC report and do not represent a comprehensive reevaluation of all aspects of the total-system cost analysis; thus, this report is issued as an addendum to the previous TSLCC report. All costs are expressed in 1988 dollars in order to be consistent with the May 1989 TSLCC report.

Based on the restructured program, the total-system cost for the system with a repository at the candidate site at Yucca Mountain in Nevada, a facility for monitored retrievable storage (MRS), and a transportation system is estimated at $26 billion (expressed in constant 1988 dollars). In the event that a second repository is required and is authorized by the Congress, the total-system cost is estimated at $34 to $35 billion, depending on the quantity of spent fuel and high-level waste (HLW) requiring disposal.

The restructured program results in an increase of approximately $2 billion in total-system costs from the estimates contained in the May 1989 TSLCC report. The vast majority of this cost impact is due to an increase in the development and evaluation (D&E) costs resulting from additional costs projected to be incurred during the 7-year delay in the repository program. The MRS facility and transportation costs have also increased slightly due primarily to the additional costs associated with the transport/storage system used to provide waste acceptance at the MRS facility in 1998 and 1999.

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Chapter 1

INTRODUCTION AND SUMMARY

1.1 PURPOSE AND SCOPE

Each year a comprehensive analysis of the total cost of the radioactive waste-management system over its complete life cycle is performed as a reference document that aids in the financial planning for the Department of Energy's (DOE) Civilian Radioactive Waste Management Program. The analysis is intended to follow as closely as possible the most current program strategy, plans, and policies. The primary use for the total-system life-cycle cost (TSLCC) analysis is to provide cost data necessary for determining whether the fees paid by the waste generators will be sufficient to fully cover the costs of the program (the fee adequacy analysis). In May 1989, the DOE published its fifth Analysis of the Total System Life Cycle Cost for the Civilian Radioactive Waste Management Program.[1] Shortly after this analysis was completed, work was initiated on assessing the overall program strategy. This activity culminated in November 1989 when the Secretary of Energy issued the Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program.[2] Subsequently, it was decided that the analysis of the adequacy of the fee should incorporate the impacts due to the restructured program presented in the Secretary's report. This analysis provides the updated cost estimates for use in the sixth annual fee adequacy evaluation.

These cost estimates are updates of the estimates contained in the May 1989 TSLCC analysis that are affected by the restructured program strategy. This study is not a comprehensive re-evaluation of all aspects of the total-system cost analysis. As such, this report has been prepared as an addendum to the May 1989 TSLCC report, and the estimates presented herein represent a preliminary assessment of the implications of the restructured program on the total-system costs. A more thorough evaluation of the cost impacts associated with the restructured program will be contained in the next complete TSLCC analysis. All costs presented in this analysis are expressed in 1988 dollars in order to remain consistent with the May 1989 TSLCC report.

As with all previous TSLCC analyses, this analysis encompasses all components of the waste-management system that are financed by disbursements from the Nuclear Waste Fund. Currently, there are five major cost components considered: development and evaluation (D&E), transportation, repository(ies), MRS facility, and benefits payments. The D&E cost component covers all siting, preliminary design development, testing, regulatory compliance, and institutional activities for the program. This category also includes the costs of program administration by the Federal Government and the fees charged by the Nuclear Regulatory Commission (NRC) for

licensing. The transportation component includes the capital and operating costs of providing the transportation system. The repository component covers the engineering, construction, operation, closure, and decommissioning of the repository(ies). Similarly, the MRS component covers the engineering, construction, operation, and decommissioning of the MRS facility. The final cost component consists of the benefits payments to the states or affected Indian Tribes as authorized by the Nuclear Waste Policy Amendments Act of 1987 (the Amendments Act).[3]

It must be recognized that the waste-management program is continually evolving. The TSLCC estimates represent "snapshots" in time which incorporate all available and appropriate information on program activities up to a specific point in time in order to develop a comprehensive set of cost estimates for the system. However, there are instances where the costs for a particular activity are not included in the estimates since it was not identified in time or adequately defined to be incorporated into the TSLCC analysis. Since the TSLCC analysis is an ongoing activity, elements of the program that merit inclusion in the cost analysis, but are omitted from the current estimates, will be included in future estimates.

Since the Amendments Act authorized the scientific investigations of only the Yucca Mountain candidate site in Nevada, the first-repository costs in this analysis address only a repository in tuff. In addition, the Amendments Act prohibited any work on a second repository and requires the DOE to report to the President and the Congress between 2007 and 2010 on the need for a second repository. Consequently, this analysis considers a case in which all waste is emplaced in a single repository. However, the Amendments Act retained the 70,000 metric tons of heavy metal (MTHM) limitation on the capacity of the first repository. Thus, as in the May 1989 TSLCC analysis, this TSLCC analysis also includes estimates for a two-repository system. If the Yucca Mountain candidate site is determined to be unsuitable, the cost estimates will have to be reevaluated.

The remainder of this chapter discusses the major programmatic changes resulting from the Secretary's reassessment of the waste-management program which affect total-system costs, presents a brief discussion of the results, and compares the results of these updated estimates to the May 1989 TSLCC results. Chapter 2 of this report presents a summary of the major programmatic assumptions used in this analysis as well as a discussion of the cases which were studied. Chapters 3 through 7 present descriptions and results of the cost estimates for the five components discussed above. The cost allocations for the disposal of defense high-level waste (DHLW) in the civilian waste-management system are presented in Chapter 8. Chapter 9 summarizes the results of this total-system cost analysis. Additional detailed information is presented in five appendixes: the waste-acceptance schedules upon which the costs are based are shown in Appendix A; the annual total-system costs by major component, the annual DHLW costs by major component, and a summary of the annual costs are presented in Appendixes B, C, and D, respectively; and the factors used in allocating costs for DHLW disposal are presented in Appendix E. More-detailed discussions of the

assumptions and methodologies used in developing these updated estimates are provided in an addendum to the report Cost Estimating Methods for the May 1989 Total System Life Cycle Cost Analysis,[4] which was initially prepared as a companion document to the May 1989 TSLCC report.

1.2 PROGRAM CHANGES

In November 1989, the Secretary of Energy presented his reassessment of the waste-management program in a report to Congress. The key programmatic changes resulting from the Secretary's reassessment which are incorporated in this cost analysis are:

- A prioritization of the scientific investigations program at the Yucca Mountain candidate site to focus on the early identification of potentially adverse conditions.
- A delay in the start of repository operations from the year 2003 to 2010.
- The start of limited waste acceptance at the MRS facility via a transport/storage system in 1998.
- A full-capability MRS facility becoming operational in 2000.

All other assumptions concerning the waste-management program remain unchanged from the May 1989 TSLCC analysis.

1.3 RESULTS

Total-system life-cycle costs were estimated for three cases and are summarized by major cost category in Table 1-1. These cases are distinguished by the number of repositories and the quantity of spent fuel requiring disposal. In all of the cases, the MRS facility was assumed to begin limited waste acceptance in 1998 and then begin operating as a full-capability facility in 2000. In addition, this analysis considers only cases with intact disposal of spent fuel. The first repository was assumed to start in 2010 in all cases, and the second repository, when included, was assumed to start 25 to 35 years after the resumption of the second repository program. All cases include a repository in tuff and an MRS facility that services only the first repository. All cases also include the transportation and disposal of 17,750 canisters of defense high-level waste (DHLW) and the disposal of 640 MTHM of civilian high-level waste. For the cases that include a second repository, a generic geologic medium in an unspecified location was assumed for costing purposes.

Table 1-1. Summary of total-system life-cycle cost estimates
(Millions of 1988 dollars)

Cost Category	Single Repository[a] Case No-new-orders	Two Repository Case No-new-orders	Two Repository Case Upper reference
Development and evaluation	11,508	15,033	15,069
Transportation	2,803	2,658	2,741
First repository	8,735	6,992	7,033
Second repository	NA[b]	6,551	7,299
MRS facility	1,862	1,613	1,616
Benefits payments	657	793	793
Total-system cost	25,565	33,640	34,551

[a] This case is based on the assumption that a single-repository disposes of the entire quantity of waste.
[b] Not applicable.

The principal findings of this analysis are as follows:

- The total-system cost for the single-repository system is estimated at $25.6 billion (in constant 1988 dollars) based on the no-new-orders, end-of-reactor-life spent-fuel projection.

- The total-system cost for the two-repository system is estimated at $33.6 billion for the no-new-orders, end-of-reactor-life spent-fuel projection (i.e., 96,300 MTHM, including 8,875 MTHM of defense waste) or $34.6 billion for the upper reference case spent-fuel projection (i.e., 106,400 MTHM, including 8,875 MTHM of defense waste).

- The defense-waste share of the total-system cost is estimated to range from $3.8 (single-repository system) to $5.8 billion (two-repository system), or 15 to 17 percent of the total-system cost (see Chapter 8).

1.4 CHANGES FROM THE MAY 1989 TSLCC ANALYSIS

The TSLCC estimates presented in this report are updated estimates from the May 1989 TSLCC analysis which reflect the changes in the system outlined in the

Table 1-2. Comparison of total-system costs to previous estimates
(Millions of 1988 dollars)

Cost Category	Single Repository No-new-orders			Two Repository No-new-orders		
	May 1989 TSLCC	Updated 1990 TSLCC	Change	May 1989 TSLCC	Updated 1990 TSLCC	Change
Development and evaluation	9,650	11,508	+1858	13,055	15,033	+1978
MRS facility	1,809	1,862	+53	1,387	1,613	+226
Transportation	2,614	2,803	+189	2,325	2,658	+333
First repository	9,063	8,735	-328	7,006	6,992	-14
Second repository	NA[a]	NA	NA	6,582	6,551	-31
Benefits payments	701	657	-44	856	793	-63
Total-system cost[b]	23,837	25,565	+1728	31,211	33,640	+2429

[a] Not applicable.
[b] Columns may not add to totals due to independent rounding.

Secretary's reassessment of the waste-management program. As such, these estimates are derived in the same manner as those presented in the May 1989 report, since the majority of the assumptions and methodologies have remained unchanged. However, a major change in the schedule had a significant impact on the updated estimates. Thus, the difference between the May 1989 estimates and the updated estimates represent the overall cost impact due to the restructured program. Table 1-2 summarizes this cost impact by major cost component. Two cases are compared since the third case in this report--the two-repository system based on the upper reference case spent-fuel projection--was not estimated in the May 1989 study for a system which emplaced intact spent fuel. The overall impact ranges from an increase of approximately $1.7 billion for the single-repository case to approximately $2.4 billion for the two-repository case.

For both cases, the majority of the cost impact of the restructured program is due to an increase of approximately $2.0 billion in the development and evaluation (D&E) cost component. This increase in the D&E cost is due to the additional costs resulting from the delay in the start of repository operations. Virtually all of the 7-year delay occurs in the pre-license application submittal phase of the repository development process. There are also slight changes in the MRS facility, transportation, first repository, and benefits payments costs due to the addition of the transport/storage system and the delay in the start of repository operations.

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Chapter 2

CASE STRUCTURE, ASSUMPTIONS, AND WASTE LOGISTICS

The cases included in this total-system life-cycle cost (TSLCC) analysis reflect the current plans of the Department of Energy (DOE) for the waste-management system being developed to meet the requirements of the Nuclear Waste Policy Act of 1982 (the NWPA),[5] as amended. They are based on the waste-management system outlined in the Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program. As such, the system consists of a repository in tuff at the candidate site at Yucca Mountain, Nevada, a monitored retrievable storage (MRS) facility, and a transportation system.

2.1 CASES EXAMINED

This TSLCC analysis examined three cases based on different assumptions about the number of repositories and the quantity of spent fuel to be discharged from commercial U.S. reactors.

2.1.1 Number of Repositories

The Amendments Act prohibits the DOE from conducting site-specific activities for the second repository unless the Congress specifically authorizes and appropriates funds for that purpose. However, it does not abolish the conditional statutory limit on the first repository specified by the NWPA. The NWPA directed the Nuclear Regulatory Commission (NRC) to prohibit the emplacement in the first repository of more than 70,000 metric tons of heavy metal (MTHM) until the second repository starts operation. Furthermore, the Amendments Act requires the DOE to report to the President and the Congress between 2007 and 2010 on the need for a second repository.

The need for a second repository will depend on the quantity of spent fuel and HLW waste requiring disposal and the ultimate capacity of the first-repository site. The total-system life-cycle cost analysis must, by definition, cover the total waste-management program over its entire life-cycle. Thus, even though the decision on the need for the second repository need not be made before the year 2010, the TSLCC analysis must consider the potential development and operation of a second repository. Therefore, this analysis, similar to the May 1989 TSLCC analysis, considered two configurations for the waste-management system: a single-repository configuration and a two-repository configuration. For the single-repository system, it was assumed that all the waste will be emplaced in one repository. For the two-repository system, it was

assumed that 70,000 MTHM of waste will be emplaced in the first repository, with the remainder going to the second repository.

It is important to note that the system configurations discussed above were postulated solely for the purpose of the TSLCC analysis to provide bounding estimates of the total-system cost. The DOE has not made a decision to develop a second repository, and no decision on this issue is needed at least until the year 2007. Similarly, no decision has been made regarding the emplacement of all waste requiring geologic disposal in the first repository, and the DOE cannot make such a decision so long as the statutory limit of 70,000 MTHM for the first repository remains in effect. It is important to recognize, however, that the need to develop a second repository would have significant effects on the waste-management system, including operations at the first repository and waste transportation and logistics.

Generic assumptions were made for the host generic geologic medium of the second repository, because no specific host generic geologic medium is currently being considered for the second repository. These assumptions were made solely for the purpose of the TSLCC analysis in order to allow a set of reasonable costs to be included for a system that contains two repositories.

2.1.2 Waste Quantities

As a basis for planning, the DOE's Office of Civilian Radioactive Waste Management (OCRWM) uses a range of forecasts[6] prepared by the DOE's Energy Information Administration (EIA) of the rates at which spent fuel will be discharged from U.S. reactors. As with the May 1989 TSLCC analysis, this analysis considers two spent-fuel-discharge projections: the no-new-orders, end-of-reactor-life projection and the upper reference case projection.

The no-new-orders, end-of-reactor-life case represents nuclear plants that are currently operating or under active construction. The total spent-fuel discharges for this case are projected to be 86,800 MTHM through the year 2037 (the last projected discharge for U.S. reactors for this case). The upper reference case assumes that the commercial nuclear generating capacity will continue to grow, essentially doubling the current capacity by 2020 and reaching nearly 25 percent of the total electricity generated in the United States. As a result of this growth, there is no "end" to the forecast. The spent-fuel discharges for this case through the year 2020 are projected to be 96,900 MTHM.

The total quantity of DHLW requiring disposal was assumed to be 17,750 canisters (about 8875 MTHM). Additionally, approximately 640 MTHM-equivalent of commercial high-level waste from the West Valley Demonstration Project was assumed to be accepted at the first repository. Therefore, the total quantity of waste to be accepted and emplaced was assumed to be approximately 96,300 MTHM for the no-new-orders case and 106,400 MTHM for the upper reference case.

2.1.3 Case Structure

The May 1989 TSLCC analysis considered cases with and without the consolidation of spent-fuel assemblies prior to emplacement in a repository. However, with the recent decision[7] that the reference waste form is intact assemblies in disposal containers, this analysis considers only the intact spent fuel disposal option. If circumstances dictate (e.g., the estimates of waste package costs increase significantly over current estimates) the issue of consolidation may need to be revisited.

This analysis, therefore, considered the following three cases:

Case	Number of repositories	Repository host geologic medium	Spent-fuel forecast
1	1	Tuff	No-new-orders, end-of-reactor-life
2	2	Tuff/generic	No-new-orders, end-of-reactor-life
3	2	Tuff/generic	Upper reference

2.2 KEY ASSUMPTIONS

As mentioned previously, the majority of assumptions concerning the waste-management system are the same as those discussed for the intact spent-fuel cases in the May 1989 TSLCC report. A detailed description of these assumptions may be found in Appendix B of that report.

Several modifications and additions to the assumptions were necessitated in order to reflect the reference schedule for the restructured program:

- The first repository was assumed to start operations in 2010.
- The generic second repository, when included, was assumed to start operating 25 to 35 years after the resumption of the second repository program.
- The MRS facility was assumed to begin limited waste acceptance in 1998 via a transport/storage system. For costing purposes only, this was assumed to be accomplished through a simple receiving and storage capability utilizing existing technology. Additional costs were included at the MRS facility to provide a recovery capability which would allow for isolation of the stored waste from the environment in the event of an off-normal condition occurring in these first two years until recovery capability is available in the fully operational MRS facility.
- The transportation of spent fuel from reactors to the MRS facility in the years 1998 and 1999 was assumed to be accomplished through the use of a

transport/storage system for transporting spent fuel from the reactors to the MRS and storing the spent fuel at the MRS. To date, OCRWM has not made any decision on the exact transportation or storage technology to implement in the first two years of MRS operation. However, for costing purposes, it was assumed that these casks will have similar physical characteristics and costs as the OCRWM from-reactor rail casks.

An in-depth discussion of these additional assumptions, along with any resulting changes in methodology, is presented in an addendum to the report Cost Estimating Methods for the May 1989 Total System Life Cycle Cost Analysis,[4] which was initially prepared as a companion document to the May 1989 TSLCC report.

2.3 WASTE LOGISTICS

The logistics analysis integrates all of the assumptions about waste generation as well as the annual and total facility-receipt capabilities to define the flows of waste between the various facilities in the system. By doing so, the waste logistics analysis defines the number of years of operation for each of the facilities and is the first step in the cost analysis.

The overall waste-acceptance strategy assumed for the TSLCC analysis specifies that the basis for establishing acceptance priorities for spent fuel is the age of the spent fuel. The TSLCC analysis assumed that the spent-fuel delivery schedule was based on accepting the oldest fuel first. Similarly, the priority for shipping defense high-level waste (DHLW) was assumed to be oldest canister first.

The methodologies used in developing the waste logistics were the same as those discussed in the May 1989 TSLCC report. In calculating the logistics, it was assumed that the DOE is able to work with Congress to modify the current linkages between the repository and the MRS facility in order to allow the MRS facility to begin accepting waste in 1998. This analysis continues to assume, however, that the capacity limits on the MRS facility of 10,000 MTHM prior to the start of operations at the repository and 15,000 MTHM thereafter, as imposed by the Amendments Act, remain in effect.

In developing the aggregate logistics, it was assumed that the MRS facility would begin limited waste acceptance at an annual rate of 400 MTHM per year in 1998. Due to the fact that spent-fuel acceptance at the MRS facility begins 12 years earlier than the repository, the MRS facility is forced to operate below its design acceptance rate until the repository has ramped-up to its full design acceptance rate in order to remain within the capacity limits imposed by the Amendments Act. The ramp-up rates at the first repository and second repository, when included, are the same as those assumed in the May 1989 TSLCC analysis. Appendix A presents the waste-acceptance schedules for the three cases analyzed in this analysis.

Chapter 3

DEVELOPMENT AND EVALUATION COSTS

3.1 INTRODUCTION

The development and evaluation (D&E) cost category covers all the siting, preliminary design development, testing, regulatory, and institutional activities associated with the repositories, the facility for monitored retrievable storage (MRS), and the transportation system. It also includes the cost of administration by the Federal Government, and the charges of the Nuclear Regulatory Commission (NRC) for licensing and continuing oversight of the waste-management facilities and operations, and certifying the transportation casks. By definition, the D&E category encompasses all current program expenditures and all program expenditures for the next several years. In addition, some D&E costs, such as the NRC charges and the costs of regulatory activities and administration by the Federal Government, will continue throughout the life cycle of the program.

The schedule of milestones used in this updated TSLCC analysis represents the program schedule contained in the Secretary's Report on the reassessment of the program. The updated schedule reflects the near-term changes in the repository scientific investigations program. The new focus of the scientific investigations will be on the early identification of potentially adverse conditions, once access to the site is obtained. The revised schedule contains durations for the investigations conducted in the exploratory shafts and the underground testing facility that are substantially longer than originally expected. Compared to the schedule assumed in the May 1989 TSLCC analysis, the new schedule represents a delay in the scheduled submission of the license application (LA) to the NRC of nearly seven years. Also, major activities related to the design of the repository will be deferred until more information is available concerning the suitability of the site.

These delays primarily impacted the D&E activities leading to the submittal of the first-repository LA to the NRC resulting in additional D&E costs for this period. The scheduled duration from LA submittal through the start of the repository operation was virtually unchanged from that assumed in the prior TSLCC analysis. Table 3-1 summarizes the major first repository milestones upon which this cost estimation is based.

Throughout this analysis, the D&E costs for fiscal years (FY) 1983 through 1989 were based on actual costs as reported by the DOE's Financial Information System; these costs are presented in Table 3-2. The primary source of data for the costs of

Table 3-1. Summary of major first repository milestones

Milestone	Completion Dates[a]
Submit license application to NRC	10/01
Receive construction authorization from the NRC	10/04
Submit updated license application to the NRC	4/08
NRC grants license, repository starts operation	1/10

[a] Source: Schedule for Restructured Program contained in Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program (Secretary's Report to Congress).

program activities starting in FY 1990 and extending through FY 1995 was the information developed for the FY 1991 budget request submitted to the Congress in January 1990. This budget request reflects the near-term changes in the scientific investigations program.

The methods for estimating the D&E costs for this updated TSLCC analysis are similar to the methods used in the May 1989 TSLCC analysis. The impact of the revised schedule required some new estimates to be made for the additional years prior to the start of first repository operations. New assumptions and methodology were incorporated, as appropriate, to derive the updated D&E estimates in this analysis. The remainder of this chapter presents a discussion of the changes in methodology and assumptions from the May 1989 TSLCC analysis, the results of the updated D&E estimates, and a comparison of these estimates to those in the May 1989 report.

3.2 CHANGES IN METHODOLOGY AND ASSUMPTIONS

For the first-repository D&E costs, it was assumed that, since the duration for activities beyond LA submittal is almost the same as the May 1989 TSLCC, the costs at level III of the work-breakdown structure (WBS) for the first repository will be maintained for this period. Thus, the only new costs that needed to be estimated were for the activities occurring in the time period starting just after the end of the budget period through the submittal of LA to the NRC (i.e., from FY 1996 to FY 2001). The estimates for this period were derived, for each level III WBS category, by interpolating between the annual cost profiles established through FY 1995 from the budget data and the post-LA submittal period (FY 2002-2010) previously estimated. This interpolation was done on a judgmental basis taking into account the schedule details contained in the Secretary's Report to Congress.

Table 3-2. Summary of actual program costs
(Millions of dollars)

Fiscal Year	Actual costs in year-of-expenditure dollars	Constant 1988 dollars
1983	175	207
1984	271	310
1985	313	346
1986	397	428
1987	468	488
1988	383	383
1989	369	352

As a result of the Secretary's Report, a more detailed schedule is now available for the transportation program. This required an update to the methodologies used in the May 1989 TSLCC analysis for estimating transportation D&E costs beyond the budget period. Although the starting point for this extrapolation is similarly based on the last year of budget data available (FY 1995) for each WBS element, the estimates for this analysis were developed by examining the relative amount of activities in the outyears, specified by the milestones in the new schedule, to the transportation activities in FY 1995.

In estimating the MRS D&E costs beyond the FY 1995 budget estimate and through the start of facility operations in FY 1998, annual factors were applied to the FY 1995 budget estimate for each WBS level of the MRS. These factors were derived based on the scope of work defined in the Secretary's Report to Congress.

There is no change in methodology from the May 1989 TSLCC for estimating D&E costs for systems integration, the administration by the Federal Government, and NRC charges.

3.3 RESULTS

Table 3-3 presents a summary of the D&E costs by major component for the three updated TSLCC cases.

The total D&E cost for the single-repository system is $11.5 billion. This is apportioned as follows: first repository, 59 percent; program management (previously government administration), 22 percent; transportation, 8 percent; NRC charges, 6 percent; MRS facility, 2 percent; systems integration, 2 percent; and second

Table 3-3. Summary of D&E costs
(Millions of 1988 dollars)

Cost Category	Single Repository No-new-orders	Two Repository No-new-orders	Two Repository Upper reference
First repository[a]	6,746	6,455	6,455
Second repository[b]	110	3,051	3,051
MRS facility	300	300	300
Transportation	902	1,223	1,223
Systems integration	301	301	301
NRC fees	659	862	868
Program management	2,490	2,841	2,871
Total D&E costs	11,508	15,033	15,069

[a] Includes costs incurred on the Basalt and Salt sites prior to the stoppage of all work on these sites per the NWPAA.
[b] Includes costs incurred prior to the stoppage of all work on the second repository per the NWPAA.

repository, 1 percent. For the two-repository system, the total D&E cost of $15.0 billion is apportioned as follows: first repository, 43 percent; second repository, 20 percent; program management, 19 percent; transportation, 8 percent; NRC charges, 6 percent; MRS facility, 2 percent; and systems integration, 2 percent. Figures 3-1 and 3-2 show the break out of D&E costs by component for a single-repository and two-repository systems, respectively.

The difference of $3.5 billion between the two systems is almost entirely due to the addition of second-repository activities in the two-repository system. The second-repository D&E cost is estimated to be about $3.0 billion. Transportation D&E costs are $0.3 billion higher in the two-repository system on account of the additional transportation operations that would be required by the addition of another repository site. Program management costs are $0.3 billion higher in the two-repository system because of the extension of the life cycle (2094 versus 2075 in the single-repository system). NRC fees increased by about $0.2 billion for the additional facility in the two-repository system. This collective increase of $3.8 billion for the two-repository system is partially offset by a $0.3 billion reduction in first-repository D&E costs. This savings is due to the avoided cost of additional scientific investigations activities for the single-repository case beyond those currently planned to provide emplacement capability for 70,000 MTHM of waste.

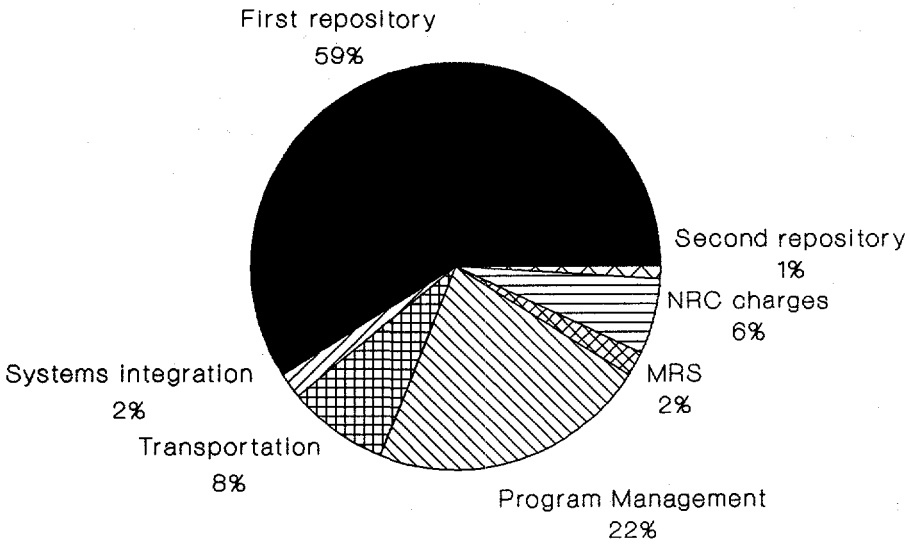

Figure 3-1. D&E costs by component for a single-repository system.

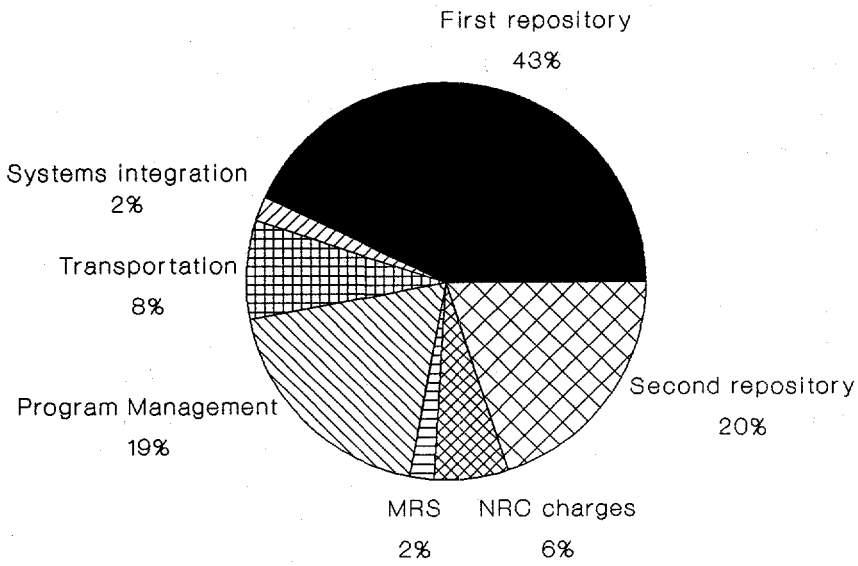

Figure 3-2. D&E costs by component for a two-repository system.

As the results in Table 3-3 indicate, D&E costs are virtually independent of the quantity of spent fuel accepted for disposal. There is no significant D&E cost difference between the two-repository system cases based on the EIA's upper reference forecast and the no-new-orders, end-of-reactor-life forecast.

There is no explicit contingency identified for the D&E estimates in this TSLCC analysis, however, allowances are made for uncertainties in the projections. D&E estimates are based on the Program's best judgment to perform the task plan during that period, thus explicit contingencies are difficult to define.

3.4 COMPARISON WITH PREVIOUS COST ESTIMATES

The D&E costs for this updated TSLCC analysis show an increase over the May 1989 TSLCC analysis of 19 percent (or $1.9 billion) for the single-repository system and 15 percent (or $2.0 billion) for the two-repository system. In most cases, the increase in costs can be attributed to two factors: higher costs during the budget time period and the additional years of operation. As a result of the Secretary's reassessment of the program, the Department is focusing on completing an integrated array of near-term milestones directed at the scientific investigations of the potential site at Yucca Mountain, Nevada. This new emphasis of the program resulted in the increase in the near-term budget for the program as well as the nearly seven additional years of scientific investigations at the repository which translates to additional years of total system operation. Table 3-4 compares these estimates by individual D&E cost category. The costs for the first repository in Table 3-4 are further divided into scientific investigations/selection (defined as all project costs through submittal of the license application to the NRC), subsequent D&E activities through the start of first repository operations, and other first repository costs (such as activities for technical support, repository-technology support program, and reclamation for the nonselected sites).

The comparison shows that the majority of the increase in the total D&E cost is due to the first-repository D&E category. The D&E costs for the first-repository category shows a net increase of $1.2 billion from the May 1989 TSLCC analysis. This is a result of an increase of $1.6 billion for the "scientific investigations/selection" component which was offset by small decreases for the "selected site" and "other first repository" components. The $1.6 billion increase in the "scientific investigations/selection" component is predominantly due to the nearly seven additional years of scientific investigations resulting from the revised schedule in the Secretary's Report. Due to the uncertainty of the second repository program, D&E costs for this category were assumed to be unchanged from the May 1989 TSLCC analysis.

Transportation D&E costs for both the single-repository and two-repository systems increased by about $0.2 billion. This resulted from the additional years required to support the start of repository operations and the availability of new budget

Table 3-4. Comparison of D&E costs to previous estimates
(Millions of 1988 dollars)

Cost Category	Single Repository			Two Repository		
	May 1989 TSLCC	Updated 1990 TSLCC	Changes	May 1989 TSLCC	Updated 1990 TSLCC	Changes
First repository						
scient invest/select[a]	3124	4,708	1584	3,124	4,708	1584
selected site[b]	1608	1,416	-192	1,317	1,125	-192
other first repository[c]	765	622	-143	765	622	-143
Total first repository	5497	6,746	1249	5,206	6,455	1249
Second repository	110	110	0	3,051	3,051	0
MRS facility	292	300	8	292	300	8
Transportation	663	902	239	976	1,223	247
System integration	249	301	52	249	301	52
NRC fees	570	659	89	718	862	144
Program management	2269	2,490	221	2,563	2,841	278
Total D&E Costs	9650	11,508	1858	13,055	15,033	1978

[a] This refers to the period from the enactment of the Nuclear Waste Policy Act of 1982 to the submittal of the license application to the NRC. In the May 1989 TSLCC, this period is from 1983 to 1/1995. In the 1990 Updated TSLCC, this period is from 1983 to 10/2001.
[b] For the two-repository system, this refers to the period after the submittal of license application to the NRC to the start of the first repository operations. In the May 1989 TSLCC analysis, this period extended from 1995 to 2003, while in the 1990 TSLCC analysis, this period extended from 2002 to 2010. For the single-repository system, this period was assumed to be extended by 3 years in each analysis for additional scientific investigations activities required for emplacing greater than 70,000 MTHM in the repository.
[c] Other first repository categories are technical support, repository technology program (RTP), and closeout and reclamation activities.

estimates for the transportation system. Since the transportation program is assumed to be in place to support facility operations when needed, transportation D&E costs are estimated through the start of the first repository, for the single-repository system, or through the start of the second repository, for the two-repository system. Thus a delay in the start of the facility(ies) results in additional years of transportation support. The slight increase in costs for systems-integration activities is due to the additional years required to support the start of repository operations. This is a direct result of the revised schedule used in this analysis. The small increase in the MRS D&E cost is due to the higher estimates made in this year's analysis for the current MRS facility. The increase of $0.2 billion and $0.3 billion in the costs of administration by the Federal Government for the single-repository and two-repository systems, respectively, is due to the additional years of program management required as a result of the revised schedule. Finally, the increase in NRC charges of $0.1 billion is due to the longer operating period for the waste-management system that requires oversight by the NRC.

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Chapter 4

TRANSPORTATION COSTS

4.1 INTRODUCTION

In accordance with the requirements of the Nuclear Waste Policy Act of 1982, as amended, the DOE is developing the transportation capability necessary to support the waste-management system. As directed by the Act, the DOE also plans to use the private industry to the maximum extent possible in the development of the transportation system and in conducting future operations. The transportation category covers the capital costs of purchasing the transportation casks (and conveyances) and the operating costs of accepting the waste and providing all the transportation services needed to support the DOE's waste-management system, including the construction, operation, and decommissioning of a cask maintenance facility. This facility will be used for the maintenance of the casks and their seals, decontamination and equipment inspections. The development of other transportation support capabilities will proceed as the needs and functional requirements are identified. Costs for additional transportation support capabilities will be included in the estimates as data become available. The costs of developing the transportation system are included in the development and evaluation category (see Chapter 3).

The overall cost estimating methodology, assumptions, and cost data used in this analysis were the same as those utilized in the May 1989 TSLCC analysis. However, the transportation cost estimates were structured to reflect the schedule for the restructured program presented in the Secretary's Report on the reassessment of the program. According to this schedule, the MRS facility will start limited waste acceptance with a transport/storage system in 1998.

4.2 RESULTS

The results of the transportation-cost estimates for these updated TSLCC cases are presented in Table 4-1. These results can be summarized as follows:

- For the single-repository case, the total transportation cost is estimated at $2.8 billion. As a result of higher "From MRS facility" cost in the single-repository case, the transportation estimate for the single-repository case is the highest among the three cases studied. This reflects the fact that it is less costly to ship spent fuel from reactor sites directly to a centrally located second repository than to ship the spent fuel to a centrally located MRS facility and then on to the first repository.

Table 4-1. Summary of transportation cost estimates
(Millions of 1988 dollars)

Cost Category	Single Repository Case No-new-orders	Two Repository Case No-new-orders	Two Repository Case Upper reference
		Spent-fuel transportation	
From reactors	1133	1162	1189
From MRS facility	789	577	598
Cask maintenance facility	528	549	580
Total spent-fuel cost	2450	2288	2367
		DHLW transportation	
From defense sites	297	307	306
Cask-maintenance facility	53	63	68
Total DHLW cost	351	370	374
Total transportation costs[a]	2803	2658	2741

[a] Columns may not add to totals due to independent rounding.

- The total transportation cost for the two-repository system is approximately $2.7 billion for each of the two spent-fuel projections considered. For the cases examined, the transportation costs vary only slightly with the total quantity of waste due to the fact that the higher cost associated with the extended period of operations required in the no-new-orders, end-of-reactor-life case offsets most of the cost savings from transporting about 10,100 MTHM less waste than the upper reference case.

- The costs for defense-waste transportation range from $351 to $374 million and account for 13 to 14 percent of the total transportation cost.

Figure 4-1 presents the transportation costs by component on a percentage basis for the single-repository case. Of the cost components for waste transportation, the shipping costs (shipping, surcharge, inspection, and detention) account for about 40 percent of the total. Security costs represent about 6 percent of the total

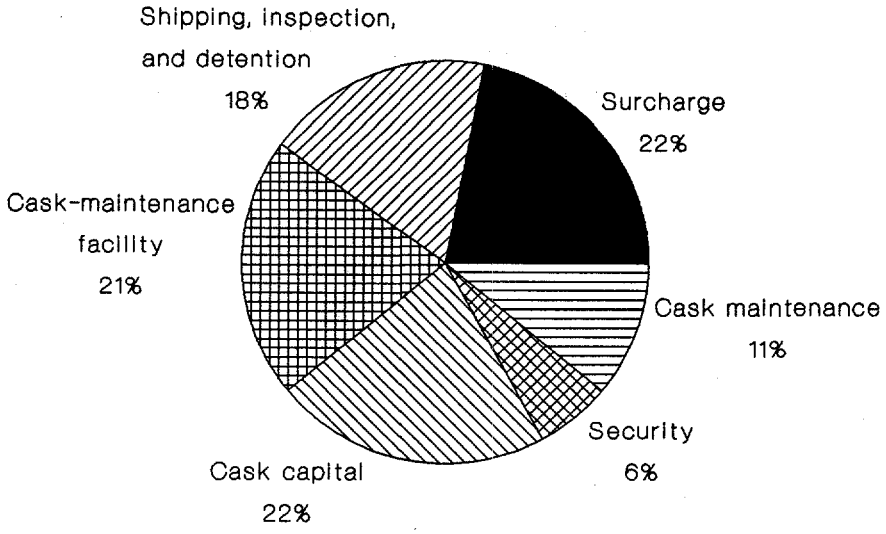

Figure 4-1. Total transportation costs by major component for the single-repository system.

transportation estimate. The cask capital and maintenance costs account for about 33 percent of the total, while the cask maintenance facility costs account for 21 percent of the total transportation cost.

Another way of examining transportation costs is by the mode of travel. Figures 4-2 and 4-3 show how the relative magnitude of the transportation costs vary by travel mode for the single-repository and two-repository cases, respectively, based on the no-new-orders, end-of-reactor-life spent fuel projection. In the single-repository case, the "from-MRS" costs are high because, although spent fuel from western reactors may be shipped directly to the repository, in this analysis, it was assumed that all spent fuel passes through the MRS facility which then ships the intact assemblies to the repository. This assumption is made for calculational purposes only. Future shipments and routings will be influenced by geographic economies and safety considerations and may go directly to the repository. For the two-repository case, the "from-reactor" costs are relatively high because some of the spent fuel is now being shipped directly from reactors to the second repository instead of first passing through the MRS facility.

A 20 percent contingency factor has been included in the transportation estimates to cover the cost uncertainties inherent in the estimates for a conceptual system and to accommodate further refinements in the scope of the OCRWM transportation program. The total amount of contingency contained in the

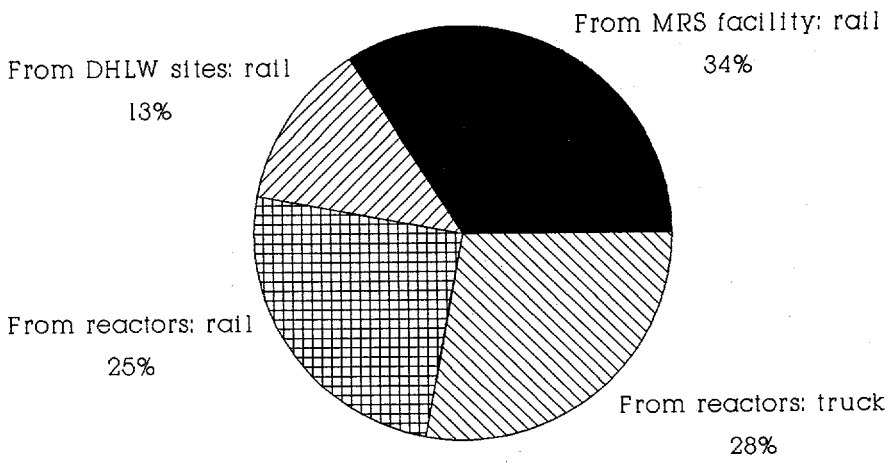

Figure 4-2. Total transportation costs by type of shipment for the single-repository system

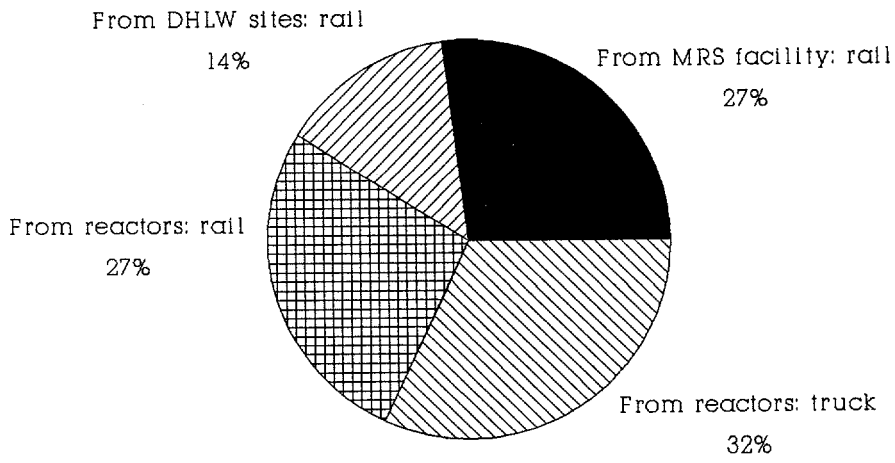

Figure 4-3. Total transportation costs by type of shipment for the two repository system.

transportation estimates in this analysis ranges from $532 million to $561 million depending on the system configuration.

4.3 COMPARISON WITH PREVIOUS COST ESTIMATES

Table 4-2 presents a comparison of the transportation cost estimates for the single-repository and two-repository cases with the comparable cases from the May 1989 TSLCC analysis.

For the single-repository case, the impact of the restructured program on the total transportation cost is an increase of $0.2 billion. The majority of this increase is due to the additional costs associated with the transport/storage system utilized in the years 1998 and 1999. There is a slight decrease in the "from-MRS" transportation costs due to a reduction in the number of years over which spent fuel is shipped to the repository. This is a direct result of the delay in the start of operations at the repository until 2010.

For the two-repository case, the restructured program results in a $0.3 billion increase in the total transportation cost. Again, the majority of this increase is due to the costs of the transport/storage system utilized for the first two years of system acceptance. In addition, there is an increase of about $0.1 billion for the cask maintenance facility due to the 7-year delay in the repository program. This delay results in an additional 7 years of operation required in order to service the MRS facility and both repositories.

Table 4-2. Comparison of transportation costs to previous estimates
(Millions of 1988 dollars)

Cost Category	Single Repository No-new-orders			Two Repository No-new-orders		
	May 1989 TSLCC	Updated 1990 TSLCC	Change	May 1989 TSLCC	Updated 1990 TSLCC	Change
		Spent fuel transportation				
From reactors	925	1133	+208	901	1162	+261
From MRS facility	810	789	-21	577	577	0
Cask maintenance facility	529	528	-1	484	549	+65
Total spent-fuel cost	2264	2450	+186	1962	2288	+326
		DHLW transportation				
From defense sites	297	297	0	307	307	0
Cask maintenance facility	53	53	0	56	63	+7
Total DHLW cost	351	351	0	363	370	+7
Total transportation costs[a]	2614	2803	186	2325	2658	+333

[a] Columns may not add to totals due to independent rounding.

Chapter 5

REPOSITORY COSTS

5.1 INTRODUCTION

The repository cost component covers the engineering, construction, operation, and closure and decommissioning costs for the repositories. The scope of the repository costs of these updated estimates has not changed from the May 1989 TSLCC analysis. The engineering costs cover the license-application design (LAD), final procurement and construction design (FPC), and the Title III design. All other preliminary design work performed prior to the LAD are considered as part of the development and evaluation (D&E) costs discussed in Chapter 3. The repository construction costs include site preparation, the construction of surface facilities including the functional testing of the waste-handling building, the installation of utility networks, the construction and outfitting of shafts and ramps, the excavation and construction of underground support areas, and a limited amount of excavation for waste emplacement. Construction costs are incurred until all repository facilities are in operation. Operating costs include all staffing, maintenance, supplies (including waste packages), and utilities during the emplacement and caretaker phases. The final component of the repository cost is the cost of closure and decommissioning, which includes all costs associated with backfilling and permanently sealing the underground repository and decommissioning the surface facilities.

The "reference schedule for the restructured program" presented in the Secretary's Report on the reassessment of the program contained several important changes in repository milestones from those assumed in the May 1989 TSLCC analysis. Among those which are related to the engineering, construction, and operation of the repository are:

- License-application design will begin in June 1996 and will continue through submittal of the license application in October 2001.
- Final procurement and construction design will then begin in October 2001.
- Repository construction will begin in October 2004.
- Start of waste emplacement will begin in January 2010.

This analysis reflects these changes in the first repository schedule and assumes that the first repository is located at the Yucca Mountain candidate site. If this site is determined to be unsuitable, the cost estimates will need to be reevaluated.

The Nuclear Waste Policy Amendments Act of 1987 prohibited site-specific activities related to a second repository unless specifically authorized by the Congress and requires the Secretary to report to Congress and the President between 2007 and 2010 on the need for a second repository. Thus, similar to the May 1989 TSLCC analysis, this analysis considers both a single-repository and a two-repository system in order to evaluate the full range of repository life-cycle costs. For the two-repository system cases, the second repository is assumed to begin 25 to 35 years after the resumption of the second repository program.

The May 1989 TSLCC analysis included cases with the emplacement of both intact and consolidated spent fuel at the repository(ies). However, due to the recent decision that the reference waste form for the system is intact spent-fuel assemblies in disposal containers, this analysis considers only cases with intact disposal of spent fuel. All other assumptions about the design and operation of the repositories and the methodologies used in developing the repository cost estimates are the same as those used in the May 1989 TSLCC analysis.

5.2 RESULTS

The results of the repository-cost estimates for these updated TSLCC cases are presented in Table 5-1. These results can be summarized as follows:

- The single-repository case has a repository cost of $8.7 billion. The single-repository case includes additional costs not accounted for in the first repository costs of the two-repository cases for the following: an additional ventilation shaft at the south end of the mining drifts, ventilation support equipment and facilities, additional drift tonnage, additional emplacement panels in the northern block, and extended panels to the southeast. The single-repository estimates are based on the assumption that these additional areas of the underground are found to be usable. This premise would have to be verified by additional scientific investigations. It should be emphasized that the single-repository estimates are primarily based on engineering judgement and, as such, do not reflect a detailed design study.

- For the two-repository case based on the no-new-orders, end-of-reactor-life spent-fuel projection, the total repository cost is $13.5 billion, or $4.8 billion higher than the cost of the comparable single-repository case. The first repository has a cost of $7.0 billion, and the generic second repository has a cost of $6.6 billion. The higher total repository cost for the two-repository system can be attributed to the additional cost of the second repository ($6.6 billion), which is partially offset by a $1.7 billion reduction in the cost of the first repository, whose capacity is now limited to 70,000 MTHM. This

Table 5-1. Summary of repository cost estimates
(Millions of 1988 dollars)

Cost Category	Single Repository Case No-new-orders	Two Repository Case No-new-orders	Two Repository Case Upper reference
		First Repository	
Engineering and construction	1179	1,119	1,119
Operation	7058	5,455	5,487
Closure and decommissioning	498	418	427
Total first repository cost	8735	6,992	7,033
		Second Repository	
Engineering and construction	NA[a]	2,242	2,249
Operation	NA	3,953	4,689
Closure and decommissioning	NA	356	361
Total second repository cost	NA	6,551	7,299
Total repository costs	8735	13,543	14,332

[a] Not applicable.

reduction in the first-repository cost reflects a facility with a smaller capacity (70,000 MTHM versus 96,300 MTHM) and a shorter waste-emplacement period (25 versus 33 years).

The reader may note that the second repository costs are relatively close to the first repository costs ($6.6 billion to $7.0 billion) in this case; but the second repository capacity is only 26,300 MTHM, whereas the first repository capacity is 70,000 MTHM. The similarity in the costs is caused by the assumed average mining conditions for the generic geologic medium second repository versus the relatively inexpensive conditions for a repository at the candidate site at Yucca Mountain. The generic second repository estimates were derived from previous TSLCC estimates prepared for salt, basalt and crystalline geologic-medium repositories prior to the Amendments Act, and these repository costs were significantly more costly than a comparable repository in tuff. Finally, the second repository costs are high because of the substantial fixed costs associated with a repository. The fixed costs include the costs of construction and the costs of maintaining retrievability for 50 years.

- For the two-repository case based on the upper reference spent-fuel projection, the total repository cost is $14.3 billion. This is $0.8 billion higher than the repository cost estimate for the comparable no-new-orders, end-of-reactor-life projection case. This increase is mostly due to the increase at the generic second repository, because the second repository is assumed to accept all of the additional waste included in the upper reference projection. The second repository accepts a total of 36,400 MTHM in the upper reference case, which represents a capacity increase of nearly 39 percent over the no-new-orders, end-of-reactor-life case.

Figures 5-1 and 5-2 present the costs for the single repository in tuff on a percentage basis by phase (engineering and construction, emplacement operations, caretaker operations, and closure and decommissioning) and by account (management and integration, site preparation, surface facilities, shafts and ramps, underground excavations, underground service systems, and waste package), respectively.

The repository cost estimates incorporate contingency factors on an account-specific basis. The composite totals of the account-specific contingencies added to the repository estimates are approximately 26% (or $1,810 million), 29% (or $3,020 million), and 29% (or $3,213 million) for the single and two repositories with a no-new-orders (NNO) spent-fuel projection, and two repositories with an upper reference spent-fuel projection cases, respectively.

5.3 COMPARISON WITH PREVIOUS COST ESTIMATES

Table 5-2 presents a comparison of the repository cost estimates for the single-repository and two-repository cases based on the no-new-orders, end-of-reactor-life spent-fuel projection with the comparable cases from the May 1989 TSLCC analysis.

For the single-repository case, the impact of the restructured program on the total repository cost is a reduction of $0.3 billion. This is due primarily to the delay in the start of operations at the repository from 2003 to 2010. Since the last projected discharge of spent fuel in the no-new-orders, end-of-reactor-life case is in 2037, the single repository must continue to accept waste until 2042 if the minimum age for spent-fuel acceptance is to remain at 5 years. Thus, delaying the start of repository operations by 7 years in this case results in a corresponding 7-year reduction in the emplacement operations phase at the repository.

For the two-repository case, the impact of the restructured program on the total-repository cost is a reduction of less than $0.1 billion. There is no significant change in the first-repository cost for this case as a result of the delay in the start of repository operations to 2010. There is a slight decrease in the second-repository cost resulting from one less year of emplacement operations due to the delay in the repository program.

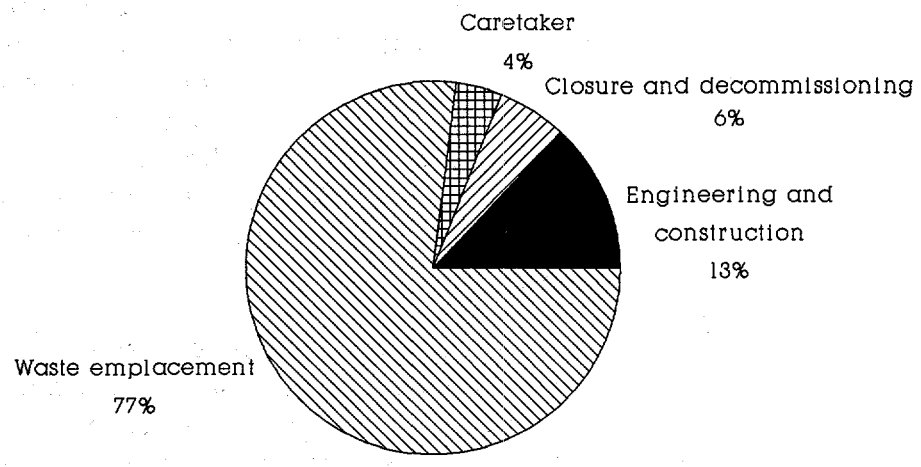

Figure 5-1. Repository costs by phase for a single repository in tuff.

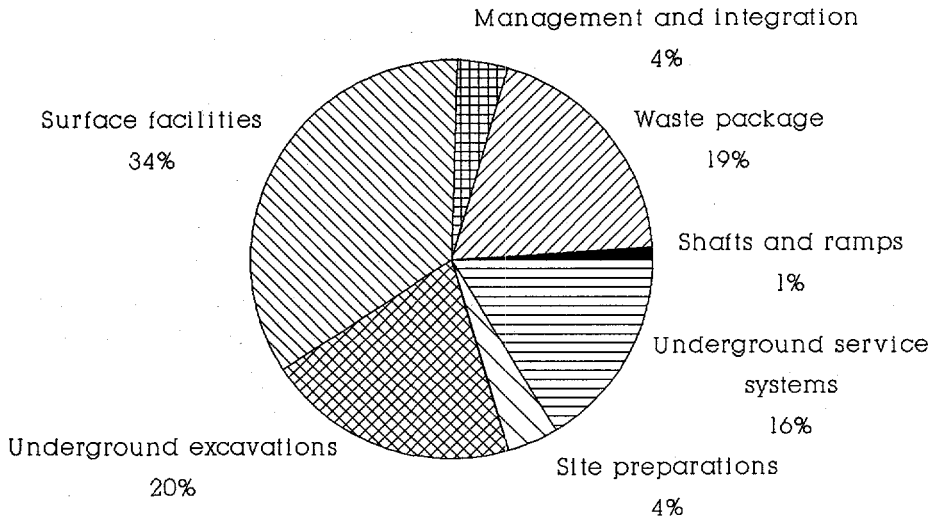

Figure 5-2. Repository costs by account for a single repository in tuff.

Table 5-2. Comparison of repository costs to previous estimates
(Millions of 1988 dollars)

Cost Category	Single Repository No-new-orders			Two Repository No-new-orders		
	May 1989 TSLCC	Updated 1990 TSLCC	Change	May 1989 TSLCC	Updated 1990 TSLCC	Change
		First Repository				
Engineering and construction	1177	1179	+2	1,118	1,119	+1
Operation	7388	7058	-330	5,461	5,455	-6
Closure and decommissioning	498	498	0	427	418	-9
Total first repository cost	9063	8735	-328	7,006	6,992	-14
		Second Repository				
Engineering and construction	NA[a]	NA	NA	2,245	2,242	-3
Operation	NA	NA	NA	3,985	3,953	-32
Closure and decommissioning	NA	NA	NA	352	356	+4
Total second repository cost	NA	NA	NA	6,582	6,551	-31
Total repository costs	9063	8735	-328	13,588	13,543	-45

[a] Not applicable.

Chapter 6

MRS FACILITY COSTS

6.1 INTRODUCTION

The Nuclear Waste Policy Amendments Act of 1987 authorized the DOE to site, construct, and operate a facility for monitored retrievable storage (MRS), subject to certain conditions. As a result, the DOE is including an MRS facility as an integral part of the waste-management system, and the assumptions used in the TSLCC analysis are based on an integral MRS facility.

The MRS estimates include the costs for the design, construction, operation, and decommissioning of the MRS facility. The design and construction costs cover the design and design support, construction and construction management, and training and testing. The operations costs include the costs of the concrete storage casks, the concrete pads on which the casks are kept in the storage yard, labor, materials, and utilities. The decommissioning costs include the costs of decontamination and restoration of the site to unrestricted use. The costs for the development of the MRS facility through the conceptual design stage are included in the development and evaluation cost category (see Chapter 3).

The Secretary's Report on the reassessment of the program focused on the initiation of a three-point action plan to safely dispose of commercial spent fuel and high-level radioactive waste. The plan included an initiative to site, construct, and operate an integrated MRS facility with a target for spent-fuel acceptance in 1998. To achieve this goal, the DOE has proposed a two-phase approach to the development of the basic MRS facility described in the MRS System Study Summary Report[8] and assumed in the May 1989 TSLCC analysis. The first-phase of the MRS facility will perform the functions of spent-fuel receipt, handling, and storage in order to provide limited waste acceptance beginning in 1998. The second-phase will consist of the full-capability MRS facility and will be ready to receive and store spent fuel starting in 2000 at a much higher throughput rate of up to 3000 MTHM per year.

The MRS cost estimates presented in this report are based on a "basic" MRS facility. Thus, the majority of assumptions concerning the full-capability MRS facility, as well as the methodologies used in developing the cost estimates, are the same as those used in the May 1989 TSLCC analysis. However, additional assumptions concerning the transport/storage system utilized during the first phase of the MRS facility operations were necessary. In order to achieve limited waste acceptance beginning in 1998, it was assumed that the MRS facility would accept and store limited quantities of spent fuel from reactors. This required the addition of a simple receiving

building to the MRS facility design. This building would be used in 1998 and 1999 to unload casks onto a transporter where they would then be moved to the storage yard. Additionally, costs were included at the MRS facility to provide a recovery capability in the event of an off-normal condition occurring in these first two years of operation.

It is important to note that the DOE is currently investigating alternative MRS facility design concepts which would allow for waste acceptance beginning in 1998. A final decision on the MRS facility design has not been made. The assumptions discussed above were made solely for the purpose of developing MRS cost estimates, and they provide a conservative estimate of the cost impact of the restructured program on the MRS costs.

6.2 RESULTS

The results of the MRS cost estimates for these updated TSLCC cases are presented in Table 6-1. These results can be summarized as follows:

- For the single-repository case, the MRS facility is estimated to cost $1.9 billion. This relatively high cost for the MRS facility reflects the fact that, in the single-repository system, the MRS facility handles all the spent fuel in the planning base (approximately 86,800 MTHM) and operates for over 40 years.

- For the two-repository system cases, the MRS facility cost is $1.6 billion. The MRS costs are insensitive to the quantity of spent fuel in the two-repository cases due to the fact that the MRS facility is assumed to service only the first repository in both cases. Thus, the MRS facility is required to operate for 37 years in both cases.

Figures 6-1 and 6-2 illustrate the relative shares of the total MRS facility cost by phase for the single-repository and two-repository cases, respectively. The figures separate engineering costs from construction and also break down operating costs by account.

The MRS estimates incorporate contingency factors that were derived based on account-specific cost categories. A composite total of account-specific contingencies of approximately 24% was included in the MRS estimates for each of the three cases. The total contingencies included in the MRS estimates are $361 million, $310 million, and $311 million for the single and two repositories with NNO spent-fuel projection, and two repositories with an upper reference spent-fuel projection, respectively.

Table 6-1. Summary of MRS facility cost estimates
(Millions of 1988 dollars)

Cost Category	Single Repository Case No-new-orders	Two Repository Case No-new-orders	Two Repository Case Upper reference
Construction	354	354	354
Operation	1484	1235	1238
Decommissioning	24	24	24
Total MRS facility cost	1862	1613	1616

6.3 COMPARISON WITH PREVIOUS COST ESTIMATES

Table 6-2 presents a comparison of the MRS cost estimates for the single-repository and two-repository cases with the comparable cases from the May 1989 TSLCC analysis.

For both the single-repository and two-repository cases, there was a slight increase in the construction costs of the MRS facility reflecting the additional costs of accommodating the transport/storage system (i.e., the first phase of the two-phase MRS facility). The restructured program results in a total increase of less than $0.1 billion in the MRS facility cost for the single-repository case. The majority of this increase is due to the two additional years of operation at the MRS facility resulting from the start of waste acceptance in 1998 compared to 2000 in the May 1989 TSLCC analysis. The delay in the repository program does not impact the last year of operation of the MRS facility in the single-repository case, since the MRS facility must continue accepting spent fuel through 2042 (in order to meet the 5-year minimum waste age requirement). As in the May 1989 TSLCC analysis, the last projected spent fuel discharge is in 2037 for the no-new-orders, end-of-reactor-life case.

For the two-repository case, the restructured program results in a $0.2 billion increase in the MRS facility cost. Again, the majority of this increase is due to the additional number of years of operation required as a result of beginning acceptance in 1998 along with an extension in the operating life of the facility resulting from the delay in the repository program. In the two-repository system, the MRS facility is assumed to service only the first repository. Thus, any delay in the start of operations at the first repository results in an equivalent number of years of additional operations at the MRS facility if the MRS start date is not delayed along with the repository. Thus, by delaying the start of operations at the first repository by 7 years and by

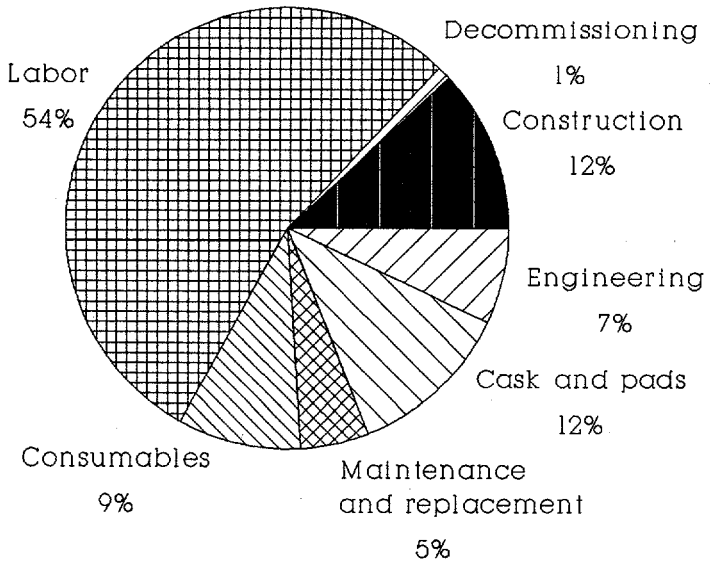

Figure 6-1. MRS facility costs by account for the single-repository system.

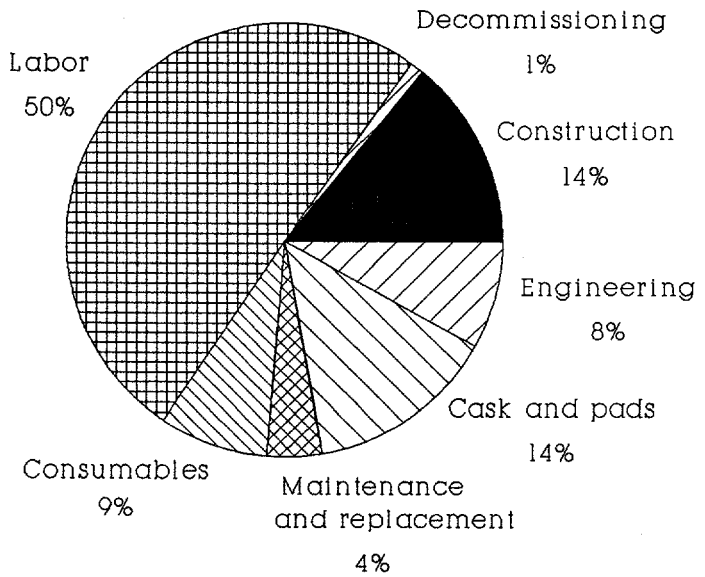

Figure 6-2. MRS facility costs by account for the two-repository system.

Table 6-2. Comparison of MRS facility costs to previous estimates
(Millions of 1988 dollars)

Cost Category	Single Repository No-new-orders			Two Repository No-new-orders		
	May 1989 TSLCC	Updated 1990 TSLCC	Change	May 1989 TSLCC	Updated 1990 TSLCC	Change
Construction	343	354	+11	343	354	+11
Operation	1442	1484	+42	1020	1235	+215
Decommissioning	24	24	0	24	24	0
Total MRS facility cost	1809	1862	+53	1387	1613	+226

starting waste acceptance in 1998 rather than 2000, the MRS facility is required to operate a total of 9 additional years compared to the equivalent case from the May 1989 TSLCC report.

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Chapter 7

BENEFITS PAYMENTS

7.1 INTRODUCTION

The Amendments Act allows the Secretary of Energy to enter into benefits agreements with the State of Nevada concerning a repository and a State or Indian Tribe concerning a facility for monitored retrievable storage (MRS). In return for these benefits, the State or Indian Tribe waives its rights to disapprove the recommendation of a site for a repository or an MRS facility and its rights for funding for impact assistance as provided for by the Nuclear Waste Policy Act, although some impacts may be mitigated by the Federal Government.

Under the provisions of the Amendments Act, the annual payment to the State of Nevada would be $10 million upon execution of a benefits agreement. It would remain at that level for each year until the start of waste acceptance at the repository. At that time, the annual payment would increase to $20 million and remain at that level until the closure and decommissioning of the repository is complete.

For the MRS facility, the annual payment to the host State or Indian Tribe would be $5 million upon execution of the agreement. This annual payment would increase to $10 million once waste acceptance begins at the MRS facility. It would remain at that level until the completion of decommissioning of the MRS facility.

The methodologies used to calculate the benefits payments in this analysis are the same as those used in the May 1989 TSLCC. The sums specified in the schedule of payments in Section 5031 of the Amendments Act were assumed to be in "year-of-expenditure" dollars. Thus, to be consistent with the other TSLCC cost components, these costs were deflated in order to express them in constant 1988 dollars.

7.2 RESULTS

The results of the benefits payments analysis for these updated TSLCC cases are presented in Table 7-1. These results can be summarized as follows:

- The single-repository case has a total benefits payments cost of nearly $0.7 billion. This is comprised of $0.4 billion in payments to the State of Nevada for the repository and $0.2 billion to a State or Indian Tribe for the MRS facility.

Table 7-1. Summary of total benefits payments
(Millions of 1988 dollars)

Cost category	Single Repository Case No-new-orders	Two Repository Case No-new-orders	Two Repository Case Upper reference
First repository	444	440	440
Second repository	NA	156	156
MRS facility	213	197	197
Total benefits payments	657	793	793

- The two-repository cases have a total benefits payments cost of $0.8 billion which is comprised of $0.4 billion in payments to the State of Nevada for the first repository, $0.2 billion in payments for the MRS facility, and $0.2 billion for the second repository to the States or affected Indian Tribes.

7.3 COMPARISON WITH PREVIOUS COST ESTIMATES

Table 7-2 presents a comparison of the estimates of the benefits payments for the single-repository and two-repository cases based on the no-new-orders, end-of-reactor-life spent-fuel projection with the comparable cases from the May 1989 TSLCC analysis.

The impact of the restructured program on the total benefits payments is a reduction of less than $0.1 billion for both the single-repository and two-repository cases. This decrease in costs is due primarily to the delay in the repository program.

Table 7-2. Comparison of benefits payments to previous estimates
(Millions of 1988 dollars)

Cost Category	Single Repository No-new-orders			Two Repository No-new-orders		
	May 1989 TSLCC	Updated 1990 TSLCC	Change	May 1989 TSLCC	Updated 1990 TSLCC	Change
First repository	480	444	-36	476	440	-36
Second repository	NA[a]	NA	NA	193	156	-37
MRS facility	221	213	-8	187	197	+10
Total benefits payments	701	657	-44	856	793	-63

[a] Not applicable.

Chapter 8

COSTS FOR THE DISPOSAL OF DEFENSE WASTE

8.1 INTRODUCTION

As explained in the 1985 Mission Plan[9] and in subsequent Mission Plan Amendment,[10] defense high-level waste (DHLW) will be accepted for disposal in the geologic repository being developed by the Office of Civilian Radioactive Waste Management (OCRWM) of the Department of Energy (DOE). The DHLW will be transported to the repository in transportation casks that will be developed by the Civilian Radioactive Waste Management Program and whose design will be certified by the Nuclear Regulatory Commission. The full cost for the transportation and the disposal of the DHLW, including accrued interest, will be paid by the DOE's Office of Defense Programs.

The assumptions and methodologies used to calculate the defense share of the total-system costs in this analysis are the same as those discussed in the May 1989 TSLCC report. The estimation of defense-waste costs is based on the concept of full cost recovery, with sharing formulas applied to all applicable cost components. The costs for facilities or activities carried out solely for defense-waste disposal are directly allocated (100 percent) as defense-waste costs. Common costs for facilities and activities used for both defense and civilian waste are apportioned between the two types of waste based on an appropriate cost-sharing factor. This method for estimating the amount to be paid for defense-waste disposal was published in the Federal Register[11] in August 1987. The total quantity of DHLW requiring disposal was assumed to be about 17,750 canisters (the equivalent of approximately 8875 MTHM). For the two-repository system, it was assumed that the defense waste would be divided between the two-repositories in the same proportion as the spent fuel.

8.2 RESULTS

The results of the defense-waste share cost analysis for these updated TSLCC cases are presented in Table 8-1. These results can be summarized as follows:

- For the single-repository case, the defense-waste share of the $25.6 billion total-system cost is $3.8 billion or 15 percent.

- For the two-repository case based on the no-new-orders, end-of-reactor-life spent-fuel projection, the defense-waste share of the $33.6 billion total-system cost is $5.8 billion or 17 percent.

Table 8-1. Summary of defense-waste and total-system cost estimates
(Millions of 1988 dollars)

Cost Category	Single Repository Case No-new-orders		Two Repository Case No-new-orders		Two Repository Case Upper reference	
	DHLW cost	Total cost	DHLW cost	Total cost	DHLW cost	Total cost
Development and evaluation	1765	11508	2571	15033	2432	15069
Transportation	347	2803	361	2658	366	2741
First repository	1632	8735	1327	6992	1189	7033
Second repository	NA[a]	NA	1384	6551	1486	7299
MRS facility	NA	1862	NA	1613	NA	1616
Benefits	78	657	116	793	107	793
Total costs	3822	25565	5759	33640	5580	34551

[a] Not applicable.

- For the two-repository system based on the upper reference case spent-fuel projection, the total-system cost increased to $34.6 billion but the defense-waste share decreased to $5.6 billion or 16 percent. Thus, the total allocation of costs for DHLW was virtually unaffected by the increase in the projected quantity of civilian spent fuel. This increase in the total quantity of waste requiring disposal resulted in a change in the quantity of defense waste to be accepted at each repository. As a result, there was a decrease in the quantity of DHLW to be emplaced in the first repository and a corresponding increase in the quantity of DHLW to be emplaced in the more-expensive second repository.

Figure 8-1 presents a comparison of the defense, civilian, and total-system costs for each of these cases.

8.3 COMPARISON WITH PREVIOUS COST ESTIMATES

Table 8-2 presents a comparison of the estimates of the defense-waste share of the total-system costs for the single-repository and two-repository cases based on the no-new-orders, end-of-reactor-life spent-fuel projection with the comparable cases from the May 1989 TSLCC analysis.

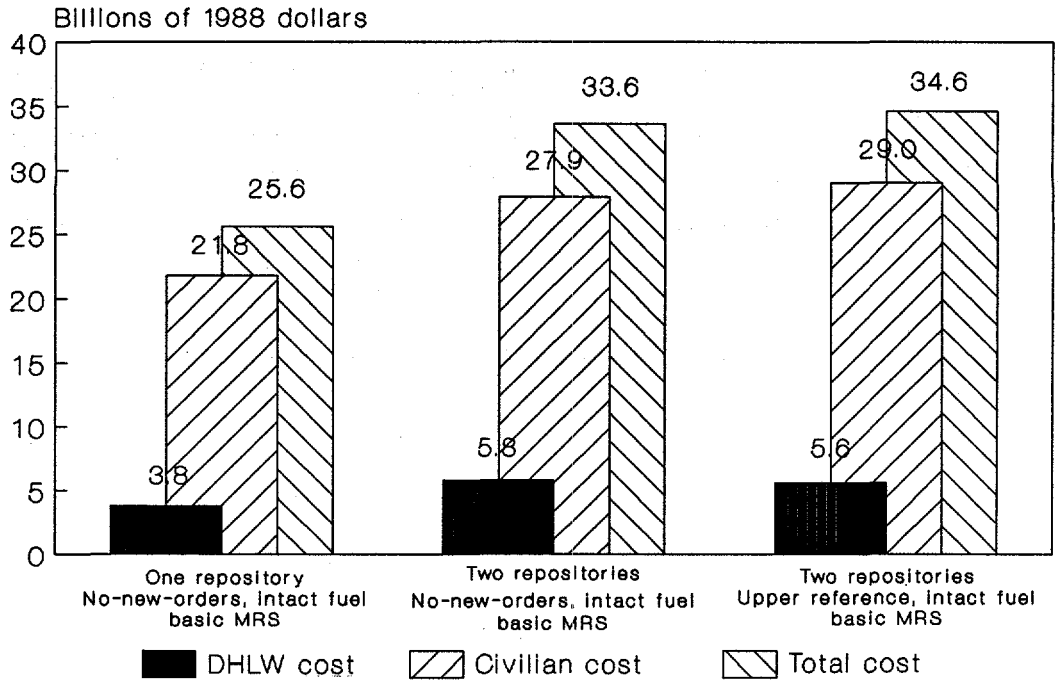

Figure 8-1. Summary of defense, civilian, and total-system costs.

Table 8-2. Comparison of defense-waste costs to previous estimates (Millions of 1988 dollars)

Cost Category	Single Repository No-new-orders			Two Repository No-new-orders		
	May 1989 TSLCC	Updated 1990 TSLCC	Change	May 1989 TSLCC	Updated 1990 TSLCC	Change
Development and evaluation	1476	1765	+289	2234	2571	+337
Transportation	347	347	0	355	361	+6
First repository	1670	1632	-38	1333	1327	-6
Second repository	NA[a]	NA	NA	1299	1384	+85
Benefits payments	87	78	-9	136	116	-20
Total-system cost[b]	3580	3822	+242	5357	5759	+402

[a] Not applicable.
[b] Columns may not add to totals due to independent rounding.

The total impact of the restructured program on the costs for disposal of defense waste is an increase of $0.2 billion for the single-repository case and an increase of $0.4 billion for the two-repository case. However, the restructured program did not affect the defense-waste share of the total-system cost (15 percent for the single-repository case and 17 percent for the two-repository case) due to the proportional increase in the total-system cost for each case.

Chapter 9

RESULTS OF THE UPDATED TSLCC ANALYSIS

The total-system costs were obtained by summing the estimated costs for each component of the waste-management system presented in the preceding chapters (i.e., development and evaluation, transportation, repository, MRS facility, and benefits payments). Table 9-1 presents a summary of the results of the cases studied in this analysis. The remainder of this chapter contains a discussion of these results on a case-by-case basis.

9.1 SINGLE REPOSITORY - NO NEW ORDERS PROJECTION

The single-repository case based on the no-new-orders, end-of-reactor-life spent-fuel projection has a total system cost of $25.6 billion. The development and evaluation and the repository components account for nearly 80 percent (45 and 34 percent, respectively) of the costs for the case. The transportation costs account for less than 11 percent, the MRS facility costs are about 7 percent, and the benefits payments add up to about 3 percent. Figure 9-1 presents the costs by major component for this case. Figure 9-2 presents the annual total-system cost stream for this single-repository case. In addition, Figure 9-3 presents the annual cost by component for the single-repository case. As seen in this figure, the majority of the D&E costs were incurred prior to the start of repository operations. First repository and MRS facility costs were incurred through the decommissioning of each facility. Transportation costs were distributed over the operating lives of the MRS facility and repository. Finally, benefits payments represent a small annual cost stream through the decommissioning of the repository.

9.2 TWO REPOSITORY - NO NEW ORDERS PROJECTION

The total-system cost for the two-repository case based on the no-new-orders, end-of-reactor-life spent-fuel projection is $33.6 billion, or approximately $8 billion higher than that for the comparable single-repository case. The development and evaluation costs were increased by approximately $3.5 billion because of the resumption of the second repository program (i.e., scientific investigations, etc.). The transportation costs were decreased by about $0.1 billion due to the savings realized by shipping directly to the second repository rather than to an MRS facility and then to the repository in Nevada. These savings were offset somewhat by the additional costs associated with the transport/storage system utilized to achieve early acceptance at the MRS facility in 1998 and 1999. The first repository costs decreased by about

Table 9-1. Summary of total-system life-cycle cost estimates
(Millions of 1988 dollars)

Cost category	Single Repository Case No-new-orders	Two Repository Case No-new-orders	Two Repository Case Upper reference
Development and evaluation	11,508	15,033	15,069
Transportation	2,803	2,658	2,741
First repository	8,735	6,992	7,033
Second repository	NA[a]	6,551	7,299
MRS facility	1,862	1,613	1,616
Benefits	657	793	793
Total costs	25,565	33,640	34,551

[a] Not applicable.

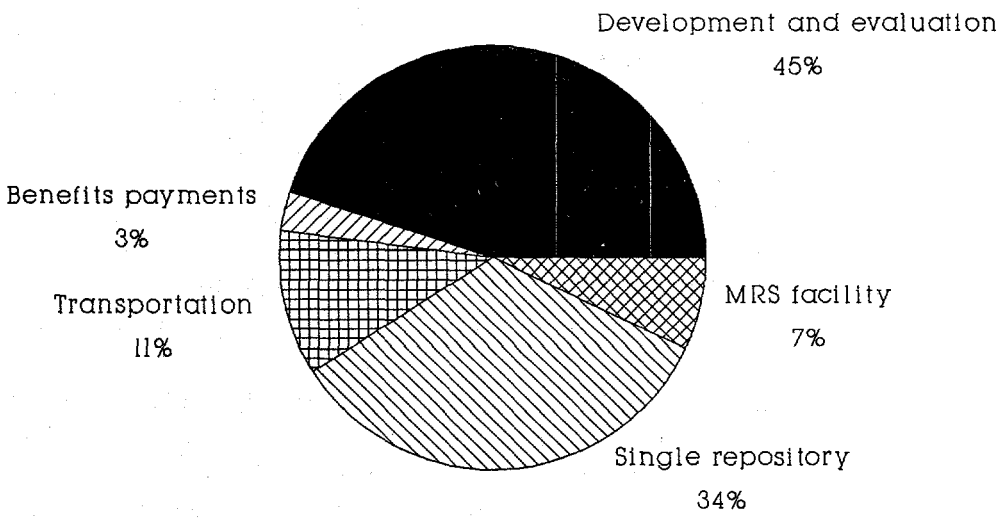

Figure 9-1. Total-system costs by major cost component for a single-repository system based on the no-new-orders, end-of-reactor-life spent-fuel projection.

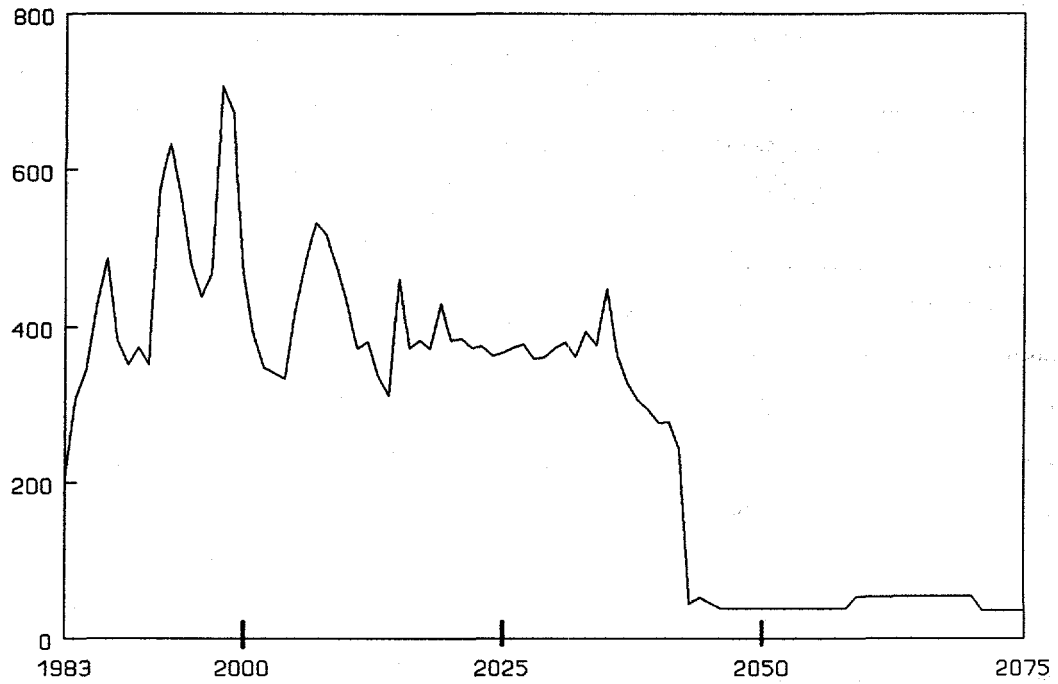

Figure 9-2. Annual total-system costs for the single-repository case.

$1.7 billion because the facility was assumed to emplace only 70,000 MTHM or about 26,300 MTHM less then the single-repository case. The costs for the second repository accounted for an additional $6.6 billion. The MRS facility costs decreased by about $0.2 billion because of the reduction in the total throughput and the operating life associated with only servicing the first repository. Finally, the benefits costs increased by approximately $0.1 billion because of the inclusion of an assumed benefits agreement for the second repository. Figure 9-4 presents the costs by major component for this case. In addition, Figure 9-5 presents the annual cost by component for this case. As seen in this figure, the majority of D&E costs were incurred prior to the start of the first- and second-repository operations. The costs for the first and second repositories and the MRS facility were mostly incurred during the operating period of each facility and the costs extend through the decommissioning of each facility. Transportation costs were distributed over the operating lives of the different facilities in the system. Finally, benefits payments were incurred through the decommissioning of the second repository.

9.3 TWO REPOSITORY - UPPER REFERENCE PROJECTION

The final TSLCC case is for a two-repository system based on the upper reference case spent-fuel projection, which forecasts 96,900 MTHM of spent fuel versus

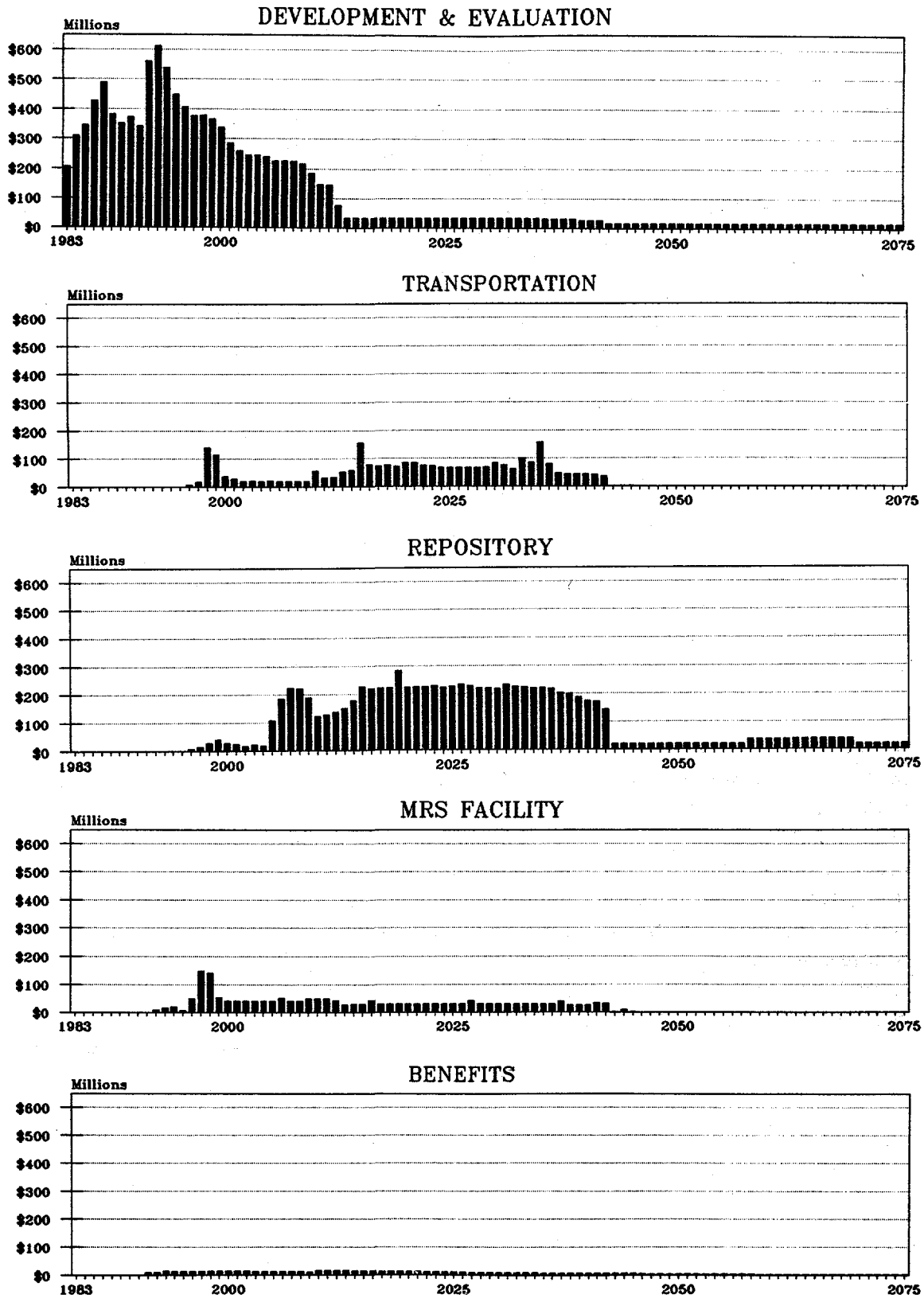

Figure 9-3. Annual life-cycle costs by component for the single-repository case.

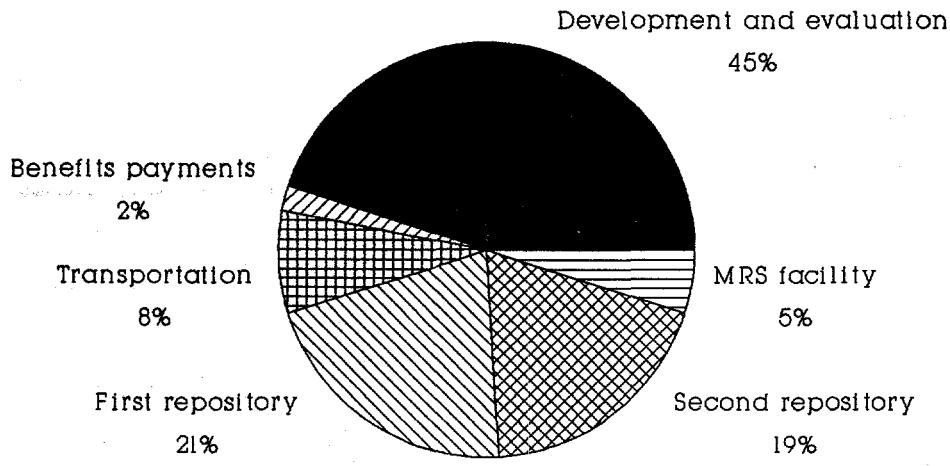

Figure 9-4. Total-system costs by major cost component for a two-repository system based on the no-new-orders, end-of-reactor-life spent-fuel projection.

the 86,800 MTHM of the no-new-orders, end-of-reactor-life projection. The upper reference case was included in the TSLCC analysis to examine the cost impacts of increases in spent-fuel discharges. The total-system cost for this case is $34.6 billion, or about $0.9 billion higher than that for the comparable no-new-orders, end-of-reactor-life case. Generally, the component costs for the two cases are similar, except that the transportation costs do increase slightly (by less than $0.1 billion) because more waste is transported. The second repository costs were increased by nearly $0.7 billion because of the disposal of more waste. Figure 9-6 presents the costs by major component for this case. Additionally, Figure 9-7 presents the annual cost streams for both two-repository cases.

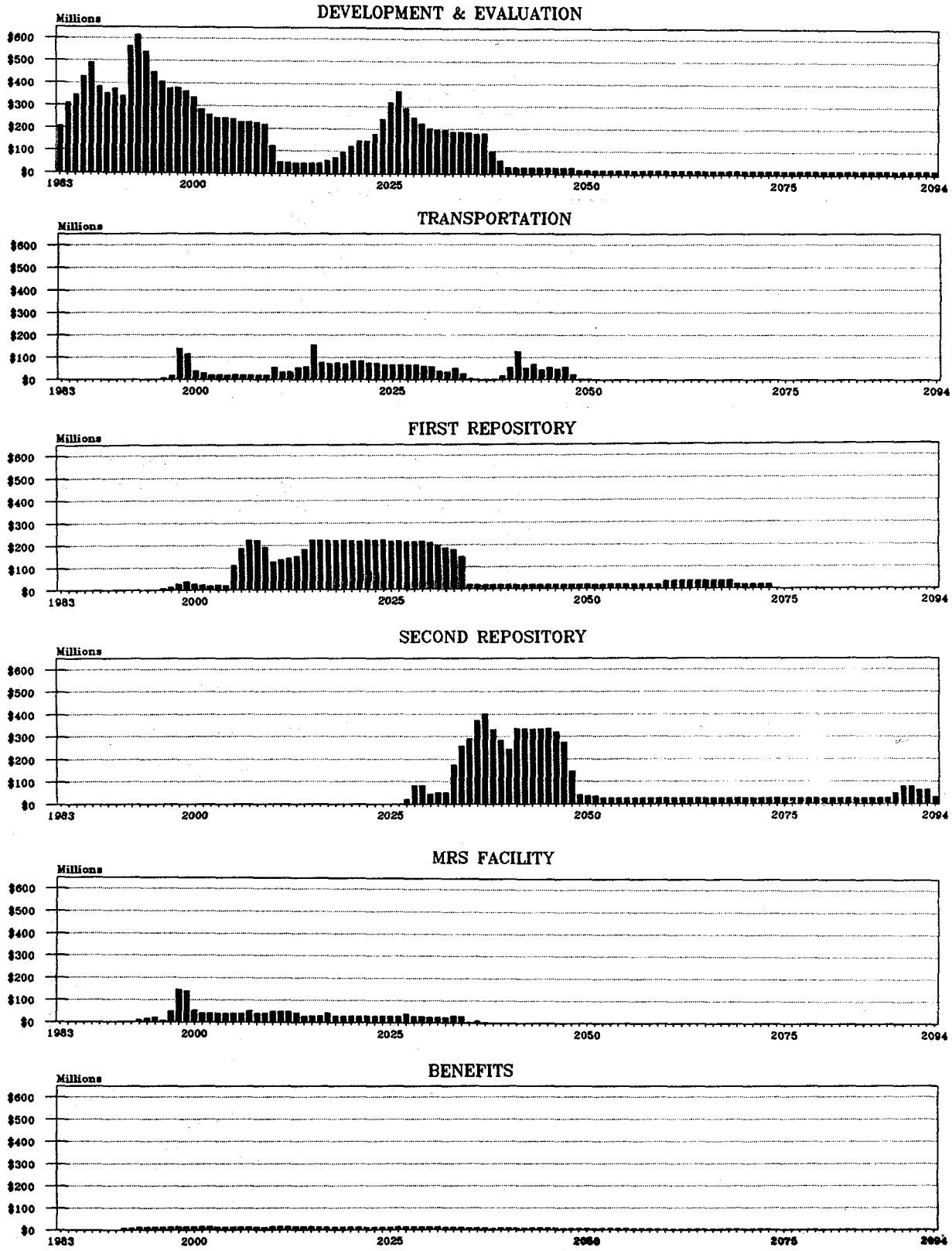

Figure 9-5. Annual life-cycle costs by component for the two-repository system based on the no-new-orders end-of-reactor-life spent-fuel projection.

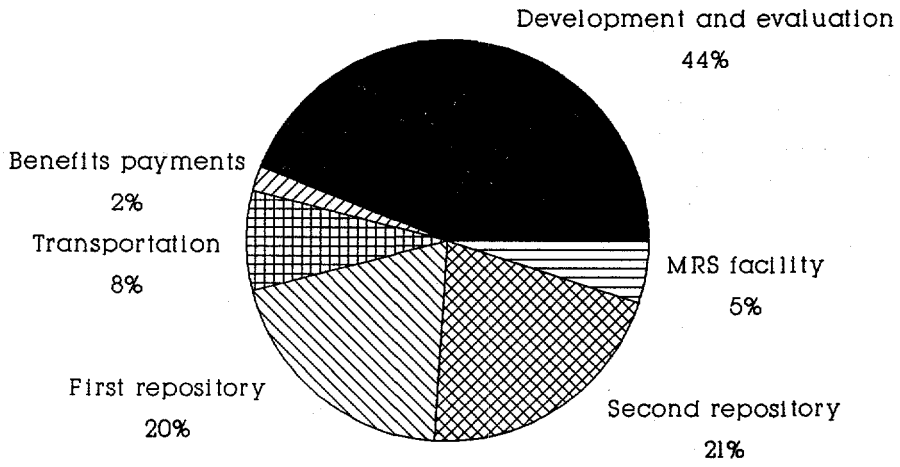

Figure 9-6. Total-system cost by major cost component for a two-repository system based on the upper reference case spent-fuel projection.

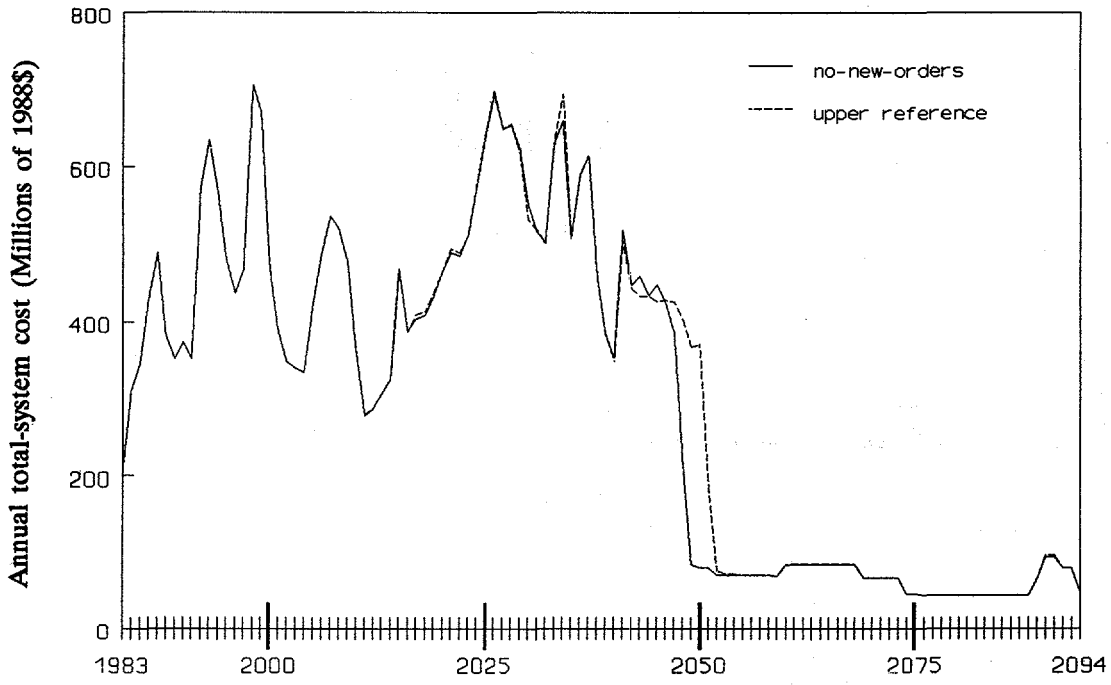

Figure 9-7. Annual total-system costs for the two-repository cases.

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Appendix A

WASTE ACCEPTANCE TABLES

Table A-1. Waste-acceptance schedule for the single-repository system: no-new-orders, end-of-reactor-life, intact fuel disposal (Metric tons of heavy metal)

	MRS facility		Single repository		Total annual system acceptance	
Year	Spent fuel received	Stored at MRS	Spent fuel from MRS	High-level waste	Spent fuel	Spent fuel and high-level waste
1998	400	400			400	400
1999	400	800			400	400
2000	900	1700			900	900
2001	900	2600			900	900
2002	900	3500			900	900
2003	900	4400			900	900
2004	900	5300			900	900
2005	900	6200			900	900
2006	900	7100			900	900
2007	900	8000			900	900
2008	900	8900			900	900
2009	900	9800			900	900
2010	1800	11200	400		1800	1800
2011	1800	12600	400		1800	1800
2012	1800	14000	400		1800	1800
2013	1800	14900	900		1800	1800
2014	1800	14900	1800		1800	1800
2015	3000	14900	3000	400	3000	3400
2016	3000	14900	3000	400	3000	3400
2017	3000	14900	3000	400	3000	3400
2018	3000	14900	3000	400	3000	3400
2019	3000	14900	3000	400	3000	3400
2020	3000	14900	3000	400	3000	3400
2021	3000	14900	3000	400	3000	3400
2022	3000	14900	3000	400	3000	3400
2023	3000	14900	3000	400	3000	3400
2024	3000	14900	3000	400	3000	3400
2025	3000	14900	3000	400	3000	3400
2026	3000	14900	3000	400	3000	3400
2027	3000	14900	3000	400	3000	3400
2028	3000	14900	3000	400	3000	3400
2029	3000	14900	3000	400	3000	3400
2030	3000	14900	3000	400	3000	3400
2031	3000	14900	3000	400	3000	3400
2032	3000	14900	3000	400	3000	3400
2033	3000	14900	3000	400	3000	3400
2034	3000	14900	3000	400	3000	3400
2035	3000	14900	3000	400	3000	3400
2036	3000	14900	3000	400	3000	3400
2037	350	12250	3000	400	350	750
2038	350	9600	3000	315	350	665
2039	350	6950	3000		350	350
2040	350	4300	3000		350	350
2041	350	1650	3000		350	350
2042	207	0	1857		207	207
Totals	86757		86757	9515	86757	96272

Table A-2. Waste-acceptance schedule for the two-repository system: no-new-orders, end-of-reactor-life case, intact fuel disposal (Metric tons of heavy metal)

	MRS facility		First repository		Second repository		Total annual system acceptance	
Year	Spent fuel received	Stored at MRS	Spent fuel from MRS	High-level waste	Spent fuel	High-level waste	Spent fuel	Spent fuel and high-level waste
1998	400	400					400	400
1999	400	800					400	400
2000	900	1700					900	900
2001	900	2600					900	900
2002	900	3500					900	900
2003	900	4400					900	900
2004	900	5300					900	900
2005	900	6200					900	900
2006	900	7100					900	900
2007	900	8000					900	900
2008	900	8900					900	900
2009	900	9800					900	900
2010	1800	11200	400				1800	1800
2011	1800	12600	400				1800	1800
2012	1800	14000	400				1800	1800
2013	1800	14900	900				1800	1800
2014	1800	14900	1800				1800	1800
2015	3000	14900	3000	400			3000	3400
2016	3000	14900	3000	400			3000	3400
2017	3000	14900	3000	400			3000	3400
2018	3000	14900	3000	400			3000	3400
2019	3000	14900	3000	400			3000	3400
2020	3000	14900	3000	400			3000	3400
2021	3000	14900	3000	400			3000	3400
2022	3000	14900	3000	400			3000	3400
2023	3000	14900	3000	400			3000	3400
2024	3000	14900	3000	400			3000	3400
2025	3000	14900	3000	400			3000	3400
2026	3000	14900	3000	400			3000	3400
2027	3000	14900	3000	400			3000	3400
2028	3000	14900	3000	400			3000	3400
2029	2107	14007	3000	400			2107	2507
2030		11007	3000	400			0	400
2031		8007	3000	400			0	400
2032		5007	3000	293			0	293
2033		2007	3000				0	0
2034		0	2007				0	0
2035							0	0
2036							0	0
2037							0	0
2038							0	0
2039					900		900	900
2040					1800		1800	1800
2041					3000	400	3000	3400
2042					3000	400	3000	3400
2043					3000	400	3000	3400
2044					3000	400	3000	3400
2045					3000	400	3000	3400
2046					3000	400	3000	3400
2047					3000	22	3000	3022
2048					150		150	150
2049							0	0
Totals	62907		62907	7093	23850	2422	86757	96272

Table A-3. Waste-acceptance schedule for the two-repository system: upper reference case, intact fuel disposal (Metric tons of heavy metal)

	MRS facility		First repository		Second repository		Total annual system acceptance	
Year	Spent fuel received	Stored at MRS	Spent fuel from MRS	High-level waste	Spent Fuel	High-level waste	Spent fuel	Spent fuel and high-level waste
1998	400	400					400	400
1999	400	800					400	400
2000	900	1700					900	900
2001	900	2600					900	900
2002	900	3500					900	900
2003	900	4400					900	900
2004	900	5300					900	900
2005	900	6200					900	900
2006	900	7100					900	900
2007	900	8000					900	900
2008	900	8900					900	900
2009	900	9800					900	900
2010	1800	11200	400				1800	1800
2011	1800	12600	400				1800	1800
2012	1800	14000	400				1800	1800
2013	1800	14900	900				1800	1800
2014	1800	14900	1800				1800	1800
2015	3000	14900	3000	400			3000	3400
2016	3000	14900	3000	400			3000	3400
2017	3000	14900	3000	400			3000	3400
2018	3000	14900	3000	400			3000	3400
2019	3000	14900	3000	400			3000	3400
2020	3000	14900	3000	400			3000	3400
2021	3000	14900	3000	400			3000	3400
2022	3000	14900	3000	400			3000	3400
2023	3000	14900	3000	400			3000	3400
2024	3000	14900	3000	400			3000	3400
2025	3000	14900	3000	400			3000	3400
2026	3000	14900	3000	400			3000	3400
2027	3000	14900	3000	400			3000	3400
2028	3000	14900	3000	400			3000	3400
2029	2722	14622	3000	400			2722	3122
2030		11622	3000	400			0	400
2031		8622	3000	78			0	78
2032		5622	3000				0	0
2033		2622	3000				0	0
2034		0	2622				0	0
2035							0	0
2036							0	0
2037							0	0
2038							0	0
2039					900		900	900
2040					1800		1800	1800
2041					3000	400	3000	3400
2042					3000	400	3000	3400
2043					3000	400	3000	3400
2044					3000	400	3000	3400
2045					3000	400	3000	3400
2046					3000	400	3000	3400
2047					3000	400	3000	3400
2048					3000	237	3000	3237
2049					3000		3000	3000
2050					3000		3000	3000
2051					677		677	677
Totals	63522		63522	6478	33377	3037	96899	106414

Appendix B

ANNUAL TOTAL-SYSTEM COSTS BY MAJOR COST COMPONENT

Table B-1

Annual total-system costs for the single-repository system
no-new-orders, end-of-reactor-life case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	MRS Facility	Total
1983	207	0	0	0	0	0	207
1984	310	0	0	0	0	0	310
1985	346	0	0	0	0	0	346
1986	428	0	0	0	0	0	428
1987	488	0	0	0	0	0	488
1988	383	0	0	0	0	0	383
1989	352	0	0	0	0	0	352
1990	374	0	0	0	0	0	374
1991	343	9	0	0	0	0	352
1992	564	9	0	0	0	0	573
1993	613	13	0	0	0	8	634
1994	540	12	0	0	0	15	567
1995	449	12	0	0	0	19	480
1996	407	12	6	7	0	6	438
1997	377	12	18	13	0	49	469
1998	379	14	140	27	0	147	707
1999	366	14	114	40	0	139	673
2000	338	14	37	27	0	53	469
2001	285	14	29	23	0	39	390
2002	260	14	20	15	0	39	348
2003	247	12	22	21	0	39	341
2004	246	12	19	18	0	39	334
2005	241	12	21	109	0	39	422
2006	228	12	20	186	0	39	485
2007	228	12	20	223	0	50	533
2008	226	12	19	222	0	39	518
2009	217	10	20	189	0	39	475
2010	186	15	55	123	0	49	428
2011	147	15	32	129	0	49	372
2012	145	15	34	138	0	49	381
2013	78	15	53	150	0	41	337
2014	35	14	58	178	0	27	312
2015	35	14	156	227	0	29	461
2016	35	13	77	219	0	29	373
2017	35	12	73	221	0	42	383
2018	35	12	75	221	0	29	372
2019	35	12	71	283	0	29	430
2020	35	12	83	224	0	29	383
2021	35	12	83	226	0	29	385
2022	35	11	74	225	0	29	374
2023	35	11	72	228	0	29	375
2024	35	10	66	223	0	29	363
2025	35	10	66	227	0	29	367
2026	35	10	66	234	0	29	374
2027	35	9	66	228	0	40	378
2028	35	9	66	220	0	29	359
2029	35	9	68	220	0	29	361
2030	35	9	83	217	0	29	373
2031	35	9	75	232	0	29	380
2032	35	8	64	225	0	29	361
2033	35	8	99	223	0	29	394
2034	35	8	85	219	0	29	376
2035	35	7	157	221	0	29	449

Table B-1 (continued)

Annual total-system costs for the single-repository system
no-new-orders, end-of-reactor-life case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	MRS Facility	Total
2036	32	7	79	218	0	29	365
2037	32	7	47	204	0	38	328
2038	32	7	44	199	0	25	307
2039	32	6	44	187	0	25	294
2040	28	6	43	175	0	25	277
2041	28	6	42	170	0	32	278
2042	28	6	36	143	0	30	243
2043	16	6	2	20	0	1	45
2044	16	6	2	20	0	9	53
2045	16	6	2	20	0	2	46
2046	16	4	0	20	0	0	40
2047	16	3	0	20	0	0	39
2048	16	3	0	20	0	0	39
2049	16	3	0	20	0	0	39
2050	16	3	0	20	0	0	39
2051	16	3	0	20	0	0	39
2052	16	3	0	20	0	0	39
2053	16	3	0	20	0	0	39
2054	16	3	0	20	0	0	39
2055	16	3	0	20	0	0	39
2056	16	3	0	20	0	0	39
2057	16	3	0	20	0	0	39
2058	16	3	0	20	0	0	39
2059	16	2	0	20	0	0	38
2060	16	2	0	36	0	0	54
2061	16	2	0	36	0	0	54
2062	16	2	0	36	0	0	54
2063	16	2	0	36	0	0	54
2064	16	2	0	37	0	0	55
2065	16	2	0	37	0	0	55
2066	16	2	0	37	0	0	55
2067	16	2	0	37	0	0	55
2068	16	2	0	37	0	0	55
2069	16	2	0	37	0	0	55
2070	16	2	0	37	0	0	55
2071	16	2	0	19	0	0	37
2072	16	2	0	19	0	0	37
2073	16	2	0	19	0	0	37
2074	16	2	0	19	0	0	37
2075	16	2	0	19	0	0	37
Total	11508	657	2803	8735	0	1862	25565

Table B-2

Annual total-system costs for the two-repository system
no-new-orders, end-of-reactor-life case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	MRS Facility	Total
1983	207	0	0	0	0	0	207
1984	310	0	0	0	0	0	310
1985	346	0	0	0	0	0	346
1986	428	0	0	0	0	0	428
1987	488	0	0	0	0	0	488
1988	383	0	0	0	0	0	383
1989	352	0	0	0	0	0	352
1990	374	0	0	0	0	0	374
1991	343	9	0	0	0	0	352
1992	564	9	0	0	0	0	573
1993	613	13	0	0	0	8	634
1994	540	12	0	0	0	15	567
1995	449	12	0	0	0	19	480
1996	406	12	6	6	0	6	436
1997	376	12	18	12	0	49	467
1998	379	14	140	25	0	147	705
1999	365	14	114	37	0	139	669
2000	338	14	37	25	0	53	467
2001	285	14	29	21	0	39	388
2002	260	14	20	16	0	39	349
2003	247	12	22	21	0	39	341
2004	246	12	19	19	0	39	335
2005	241	12	21	110	0	39	423
2006	228	12	20	187	0	39	486
2007	228	12	20	225	0	50	535
2008	226	12	19	224	0	39	520
2009	217	10	20	191	0	39	477
2010	121	15	55	125	0	48	364
2011	50	15	32	134	0	48	279
2012	48	15	34	142	0	48	287
2013	46	15	53	151	0	41	306
2014	46	14	58	181	0	27	326
2015	46	14	156	223	0	29	468
2016	46	13	77	223	0	29	388
2017	56	12	73	221	0	42	404
2018	71	12	75	221	0	29	408
2019	96	12	71	223	0	29	431
2020	121	12	83	219	0	29	464
2021	146	12	83	218	0	29	488
2022	146	11	74	224	0	29	484
2023	177	11	72	221	0	29	510
2024	243	10	66	224	0	29	572
2025	317	10	66	218	0	29	640
2026	367	13	66	219	0	29	694
2027	294	12	66	216	21	40	649
2028	250	12	66	214	82	29	653
2029	223	12	59	218	82	29	623
2030	202	12	58	211	43	24	550
2031	194	12	37	198	50	24	515
2032	195	11	35	186	50	24	501
2033	187	11	51	178	174	31	632
2034	187	11	27	147	258	29	659
2035	184	9	4	20	288	1	506

Table B-2 (continued)

Annual total-system costs for the two-repository system
no-new-orders, end-of-reactor-life case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	MRS Facility	Total
2036	177	9	2	20	372	9	589
2037	179	9	2	20	402	2	614
2038	99	7	2	20	330	0	458
2039	58	8	16	20	282	0	384
2040	29	8	55	20	241	0	353
2041	29	8	125	20	335	0	517
2042	29	8	53	20	336	0	446
2043	29	8	68	20	333	0	458
2044	29	8	43	20	333	0	433
2045	29	8	54	20	336	0	447
2046	29	8	49	20	319	0	425
2047	29	6	58	20	274	0	387
2048	29	6	23	20	146	0	224
2049	17	6	2	20	39	0	84
2050	17	6	2	20	35	0	80
2051	17	6	2	20	35	0	80
2052	17	6	0	20	27	0	70
2053	17	6	0	20	27	0	70
2054	17	6	0	20	27	0	70
2055	17	6	0	20	27	0	70
2056	17	6	0	20	27	0	70
2057	17	6	0	20	27	0	70
2058	17	6	0	20	27	0	70
2059	17	4	0	20	27	0	68
2060	17	4	0	35	27	0	83
2061	17	4	0	36	27	0	84
2062	17	4	0	36	27	0	84
2063	17	4	0	36	27	0	84
2064	17	4	0	36	27	0	84
2065	17	4	0	36	27	0	84
2066	17	4	0	36	27	0	84
2067	17	4	0	36	27	0	84
2068	17	4	0	36	27	0	84
2069	17	4	0	19	27	0	67
2070	17	4	0	19	27	0	67
2071	17	4	0	19	27	0	67
2072	17	4	0	19	27	0	67
2073	17	4	0	19	27	0	67
2074	16	2	0	0	27	0	45
2075	16	2	0	0	27	0	45
2076	16	1	0	0	27	0	44
2077	16	1	0	0	27	0	44
2078	16	1	0	0	27	0	44
2079	16	1	0	0	27	0	44
2080	16	1	0	0	27	0	44
2081	16	1	0	0	27	0	44
2082	16	1	0	0	27	0	44
2083	16	1	0	0	27	0	44
2084	16	1	0	0	27	0	44
2085	16	1	0	0	27	0	44
2086	16	1	0	0	27	0	44
2087	16	1	0	0	27	0	44
2088	16	1	0	0	27	0	44

Table B-2 (continued)

Annual total-system costs for the two-repository system
no-new-orders, end-of-reactor-life case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	MRS Facility	Total
2089	16	1	0	0	47	0	64
2090	16	1	0	0	77	0	94
2091	16	1	0	0	77	0	94
2092	16	1	0	0	62	0	79
2093	16	1	0	0	62	0	79
2094	16	1	0	0	31	0	48
Total	15033	793	2658	6992	6551	1613	33640

Table B-3

Annual total-system costs for the two-repository system
upper reference case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	MRS Facility	Total
1983	207	0	0	0	0	0	207
1984	310	0	0	0	0	0	310
1985	346	0	0	0	0	0	346
1986	428	0	0	0	0	0	428
1987	488	0	0	0	0	0	488
1988	383	0	0	0	0	0	383
1989	352	0	0	0	0	0	352
1990	374	0	0	0	0	0	374
1991	343	9	0	0	0	0	352
1992	564	9	0	0	0	0	573
1993	613	13	0	0	0	8	634
1994	540	12	0	0	0	15	567
1995	449	12	0	0	0	19	480
1996	406	12	6	6	0	6	436
1997	376	12	18	12	0	49	467
1998	379	14	140	25	0	147	705
1999	365	14	114	37	0	139	669
2000	338	14	37	25	0	53	467
2001	285	14	29	21	0	39	388
2002	260	14	20	16	0	39	349
2003	247	12	22	21	0	39	341
2004	246	12	19	19	0	39	335
2005	241	12	21	110	0	39	423
2006	228	12	20	187	0	39	486
2007	228	12	20	225	0	50	535
2008	226	12	19	224	0	39	520
2009	217	10	20	191	0	39	477
2010	121	15	55	125	0	49	365
2011	50	15	32	134	0	49	280
2012	48	15	34	142	0	49	288
2013	46	15	53	152	0	41	307
2014	46	14	58	182	0	27	327
2015	46	14	156	223	0	29	468
2016	46	13	75	224	0	29	387
2017	56	12	76	223	0	42	409
2018	71	12	77	223	0	29	412
2019	96	12	72	227	0	29	436
2020	121	12	79	223	0	29	464
2021	146	12	84	222	0	29	493
2022	146	11	76	226	0	29	488
2023	177	11	68	225	0	29	510
2024	243	10	66	227	0	29	575
2025	317	10	65	222	0	29	643
2026	367	13	67	222	0	29	698
2027	294	12	64	217	21	40	648
2028	250	12	66	216	82	29	655
2029	223	12	60	210	82	29	616
2030	202	12	51	199	43	24	531
2031	194	12	35	201	51	24	517
2032	195	11	35	183	51	24	499
2033	187	11	51	180	175	31	635
2034	187	11	49	159	259	29	694
2035	184	9	4	20	289	1	507

Table B-3 (continued)

Annual total-system costs for the two-repository system
upper reference case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	MRS Facility	Total
2036	177	9	2	20	373	9	590
2037	179	9	2	20	401	2	613
2038	99	7	2	20	331	0	459
2039	58	8	21	20	280	0	387
2040	29	8	55	20	237	0	349
2041	29	8	117	20	329	0	503
2042	29	8	54	20	331	0	442
2043	29	8	47	20	328	0	432
2044	29	8	46	20	329	0	432
2045	29	8	46	20	323	0	426
2046	29	8	46	20	324	0	427
2047	29	6	45	20	325	0	425
2048	29	6	40	20	309	0	404
2049	29	6	34	20	278	0	367
2050	29	6	43	20	273	0	371
2051	29	6	22	20	111	0	188
2052	17	6	2	20	31	0	76
2053	17	6	2	20	27	0	72
2054	17	6	2	20	27	0	72
2055	17	6	0	20	27	0	70
2056	17	6	0	20	27	0	70
2057	17	6	0	20	27	0	70
2058	17	6	0	20	27	0	70
2059	17	4	0	20	27	0	68
2060	17	4	0	36	27	0	84
2061	17	4	0	37	27	0	85
2062	17	4	0	37	27	0	85
2063	17	4	0	37	27	0	85
2064	17	4	0	37	27	0	85
2065	17	4	0	37	27	0	85
2066	17	4	0	37	27	0	85
2067	17	4	0	37	27	0	85
2068	17	4	0	37	27	0	85
2069	17	4	0	19	27	0	67
2070	17	4	0	19	27	0	67
2071	17	4	0	19	27	0	67
2072	17	4	0	19	27	0	67
2073	17	4	0	19	27	0	67
2074	16	2	0	0	27	0	45
2075	16	2	0	0	27	0	45
2076	16	1	0	0	27	0	44
2077	16	1	0	0	27	0	44
2078	16	1	0	0	27	0	44
2079	16	1	0	0	27	0	44
2080	16	1	0	0	27	0	44
2081	16	1	0	0	27	0	44
2082	16	1	0	0	27	0	44
2083	16	1	0	0	27	0	44
2084	16	1	0	0	27	0	44
2085	16	1	0	0	27	0	44
2086	16	1	0	0	27	0	44
2087	16	1	0	0	27	0	44
2088	16	1	0	0	27	0	44

Table B-3 (continued)

Annual total-system costs for the two-repository system
upper reference case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	MRS Facility	Total
2089	16	1	0	0	48	0	65
2090	16	1	0	0	79	0	96
2091	16	1	0	0	79	0	96
2092	16	1	0	0	62	0	79
2093	16	1	0	0	62	0	79
2094	16	1	0	0	31	0	48
Total	15069	793	2741	7033	7299	1616	34551

Appendix C

ANNUAL DEFENSE-WASTE COSTS BY MAJOR COST COMPONENT

Table C-1

Annual defense-waste costs for the single-repository system
no-new-orders, end-of-reactor-life case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	Total
1983	35	0	0	0	0	35
1984	49	0	0	0	0	49
1985	53	0	0	0	0	53
1986	68	0	0	0	0	68
1987	78	0	0	0	0	78
1988	64	0	0	0	0	64
1989	55	0	0	0	0	55
1990	57	0	0	0	0	57
1991	53	2	0	0	0	55
1992	87	2	0	0	0	89
1993	92	2	0	0	0	94
1994	79	1	0	0	0	80
1995	64	1	0	0	0	65
1996	61	1	1	1	0	64
1997	57	1	2	3	0	63
1998	57	1	2	5	0	65
1999	55	1	1	7	0	64
2000	51	1	1	5	0	58
2001	46	1	1	4	0	52
2002	41	1	1	3	0	46
2003	40	1	1	4	0	46
2004	40	1	1	3	0	45
2005	39	1	1	20	0	61
2006	38	1	1	34	0	74
2007	38	1	1	41	0	81
2008	38	1	1	41	0	81
2009	36	1	1	35	0	73
2010	30	2	1	46	0	79
2011	24	2	1	46	0	73
2012	24	2	1	46	0	73
2013	12	2	1	46	0	61
2014	5	2	1	46	0	54
2015	5	2	60	46	0	113
2016	5	2	17	46	0	70
2017	5	1	17	46	0	69
2018	5	1	17	46	0	69
2019	5	1	14	57	0	77
2020	5	1	15	46	0	67
2021	5	1	14	46	0	66
2022	5	1	15	46	0	67
2023	5	1	10	46	0	62
2024	5	1	8	46	0	60
2025	5	1	8	46	0	60
2026	5	1	8	46	0	60
2027	5	1	8	46	0	60
2028	5	1	8	46	0	60
2029	5	1	8	46	0	60
2030	5	1	8	46	0	60
2031	5	1	8	46	0	60
2032	5	1	8	46	0	60
2033	5	1	8	46	0	60
2034	5	1	8	46	0	60
2035	5	1	40	46	0	92

Table C-1 (continued)

Annual defense-waste costs for the single-repository system
no-new-orders, end-of-reactor-life case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	Total
2036	4	1	9	46	0	60
2037	4	1	5	46	0	56
2038	4	1	1	3	0	9
2039	4	1	1	3	0	9
2040	4	1	1	3	0	9
2041	4	1	1	3	0	9
2042	4	1	1	3	0	9
2043	2	1	0	3	0	6
2044	2	1	0	3	0	6
2045	2	1	0	3	0	6
2046	2	1	0	3	0	6
2047	2	1	0	3	0	6
2048	2	1	0	3	0	6
2049	2	1	0	3	0	6
2050	2	1	0	3	0	6
2051	2	1	0	3	0	6
2052	2	1	0	3	0	6
2053	2	1	0	3	0	6
2054	2	1	0	3	0	6
2055	2	1	0	3	0	6
2056	2	1	0	3	0	6
2057	2	1	0	3	0	6
2058	2	1	0	3	0	6
2059	2	0	0	3	0	5
2060	2	0	0	4	0	6
2061	2	0	0	4	0	6
2062	2	0	0	4	0	6
2063	2	0	0	4	0	6
2064	2	0	0	5	0	7
2065	2	0	0	5	0	7
2066	2	0	0	5	0	7
2067	2	0	0	5	0	7
2068	2	0	0	5	0	7
2069	2	0	0	5	0	7
2070	2	0	0	5	0	7
2071	2	0	0	2	0	4
2072	2	0	0	2	0	4
2073	2	0	0	2	0	4
2074	2	0	0	2	0	4
2075	2	0	0	2	0	4
Total	1765	78	347	1632	0	3822

Table C-2

Annual defense-waste costs for the two-repository system
no-new-orders, end-of-reactor-life case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	Total
1983	37	0	0	0	0	37
1984	54	0	0	0	0	54
1985	58	0	0	0	0	58
1986	74	0	0	0	0	74
1987	85	0	0	0	0	85
1988	70	0	0	0	0	70
1989	61	0	0	0	0	61
1990	63	0	0	0	0	63
1991	58	2	0	0	0	60
1992	96	2	0	0	0	98
1993	100	2	0	0	0	102
1994	87	2	0	0	0	89
1995	70	2	0	0	0	72
1996	66	2	1	1	0	70
1997	62	2	2	2	0	68
1998	62	1	2	5	0	70
1999	60	1	1	7	0	69
2000	56	1	1	5	0	63
2001	50	1	1	4	0	56
2002	45	1	1	3	0	50
2003	44	1	1	4	0	50
2004	43	1	1	4	0	49
2005	43	1	1	21	0	66
2006	41	1	1	36	0	79
2007	42	1	1	43	0	87
2008	41	1	1	43	0	86
2009	40	1	1	37	0	79
2010	20	2	1	44	0	67
2011	7	2	1	44	0	54
2012	7	2	1	44	0	54
2013	7	2	1	44	0	54
2014	7	2	1	44	0	54
2015	7	2	60	44	0	113
2016	7	2	17	44	0	70
2017	9	2	17	44	0	72
2018	12	2	17	44	0	75
2019	17	2	14	44	0	77
2020	22	2	15	44	0	83
2021	27	2	14	44	0	87
2022	27	1	15	44	0	87
2023	31	1	10	44	0	86
2024	43	1	8	44	0	96
2025	57	1	8	44	0	110
2026	66	2	8	44	0	120
2027	53	2	8	44	4	111
2028	45	2	8	44	18	117
2029	40	2	8	44	18	112
2030	36	2	8	44	9	99
2031	35	2	4	44	11	96
2032	35	2	1	3	11	52
2033	34	2	1	3	40	80
2034	34	2	1	3	61	101
2035	34	1	0	3	68	106

Table C-2 (continued)

Annual defense-waste costs for the two-repository system
no-new-orders, end-of-reactor-life case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	Total
2036	32	1	0	3	88	124
2037	33	1	0	3	94	131
2038	17	1	0	3	78	99
2039	9	2	1	3	80	95
2040	4	2	1	3	59	69
2041	4	2	42	3	59	110
2042	4	2	10	3	59	78
2043	4	2	10	3	59	78
2044	4	2	10	3	59	78
2045	4	2	10	3	59	78
2046	4	2	10	3	59	78
2047	4	2	3	3	59	71
2048	4	2	1	3	6	16
2049	3	2	0	3	9	17
2050	3	2	0	3	8	16
2051	3	2	0	3	8	16
2052	3	2	0	3	6	14
2053	3	2	0	3	6	14
2054	3	2	0	3	6	14
2055	3	2	0	3	6	14
2056	3	2	0	3	6	14
2057	3	2	0	3	6	14
2058	3	2	0	3	6	14
2059	3	0	0	3	6	12
2060	3	0	0	5	6	14
2061	3	0	0	5	6	14
2062	3	0	0	5	6	14
2063	3	0	0	5	6	14
2064	3	0	0	5	6	14
2065	3	0	0	5	6	14
2066	3	0	0	5	6	14
2067	3	0	0	5	6	14
2068	3	0	0	5	6	14
2069	3	0	0	3	6	12
2070	3	0	0	3	6	12
2071	3	0	0	3	6	12
2072	3	0	0	3	6	12
2073	3	0	0	3	6	12
2074	2	0	0	0	6	8
2075	2	0	0	0	6	8
2076	2	0	0	0	6	8
2077	2	0	0	0	6	8
2078	2	0	0	0	6	8
2079	2	0	0	0	6	8
2080	2	0	0	0	6	8
2081	2	0	0	0	6	8
2082	2	0	0	0	6	8
2083	2	0	0	0	6	8
2084	2	0	0	0	6	8
2085	2	0	0	0	6	8
2086	2	0	0	0	6	8
2087	2	0	0	0	6	8
2088	2	0	0	0	6	8

Table C-2 (continued)

Annual defense-waste costs for the two-repository system
no-new-orders, end-of-reactor-life case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	Total
2089	2	0	0	0	10	12
2090	2	0	0	0	17	19
2091	2	0	0	0	17	19
2092	2	0	0	0	14	16
2093	2	0	0	0	14	16
2094	2	0	0	0	7	9
Total	2571	116	361	1327	1384	5759

Table C-3

Annual defense-waste costs for the two-repository system
upper reference case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	Total
1983	35	0	0	0	0	35
1984	50	0	0	0	0	50
1985	55	0	0	0	0	55
1986	70	0	0	0	0	70
1987	80	0	0	0	0	80
1988	66	0	0	0	0	66
1989	57	0	0	0	0	57
1990	59	0	0	0	0	59
1991	55	2	0	0	0	57
1992	90	2	0	0	0	92
1993	94	2	0	0	0	96
1994	82	1	0	0	0	83
1995	66	1	0	0	0	67
1996	62	1	1	1	0	65
1997	58	1	2	2	0	63
1998	59	1	2	4	0	66
1999	56	1	1	6	0	64
2000	53	1	1	4	0	59
2001	47	1	1	4	0	53
2002	43	1	1	3	0	48
2003	41	1	1	4	0	47
2004	41	1	1	3	0	46
2005	41	1	1	19	0	62
2006	39	1	1	32	0	73
2007	39	1	1	39	0	80
2008	39	1	1	39	0	80
2009	37	1	1	33	0	72
2010	19	2	1	43	0	65
2011	7	2	1	43	0	53
2012	7	2	1	43	0	53
2013	7	2	1	43	0	53
2014	7	2	1	43	0	53
2015	7	2	60	43	0	112
2016	7	2	17	43	0	69
2017	8	1	17	43	0	69
2018	11	1	17	43	0	72
2019	16	1	14	43	0	74
2020	21	1	15	43	0	80
2021	25	1	14	43	0	83
2022	25	1	15	43	0	84
2023	29	1	10	43	0	83
2024	41	1	8	43	0	93
2025	54	1	8	43	0	106
2026	62	2	8	43	0	115
2027	49	2	8	43	4	106
2028	42	2	8	43	17	112
2029	37	2	6	43	17	105
2030	34	2	1	3	9	49
2031	33	2	1	3	10	49
2032	33	2	1	3	10	49
2033	32	2	1	3	39	77
2034	32	2	1	3	59	97
2035	32	1	0	3	66	102

Table C-3 (continued)

Annual defense-waste costs for the two-repository system
upper reference case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	Total
2036	30	1	0	3	85	119
2037	31	1	0	3	91	126
2038	16	1	0	3	76	96
2039	8	2	1	3	86	100
2040	4	2	1	3	66	76
2041	4	2	42	3	66	117
2042	4	2	10	3	66	85
2043	4	2	10	3	66	85
2044	4	2	10	3	66	85
2045	4	2	10	3	66	85
2046	4	2	10	3	66	85
2047	4	2	10	3	66	85
2048	4	2	8	3	66	83
2049	4	2	1	3	6	16
2050	4	2	1	3	6	16
2051	4	2	1	3	6	16
2052	3	2	0	3	7	15
2053	3	2	0	3	6	14
2054	3	2	0	3	6	14
2055	3	2	0	3	6	14
2056	3	2	0	3	6	14
2057	3	2	0	3	6	14
2058	3	2	0	3	6	14
2059	3	0	0	3	6	12
2060	3	0	0	4	6	13
2061	3	0	0	4	6	13
2062	3	0	0	4	6	13
2063	3	0	0	4	6	13
2064	3	0	0	4	6	13
2065	3	0	0	4	6	13
2066	3	0	0	4	6	13
2067	3	0	0	4	6	13
2068	3	0	0	4	6	13
2069	3	0	0	2	6	11
2070	3	0	0	2	6	11
2071	3	0	0	2	6	11
2072	3	0	0	2	6	11
2073	3	0	0	2	6	11
2074	2	0	0	0	6	8
2075	2	0	0	0	6	8
2076	2	0	0	0	6	8
2077	2	0	0	0	6	8
2078	2	0	0	0	6	8
2079	2	0	0	0	6	8
2080	2	0	0	0	6	8
2081	2	0	0	0	6	8
2082	2	0	0	0	6	8
2083	2	0	0	0	6	8
2084	2	0	0	0	6	8
2085	2	0	0	0	6	8
2086	2	0	0	0	6	8
2087	2	0	0	0	6	8
2088	2	0	0	0	6	8

Table C-3 (continued)

Annual defense-waste costs for the two-repository system
upper reference case with intact disposal
(millions of 1988 dollars)

Year	Development & Evaluation	Benefits	Transportation	First Repository	Second Repository	Total
2089	2	0	0	0	11	13
2090	2	0	0	0	18	20
2091	2	0	0	0	18	20
2092	2	0	0	0	14	16
2093	2	0	0	0	14	16
2094	2	0	0	0	7	9
Total	2432	107	366	1189	1486	5580

Appendix D

SUMMARY OF ANNUAL TOTAL-SYSTEM COSTS

Table D-1

Summary of total annual costs for the single-repository system no-new-orders, end-of-reactor-life case with intact disposal (millions of 1988 dollars)

Year	Total Defense Waste	Total Civilian Waste	Total
1983	35	172	207
1984	49	261	310
1985	53	293	346
1986	68	360	428
1987	78	410	488
1988	64	319	383
1989	55	297	352
1990	57	317	374
1991	55	297	352
1992	89	484	573
1993	94	540	634
1994	80	487	567
1995	65	415	480
1996	64	374	438
1997	63	406	469
1998	65	642	707
1999	64	609	673
2000	58	411	469
2001	52	338	390
2002	46	302	348
2003	46	295	341
2004	45	289	334
2005	61	361	422
2006	74	411	485
2007	81	452	533
2008	81	437	518
2009	73	402	475
2010	79	349	428
2011	73	299	372
2012	73	308	381
2013	61	276	337
2014	54	258	312
2015	113	348	461
2016	70	303	373
2017	69	314	383
2018	69	303	372
2019	77	353	430
2020	67	316	383
2021	66	319	385
2022	67	307	374
2023	62	313	375
2024	60	303	363
2025	60	307	367
2026	60	314	374
2027	60	318	378
2028	60	299	359
2029	60	301	361
2030	60	313	373
2031	60	320	380
2032	60	301	361
2033	60	334	394
2034	60	316	376
2035	92	357	449

Table D-1 (continued)

Summary of total annual costs for the single-repository system no-new-orders, end-of-reactor-life case with intact disposal (millions of 1988 dollars)

Year	Total Defense Waste	Total Civilian Waste	Total
2036	60	305	365
2037	56	272	328
2038	9	298	307
2039	9	285	294
2040	9	268	277
2041	9	269	278
2042	9	234	243
2043	6	39	45
2044	6	47	53
2045	6	40	46
2046	6	34	40
2047	6	33	39
2048	6	33	39
2049	6	33	39
2050	6	33	39
2051	6	33	39
2052	6	33	39
2053	6	33	39
2054	6	33	39
2055	6	33	39
2056	6	33	39
2057	6	33	39
2058	6	33	39
2059	5	33	38
2060	6	48	54
2061	6	48	54
2062	6	48	54
2063	6	48	54
2064	7	48	55
2065	7	48	55
2066	7	48	55
2067	7	48	55
2068	7	48	55
2069	7	48	55
2070	7	48	55
2071	4	33	37
2072	4	33	37
2073	4	33	37
2074	4	33	37
2075	4	33	37
TOTAL	3822	21743	25565

Table D-2

Summary of total annual costs for the two-repository system no-new-orders, end-of-reactor-life case with intact disposal (millions of 1988 dollars)

Year	Total Defense Waste	Total Civilian Waste	Total
1983	37	170	207
1984	54	256	310
1985	58	288	346
1986	74	354	428
1987	85	403	488
1988	70	313	383
1989	61	291	352
1990	63	311	374
1991	60	292	352
1992	98	475	573
1993	102	532	634
1994	89	478	567
1995	72	408	480
1996	70	366	436
1997	68	399	467
1998	70	635	705
1999	69	600	669
2000	63	404	467
2001	56	332	388
2002	50	299	349
2003	50	291	341
2004	49	286	335
2005	66	357	423
2006	79	407	486
2007	87	448	535
2008	86	434	520
2009	79	398	477
2010	67	297	364
2011	54	225	279
2012	54	233	287
2013	54	252	306
2014	54	272	326
2015	113	355	468
2016	70	318	388
2017	72	332	404
2018	75	333	408
2019	77	354	431
2020	83	381	464
2021	87	401	488
2022	87	397	484
2023	86	424	510
2024	96	476	572
2025	110	530	640
2026	120	574	694
2027	111	538	649
2028	117	536	653
2029	112	511	623
2030	99	451	550
2031	96	419	515
2032	52	449	501
2033	80	552	632
2034	101	558	659
2035	106	400	506

Table D-2 (continued)

Summary of total annual costs for the two-repository system no-new-orders, end-of-reactor-life case with intact disposal (millions of 1988 dollars)

Year	Total Defense Waste	Total Civilian Waste	Total
2036	124	465	589
2037	131	483	614
2038	99	359	458
2039	95	289	384
2040	69	284	353
2041	110	407	517
2042	78	368	446
2043	78	380	458
2044	78	355	433
2045	78	369	447
2046	78	347	425
2047	71	316	387
2048	16	208	224
2049	17	67	84
2050	16	64	80
2051	16	64	80
2052	14	56	70
2053	14	56	70
2054	14	56	70
2055	14	56	70
2056	14	56	70
2057	14	56	70
2058	14	56	70
2059	12	56	68
2060	14	69	83
2061	14	70	84
2062	14	70	84
2063	14	70	84
2064	14	70	84
2065	14	70	84
2066	14	70	84
2067	14	70	84
2068	14	70	84
2069	12	55	67
2070	12	55	67
2071	12	55	67
2072	12	55	67
2073	12	55	67
2074	8	37	45
2075	8	37	45
2076	8	36	44
2077	8	36	44
2078	8	36	44
2079	8	36	44
2080	8	36	44
2081	8	36	44
2082	8	36	44
2083	8	36	44
2084	8	36	44
2085	8	36	44
2086	8	36	44
2087	8	36	44
2088	8	36	44

Table D-2 (continued)

Summary of total annual costs for the two-repository system no-new-orders, end-of-reactor-life case with intact disposal (millions of 1988 dollars)

Year	Total Defense Waste	Total Civilian Waste	Total
2089	12	52	64
2090	19	75	94
2091	19	75	94
2092	16	63	79
2093	16	63	79
2094	9	39	48
Total	5759	27881	33640

Table D-3

Summary of total annual costs for the two-repository system upper reference case with intact disposal (millions of 1988 dollars)

Year	Total Defense Waste	Total Civilian Waste	Total
1983	35	172	207
1984	50	260	310
1985	55	291	346
1986	70	358	428
1987	80	408	488
1988	66	317	383
1989	57	295	352
1990	59	315	374
1991	57	295	352
1992	92	481	573
1993	96	538	634
1994	83	484	567
1995	67	413	480
1996	65	371	436
1997	63	404	467
1998	66	639	705
1999	64	605	669
2000	59	408	467
2001	53	335	388
2002	48	301	349
2003	47	294	341
2004	46	289	335
2005	62	361	423
2006	73	413	486
2007	80	455	535
2008	80	440	520
2009	72	405	477
2010	65	300	365
2011	53	227	280
2012	53	235	288
2013	53	254	307
2014	53	274	327
2015	112	356	468
2016	69	318	387
2017	69	340	409
2018	72	340	412
2019	74	362	436
2020	80	384	464
2021	83	410	493
2022	84	404	488
2023	83	427	510
2024	93	482	575
2025	106	537	643
2026	115	583	698
2027	106	542	648
2028	112	543	655
2029	105	511	616
2030	49	482	531
2031	49	468	517
2032	49	450	499
2033	77	558	635
2034	97	597	694
2035	102	405	507

Table D-3 (continued)

Summary of total annual costs for the two-repository system
upper reference case with intact disposal
(millions of 1988 dollars)

Year	Total Defense Waste	Total Civilian Waste	Total
2036	119	471	590
2037	126	487	613
2038	96	363	459
2039	100	287	387
2040	76	273	349
2041	117	386	503
2042	85	357	442
2043	85	347	432
2044	85	347	432
2045	85	341	426
2046	85	342	427
2047	85	340	425
2048	83	321	404
2049	16	351	367
2050	16	355	371
2051	16	172	188
2052	15	61	76
2053	14	58	72
2054	14	58	72
2055	14	56	70
2056	14	56	70
2057	14	56	70
2058	14	56	70
2059	12	56	68
2060	13	71	84
2061	13	72	85
2062	13	72	85
2063	13	72	85
2064	13	72	85
2065	13	72	85
2066	13	72	85
2067	13	72	85
2068	13	72	85
2069	11	56	67
2070	11	56	67
2071	11	56	67
2072	11	56	67
2073	11	56	67
2074	8	37	45
2075	8	37	45
2076	8	36	44
2077	8	36	44
2078	8	36	44
2079	8	36	44
2080	8	36	44
2081	8	36	44
2082	8	36	44
2083	8	36	44
2084	8	36	44
2085	8	36	44
2086	8	36	44
2087	8	36	44
2088	8	36	44

Table D-3 (continued)

Summary of total annual costs for the two-repository system
upper reference case with intact disposal
(millions of 1988 dollars)

Year	Total Defense Waste	Total Civilian Waste	Total
2089	13	52	65
2090	20	76	96
2091	20	76	96
2092	16	63	79
2093	16	63	79
2094	9	39	48
TOTAL	5580	28971	34551

Appendix E

REFERENCE DEFENSE-WASTE COST ALLOCATION FACTORS

The tables in this Appendix contain the cost allocation factors used in the calculation of the defense high level waste costs by major cost component. The defense cost allocation factors can be found at the far right margin in the first section of each table. Additional information contained in the first sections includes the cost of major components broken down by totals, assignable and common unassigned costs and civilian/defense costs.

The lower sections of each table contain the repository cost breakdown of assignable and common unassigned costs. The repository piece count and areal dispersion factors for defense are also contained in this section.

Costs in this Appendix were derived from the independent rounding of the total costs by component, whereas the comparable costs in Appendix C (defense by major cost component) were derived from the independent rounding of costs on a yearly basis. Consequently, totals in this Appendix are slightly different than the totals in Appendix C. Table E-1 compares both sets of defense costs by major cost component.

Table E-1
Comparsion of defense costs by major cost component
for Appendices C & E.
(Millions of 1988 dollars)

Cost Category	Single Repository No New Orders			Two Repository No New Orders			Two Repository Upper Reference		
	App. C	App. E	Diff.	App. C	App. E	Diff.	App. C	App. E	Diff.
Development and Evaluation	1765	1759	-6	2571	2576	+5	2432	2424	-8
Transportation	347	351	+4	361	361		366	366	-
First Repository	1632	1621	-11	1327	1317	-10	1189	1187	-2
Second Repository	NA	NA	NA	1384	1393	+9	1486	1476	-10
Benefits	78	82	+4	116	119	+3	107	111	+4
Total	3822	3813	-9	5759	5766	+7	5580	5564	-16

Table E-2

Defense Waste Allocation Factors for the Single-Repository System
No-New-Orders, End-of-Reactor-Life Case with Intact Disposal
(Millions of 1988 Dollars) *

		********** ASSIGNABLE COSTS **********				******** COMMON UNASSIGNED COSTS ********				** TOTAL COST ALLOCATION **		
TSLCC COST COMPONENT	TOTAL COST	TOTAL	CIVILIAN	DEFENSE	DEF %	TOTAL	CIVILIAN	DEFENSE	DEF %	CIVILIAN	DEFENSE	DEF %
TRANSPORTATION	$2,802	$2,802	$2,451	$351	12.53%	$0	$0	$0	0.00%	$2,451	$351	12.53%
REPOSITORY 1	$8,737	$6,554	$5,338	$1,216	18.56%	$2,184	$1,778	$405	18.56%	$7,116	$1,621	18.56%
REPOSITORY 2	$0	$0	$0	$0	0.00%	$0	$0	$0	0.00%	$0	$0	0.00%
SUBTOTAL REPOSITORY	$8,737	$6,554	$5,338	$1,216	18.56%	$2,184	$1,778	$405	18.56%	$7,116	$1,621	18.56%
D&E:												
MRS	$300	$300	$300	$0	0.00%	$0	$0	$0	0.00%	$300	$0	0.00%
Waste Pkg.-1	$385	$385	$385	$0	0.00%	$0	$0	$0	0.00%	$385	$0	0.00%
Waste Pkg.-2	$0	$0	$0	$0	0.00%	$0	$0	$0	0.00%	$0	$0	0.00%
Trans/Syst Int	$1,203	$0	$0	$0	0.00%	$1,203	$1,052	$151	12.53%	$1,052	$151	12.53%
Other Repository	$6,471	$0	$0	$0	0.00%	$6,471	$5,270	$1,201	18.56%	$5,270	$1,201	18.56%
Governmnt Admin	$3,149	$0	$0	$0	0.00%	$3,149	$2,742	$407	12.93%	$2,742	$407	12.93%
	$11,508	$685	$685	$0	0.00%	$10,823	$9,064	$1,759	16.25%	$9,749	$1,759	15.28%
SUBTOTAL	$23,047	$10,041	$8,474	$1,567	15.61%	$13,007	$10,843	$2,164	16.64%	$19,316	$3,731	16.19%
MRS	$1,862	$1,862	$1,862	$0	0.00%	$0	$0	$0	0.00%	$1,862	$0	0.00%
BENEFITS:												
MRS	$213	$213	$213	$0	0.00%	$0	$0	$0	0.00%	$213	$0	0.00%
Repository 1	$444	$0	$0	$0	0.00%	$444	$362	$82	18.56%	$362	$82	18.56%
Repository 2	$0	$0	$0	$0	0.00%	$0	$0	$0	0.00%	$0	$0	0.00%
	$657	$213	$213	$0	0.00%	$444	$362	$82	18.56%	$575	$82	12.54%
TOTAL	$25,566	$12,116	$10,549	$1,567	12.93%	$13,451	$11,204	$2,246	16.70%	$21,753	$3,813	14.92%

* Totals may not add to annualized totals due to independent rounding.

Table E-2 (continued)

Defense Waste Allocation Factors for the Single-Repository System
No-New-Orders, End-of-Reactor-Life Case with Intact Disposal
(Millions of 1988 Dollars) *

REPOSITORY COST BREAKDOWN	********* TOTAL COSTS ********** REPOS. 1	REPOS. 2	TOTAL	DHLW / TOTAL = FACTOR			******* DEFENSE COSTS ********* DHLW / TOTAL = FACTOR			REPOS. 1	REPOS. 2	TOTAL
COMMON VARIABLE:				(Waste Packages or Thous. Tons)			(Waste Packages or Thous. Tons)					
PIECE COUNT:												
TOTAL PIECE COUNT	$851	$0	$851	17,750	61,648	28.79%	0	0	0.00%	$245	$0	$245
WHB#1 PIECE COUNT	$0	$0	$0	0	0	0.00%	0	0	0.00%	$0	$0	$0
WHB#2 PIECE COUNT	$1,044	$0	$1,044	17,750	61,648	28.79%	0	0	0.00%	$301	$0	$301
AREAL DISPERSION	$2,667	$0	$2,667	2,388	23,391	10.21%	0	0	0.00%	$272	$0	$272
DIRECT:												
CIVILIAN	$1,594	$0	$1,594			0.00%			0.00%	$0	$0	$0
DEFENSE	$398	$0	$398			100.00%			100.00%	$398	$0	$398
SUBTOTAL ASSIGNABLE	$6,554	$0	$6,554			18.56%			0.00%	$1,216	$0	$1,216
COMMON UNASSIGNED	$2,184	$0	$2,184							$405	$0	$405
TOTAL	$8,737	$0	$8,737							$1,621	$0	$1,621

* Totals may not add to annualized totals due to independent rounding.

Table E-3

Defense Waste Cost Allocation Factors for the Two-Repository System
No-New-Orders, End-of-Reactor-Life Case with Intact Disposal
(Millions of 1988 Dollars) *

		********** ASSIGNABLE COSTS **********				******** COMMON UNASSIGNED COSTS ********				** TOTAL COST ALLOCATION **		
TSLCC COST COMPONENT	TOTAL COST	TOTAL	CIVILIAN	DEFENSE	DEF %	TOTAL	CIVILIAN	DEFENSE	DEF %	CIVILIAN	DEFENSE	DEF %
TRANSPORTATION	$2,658	$2,658	$2,297	$361	13.58%	$0	$0	$0	0.00%	$2,297	$361	13.58%
REPOSITORY 1	$6,991	$5,104	$4,142	$962	18.84%	$1,887	$1,531	$355	18.84%	$5,674	$1,317	18.84%
REPOSITORY 2	$6,557	$4,636	$3,651	$985	21.25%	$1,920	$1,512	$408	21.25%	$5,163	$1,393	21.25%
SUBTOTAL REPOSITORY	$13,547	$9,740	$7,794	$1,947	19.99%	$3,807	$3,044	$764	20.05%	$10,837	$2,710	20.01%
D&E:												
MRS	$300	$300	$300	$0	0.00%	$0	$0	$0	0.00%	$300	$0	0.00%
Waste Pkg.-1	$385	$385	$385	$0	0.00%	$0	$0	$0	0.00%	$385	$0	0.00%
Waste Pkg.-2	$117	$117	$117	$0	0.00%	$0	$0	$0	0.00%	$117	$0	0.00%
Trans/Syst Int	$1,524	$0	$0	$0	0.00%	$1,524	$1,317	$207	13.58%	$1,317	$207	13.58%
Other Repository	$9,004	$0	$0	$0	0.00%	$9,004	$7,204	$1,800	19.99%	$7,204	$1,800	19.99%
Governmnt Admin	$3,703	$0	$0	$0	0.00%	$3,703	$3,134	$569	15.37%	$3,134	$569	15.37%
	$15,033	$802	$802	$0	0.00%	$14,231	$11,655	$2,576	18.10%	$12,457	$2,576	17.13%
SUBTOTAL	$31,238	$13,200	$10,893	$2,308	17.48%	$18,038	$14,699	$3,339	18.51%	$25,591	$5,647	18.08%
MRS	$1,613	$1,613	$1,613	$0	0.00%	$0	$0	$0	0.00%	$1,613	$0	0.00%
BENEFITS:												
MRS	$197	$197	$197	$0	0.00%	$0	$0	$0	0.00%	$197	$0	0.00%
Repository 1	$440	$0	$0	$0	0.00%	$440	$352	$88	19.99%	$352	$88	19.99%
Repository 2	$156	$0	$0	$0	0.00%	$156	$125	$31	19.99%	$125	$31	19.99%
	$793	$197	$197	$0	0.00%	$596	$477	$119	19.99%	$674	$119	15.02%
TOTAL	$33,644	$15,010	$12,703	$2,308	15.37%	$18,634	$15,176	$3,458	18.56%	$27,878	$5,766	17.14%

* Totals may not add to annualized totals due to independent rounding.

Table E-3 (continued)

Defense Waste Cost Allocation Factors for the Two-Repository System
No-New-Orders, End-of-Reactor-Life Case with Intact Disposal
(Millions of 1988 Dollars) *

	********* TOTAL COSTS **********			** REPOSITORY 1 COST FACTORS **			** REPOSITORY 2 COST FACTORS **			******* DEFENSE COSTS *********		
REPOSITORY COST BREAKDOWN	REPOS. 1	REPOS. 2	TOTAL	DHLW / TOTAL =		FACTOR	DHLW /	TOTAL	= FACTOR	REPOS. 1	REPOS. 2	TOTAL
COMMON VARIABLE:				(Waste Packages or Thous. Tons)			(Waste Packages or Thous. Tons)					
PIECE COUNT:												
TOTAL PIECE COUNT	$669	$211	$881	12,906	44,062	29.29%	4,844	18,720	25.88%	$196	$55	$251
WHB#1 PIECE COUNT	$0	$0	$0	0	0	0.00%	0	0	0.00%	$0	$0	$0
WHB#2 PIECE COUNT	$852	$1,041	$1,893	12,906	44,062	29.29%	4,844	18,720	25.88%	$249	$269	$519
AREAL DISPERSION	$2,162	$1,891	$4,054	1,752	16,769	10.45%	2,848	12,934	22.02%	$226	$417	$642
DIRECT:												
CIVILIAN	$1,131	$1,248	$2,378			0.00%			0.00%	$0	$0	$0
DEFENSE	$290	$244	$535			100.00%			100.00%	$290	$244	$535
SUBTOTAL ASSIGNABLE	$5,104	$4,636	$9,740			18.84%			21.25%	$962	$985	$1,947
COMMON UNASSIGNED	$1,887	$1,920	$3,807							$355	$408	$764
TOTAL	$6,991	$6,557	$13,547							$1,317	$1,393	$2,710

* Totals may not add to annualized totals due to independent rounding.

Table E-4

Defense Waste Allocation Factors for the Two-Repository System
Upper-Reference Case with Intact Disposal
(Millions of 1988 Dollars) *

TSLCC COST COMPONENT	TOTAL COST	********** ASSIGNABLE COSTS ********** TOTAL	CIVILIAN	DEFENSE	DEF %	******** COMMON UNASSIGNED COSTS ******** TOTAL	CIVILIAN	DEFENSE	DEF %	** TOTAL COST ALLOCATION ** CIVILIAN	DEFENSE	DEF %
TRANSPORTATION	$2,741	$2,741	$2,375	$366	13.35%	$0	$0	$0	0.00%	$2,375	$366	13.35%
REPOSITORY 1	$7,022	$5,135	$4,266	$868	16.91%	$1,887	$1,568	$319	16.91%	$5,834	$1,187	16.91%
REPOSITORY 2	$7,299	$5,308	$4,234	$1,073	20.22%	$1,992	$1,589	$403	20.22%	$5,823	$1,476	20.22%
SUBTOTAL REPOSITORY	$14,321	$10,442	$8,501	$1,941	18.59%	$3,879	$3,157	$722	18.61%	$11,658	$2,663	18.60%
D&E:												
MRS	$300	$300	$300	$0	0.00%	$0	$0	$0	0.00%	$300	$0	0.00%
Waste Pkg.-1	$385	$385	$385	$0	0.00%	$0	$0	$0	0.00%	$385	$0	0.00%
Waste Pkg.-2	$117	$117	$117	$0	0.00%	$0	$0	$0	0.00%	$117	$0	0.00%
Trans/Syst Int	$1,524	$0	$0	$0	0.00%	$1,524	$1,321	$203	13.35%	$1,321	$203	13.35%
Other Repository	$9,004	$0	$0	$0	0.00%	$9,004	$7,330	$1,674	18.59%	$7,330	$1,674	18.59%
Governmnt Admin	$3,739	$0	$0	$0	0.00%	$3,739	$3,193	$546	14.61%	$3,193	$546	14.61%
	$15,069	$802	$802	$0	0.00%	$14,267	$11,843	$2,424	16.99%	$12,654	$2,424	16.08%
SUBTOTAL	$32,131	$13,985	$11,678	$2,307	16.50%	$18,146	$15,000	$3,145	17.33%	$26,678	$5,453	16.97%
MRS	$1,616	$1,616	$1,616	$0	0.00%	$0	$0	$0	0.00%	$1,616	$0	0.00%
BENEFITS:												
MRS	$197	$197	$197	$0	0.00%	$0	$0	$0	0.00%	$197	$0	0.00%
Repository 1	$440	$0	$0	$0	0.00%	$440	$358	$82	18.59%	$358	$82	18.59%
Repository 2	$156	$0	$0	$0	0.00%	$156	$127	$29	18.59%	$127	$29	18.59%
	$793	$197	$197	$0	0.00%	$596	$485	$111	18.59%	$682	$111	13.97%
TOTAL	$34,540	$15,798	$13,491	$2,307	14.61%	$18,742	$15,486	$3,256	17.37%	$28,976	$5,564	16.11%

* Totals may not add to annualized totals due to independent rounding.

Table E-4 (continued)

Defense Waste Allocation Factors for the Two-Repository System
Upper-Reference Case with Intact Disposal
(Millions of 1988 Dollars) *

	********* TOTAL COSTS *********			** REPOSITORY 1 COST FACTORS **			** REPOSITORY 2 COST FACTORS **			******* DEFENSE COSTS *********		
REPOSITORY COST BREAKDOWN	REPOS. 1	REPOS. 2	TOTAL	DHLW / TOTAL =		FACTOR	DHLW / TOTAL =		FACTOR	REPOS. 1	REPOS. 2	TOTAL
COMMON VARIABLE:				(Waste Packages or Thous. Tons)			(Waste Packages or Thous. Tons)					
PIECE COUNT:												
TOTAL PIECE COUNT	$673	$222	$895	11,676	43,974	26.56%	6,074	24,903	24.39%	$179	$54	$233
WHB#1 PIECE COUNT	$0	$0	$0	0	0	0.00%	0	0	0.00%	$0	$0	$0
WHB#2 PIECE COUNT	$852	$1,124	$1,976	11,676	43,974	26.56%	6,074	24,903	24.39%	$226	$274	$500
AREAL DISPERSION	$2,175	$1,976	$4,151	1,584	17,179	9.22%	3,395	15,259	22.25%	$201	$440	$640
DIRECT:												
CIVILIAN	$1,172	$1,680	$2,852			0.00%			0.00%	$0	$0	$0
DEFENSE	$263	$305	$568			100.00%			100.00%	$263	$305	$568
SUBTOTAL ASSIGNABLE	$5,135	$5,308	$10,442			16.91%			20.22%	$868	$1,073	$1,941
COMMON UNASSIGNED	$1,887	$1,992	$3,879							$319	$403	$722
TOTAL	$7,022	$7,298	$14,321							$1,187	$1,476	$2,663

* Totals may not add to annualized totals due to independent rounding.