Nuclear Waste Disposal: Achieving Adequate Financing

Special Study

August 1984

CONGRESS OF THE UNITED STATES CONGRESSIONAL BUDGET OFFICE

NUCLEAR WASTE DISPOSAL: ACHIEVING ADEQUATE FINANCING

The Congress of the United States
Congressional Budget Office

NOTES

Except for the use of the Composite Cost Index in the indexing option in Chapter IV, the annual inflation rate used in this report is the gross national product (GNP) implicit price deflator.

Unless otherwise noted, all dollar amounts are in 1983 dollars.

PREFACE

About 10,000 metric tons of high-level radioactive waste, primarily spent nuclear fuel, are now stored on-site by commercial nuclear electric utilities, until permanent underground repositories are built to accept the waste. In 1982, the Congress passed the Nuclear Waste Policy Act, requiring the Department of Energy to develop and operate two federal repositories and to begin accepting civilian high-level radioactive waste in 1998. The act also specifies that the owners and generators of the nuclear waste--primarily the nuclear electric utilities--should pay the full costs of the waste disposal program.

The Congressional Budget Office (CBO) has prepared this analysis in response to a request by Chairman John Moakley of the Subcommittee on Rules of the House Committee on Rules. The study evaluates whether the current 1 mill fee now charged to nuclear-electricity consumers will adequately finance the waste disposal program, and suggests several alternatives for fee revision. In keeping with CBO's mandate to provide objective analysis, the report makes no recommendations.

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SUMMARY

Nuclear electric utilities now store about 10,000 metric tons of spent nuclear fuel, which is at on-site facilities awaiting shipment to permanent disposal sites. The federal government has assumed responsibility for the permanent disposal of radioactive waste because of its potential risks to human health and the length of time--over 10,000 years--it must be sequestered from the environment.

Although permanent sites do not yet exist in the United States, the Congress passed the Nuclear Waste Policy Act (NWPA) of 1982 to address this lack. The act requires the Department of Energy (DOE) to develop and manage two underground repositories to dispose of the radioactive waste generated by civilian nuclear utilities. It also requires utilities, as the owners and generators of the wastes to pay for its disposal through fees levied on their electricity consumers.

The DOE has published its draft plan for meeting the act's objectives. Two underground repositories will be built with sufficient disposal capacity to contain all high-level radioactive waste from commercial power reactors through at least 2020. Disposal will begin in 1998. The waste disposal program will be financed through a fee now set at 1 mill per kilowatt-hour of electricity produced from commercial reactors (roughly 1.5 percent of the average residential price of electricity in 1983). The fee was instituted on April 7, 1983. One-time fee assessments will also be levied on the spent fuel inventories that existed before April 7, 1983.

Fee proceeds, deposited in the Nuclear Waste Fund, are to be disbursed as development and construction of the disposal sites progress. Although actual construction of the sites will not begin until the 1990s, revenues must be collected now and over the construction period to finance the program in later years, when costs will often exceed annual fee receipts. Therefore, this study addresses three questions:

- Is the current fee adequate to finance the development, construction, and operation of the permanent radioactive waste disposal facilities under different assumptions about the growth rates of nuclear power?

- What adjustments must be made to the fee to provide for possible contingencies, such as program delays, changes in costs, and different inflation rates?

- o What are the alternatives for revising the fee to ensure full cost recovery?

The CBO found that, if the fee is adjusted annually to maintain a real (inflation-adjusted) rate of 1 mill per kwh, it should provide more than sufficient revenues to cover fully all program costs under all nuclear-growth forecasts. Indexing the fee to offset inflation beginning in 1984 also would protect the fund from cost overruns of 30 percent to 80 percent. If the fee is unchanged over the program's duration, however, the resulting revenues would not cover all program costs under any of the nuclear electricity-generation forecasts if cost inflation exceeds 3 percent annually. The fee would have to be increased at some point, although not necessarily in the immediate future.

The fee is considered adequate if it finances all expected costs and leaves a zero or positive trust fund balance when the program ends (after the second and final repository is filled and decommissioned). But an "adequate" fee may not be desirable if the fee overcollects substantial amounts from ratepayers. Such overcharges, resulting in large fund surpluses when the program ends, would lead to overpriced electricity and losses in economic efficiency.

An "optimal" fee is one that neither overcollects nor undercollects--that assigns to the consumers of nuclear electricity neither more nor less than the full cost of radioactive waste disposal. Because it is impossible to estimate accurately costs spanning 50 years into the future, an ideal fee schedule will certainly require adjustment. Fund management, therefore, has two components: assigning the correct fee based on current estimates of program costs and waste generation and providing a mechanism for adjusting the fee.

SETTING THE CORRECT FEE UNDER VARYING PROGRAM ASSUMPTIONS

DOE's current program--the **reference program** in this report--includes developing two repositories in either salt, tuff (compacted volcanic ash), or basalt, each with a storage capacity of 72,000 metric tons of spent fuel or the solidified reprocessed waste equivalent. Several potential sites for the first repository have been nominated, but none has been selected. The first repository will begin to accept commercial wastes in 1998, at a rate of 1,800 metric tons per year for the first five years and up to 3,000 metric tons per year thereafter. The second repository is scheduled to open in 2002 with the same rate of waste acceptance. (In April 1984, the DOE revised this schedule to slow the fill rate for the first repository, delay opening of the second for three years, and slightly reduce the capacity of both.) The conclusions reported in this paper would not be notably affected by these changes. The DOE will transfer the spent fuel from the utilities to the repositories, accepting title to the fuel when it is shipped. The program also includes developing and demonstrating the repository disposal concept and providing financial assistance to state and local governments and Indian tribes affected by any repository.

Fee payments are deposited in the Nuclear Waste Fund. By June 30, 1983, the DOE had signed contracts with all domestic commercial nuclear utilities requiring quarterly fee payments in return for the DOE's commitment to begin accepting the utilities' spent fuel inventories by 1998. Since annual revenues will not always match outlays, the DOE is required to invest any excess revenues in U.S. Treasury bills, or, if needed, to borrow from the U.S. Treasury if costs exceed the trust fund's balance in any year. Thus, any surplus trust fund balance will earn interest and any borrowed funds will have to be repaid with interest out of future fee receipts. The trust fund's final balance will reflect such transactions.

This analysis assumes that the fee will be levied until the first 144,000 metric tons of spent fuel (the capacity of the two repositories) have been generated, unless nuclear growth is insufficient to generate this total amount. Any additional spent fuel would be disposed of in additional repositories, paid for by fees levied on the electricity which produced that spent fuel.

Effect of Different Growth Rates for Nuclear Power

The waste disposal filling rates and associated costs of the two repositories depend to a large extent on the growth of nuclear-power generation. The CBO evaluated program costs and projected fund receipts under forecasts of high, medium, low, and no growth in nuclear capacity, prepared by the Energy Information Administration (EIA) in September 1983; the forecasts have been revised downward slightly since then. These assume that U.S. installed nuclear capacity in the year 2000 will reach 140 gigawatts-electric (GWe) under high growth, 130 GWe under medium growth, and 109 GWe under the low- and no-growth schedules, up from the 1983 nuclear capacity of 64.5 GWe.

Under high nuclear growth, the two repositories would be filled by 2027, while under low growth the second repository would have to remain open until 2037, extending the schedules for spent fuel shipping and repository operating and decommissioning. Total program costs under the low-growth projection, however, would not be significantly higher because its lower filling rates would lead to lower annual shipping and operating costs. The no-growth projection would result in only 82,000 metric tons of spent fuel, which would be disposed of by 2026, and its disposal costs would be significantly lower. Disposal costs ranging from $15 billion to $20 billion (in 1983 dollars) reflect the different disposal rates arising from differences in nuclear-power growth. The program cost assumptions were derived from DOE's report entitled, "Report on Financing the Disposal of Commercial Spent Nuclear Fuel and Processed High-Level Radioactive Waste" (July 1983). Some of these program assumptions have been revised in DOE's April 1984 draft Mission Plan. Further program modifications and revised cost estimates will be included when the final Mission Plan is issued in late 1984.

Fund Balances Under the Reference Program

The final trust fund balances for the reference program are shown in the Summary Table. These trust fund projections are based on long-term inflation and real interest rate assumptions of 4.3 percent and 3.5 percent, respectively. Under these assumptions, future fee adjustments would be necessary to finance total program costs. If the 1 mill per kilowatt-hour fee were not increased over the program's duration, the fee would be insufficient under all nuclear-growth cases. The final fund deficit under the fixed fee would range from -$8.5 billion to -$0.6 billion.

If, instead, the fee were adjusted annually for inflation to maintain the fee's real rate at 1 mill per kwh, the subsequent fee receipts would earn significant interest income to finance program costs. Adjusting the fee for inflation (as measured by the percentage change in the gross national product implicit price deflator) beginning in 1984 would result in a final fund surplus of $12.9 billion to $45.0 billion. Such large final balances would overcharge the ratepayers, and suggest consideration of an alternative fee structure, such as indexing the fee later in the program's lifetime, to bring total revenues more closely in line with program costs.

Under the no-growth forecast, the total spent fuel storage requirement is only 82,000 metric tons. The CBO therefore evaluated an alternative no-growth repository program whereby the DOE would build two 42,000 metric tons capacity repositories, rather than the full-scale 72,000 metric ton facilities. This alternative program would cost about $13.5 billion under current estimates. The associated final fund balance would be 0 if the fee remains constant, and $18.7 billion if the fee is adjusted by the annual inflation rate.

SUMMARY TABLE. NUCLEAR WASTE FUND PROJECTIONS UNDER DIFFERENT NUCLEAR-GENERATED ELECTRICITY SCENARIOS (In billions of 1983 dollars)

	High Nuclear Growth	Medium Nuclear Growth	Low Nuclear Growth	No Nuclear Growth
Fixed Fee of 1 Mill per Kilowatt-Hour				
Total Program Costs	20.0	20.1	20.3	15.3
Total Fee Collections a/	16.2	15.4	14.2	10.7
Net Interest b/	3.2	1.3	-2.4	-1.2
Final Fund Balance	-0.6	-3.4	-8.5	-5.8
Optimal Fee for Zero Final Balance (In mills per kilowatt-hour)	1.02	1.10	1.19	1.22
Fee Increased by Annual Inflation Rate c/				
Total Program Costs	20.0	20.1	20.3	15.3
Total Fee Collections a/	34.8	34.2	34.3	17.7
Net Interest b/	27.1	26.1	31.0	10.5
Final Fund Balance	41.9	40.2	45.0	12.9
Optimal Fee for Zero Final Balance (In mills per kilowatt-hour)	0.5	0.52	0.55	0.72

SOURCE: Congressional Budget Office.

NOTES: The long-term inflation and real interest rate assumptions are 4.3 percent and 3.5 percent, respectively.

a. Total fee collections include the one-time payments made for spent fuel generated before April 7, 1983, estimated at $2.3 billion (in nominal dollars).

b. Net interest includes earnings on invested fund revenues and payments on borrowed funds.

c. This fee design would increase the current fee by the annual percent change in the gross national product implicit price deflator, beginning in 1984. The optimal fee under this schedule refers to the rate at which the fee should have been set in 1983 in order to leave a final fund balance of zero.

Determining an Optimal Fee

If the current cost and inflation projections for the program were reliable, an optimal fee could be determined that would produce total revenues that finance program costs exactly. The Summary Table shows these optimal fee rates under the four nuclear-power growth alternatives. If a fee were set in 1983 to remain in effect over the program's duration, its fixed rate would range from 1.02 to 1.22 mills per kwh.

Alternatively, if the DOE chose to adopt a constant real fee (a fee whose nominal rate would increase annually by the current rate of inflation), the current fee would have to be reduced so that the program would not end with a surplus. A 1983 fee of 0.5 to 0.72 mills per kwh would result in a zero fund balance if that fee were increased by the annual inflation rate beginning in 1984.

The Effect of Cost Overruns

The current cost estimates totaling about $20 billion for the waste disposal program are inherently uncertain, since the repository concept is still being developed and the program will span 50 years. Moreover, until the sites and geology of the two repositories are selected, the shipping costs for spent fuel and the repository capital and operating costs can only be estimated. Adjusting the fee for inflation would provide some insurance that future program cost increases could be financed by fee receipts and greater interest earnings. If the fee were adjusted for inflation beginning in 1984, actual costs could exceed current estimates by 30 percent (under the no-growth forecast) to 80 percent (under the high-growth forecast) and still be covered by projected fund revenues. Delaying the adjustment of the fee would mean accepting a higher level of risk regarding potential cost overruns.

The Effect of Delays in the Repository Schedules

Although DOE's current waste disposal program calls for the first repository to open by 1998, this schedule probably will be delayed, possibly up to ten years or more. As a back-up, the DOE is now developing the monitored retrievable storage (MRS) concept, a centralized above-ground facility that could store high-level radioactive waste temporarily beginning in 1998. The costs of an MRS facility could range from about $0.7 billion for a 15,000 metric ton facility to $5.8 billion for a 72,000 metric ton facility.

If both repositories are completed three years behind schedule under medium nuclear growth and the DOE deploys a 15,000 metric tons MRS facility, the final fund balance will be almost $43 billion if the fee is fully adjusted for inflation. This final balance would exceed that of the reference program if the current cost projections for the repositories and the MRS facility are reliable. The delay in the repository construction, operating, and decommissioning schedules would allow the unneeded fund revenues to earn additional interest income that would offset the MRS-related outlays.

Thus, moderate delays in the program schedule would not seriously affect the program's fiscal solvency. If the fee were increased annually by the inflation rate, the fund balance would be higher than that of the reference program, even if the repositories open ten years late. The final fund balance could range from $15.6 billion under no nuclear growth to $43.1 billion under medium nuclear growth, assuming that 30,000 and 72,000 metric ton MRS facilities, respectively, are built. Actual program costs could exceed current projections by about 40 percent to 80 percent under the three delayed schedule scenarios, and still be fully financed by projected fund revenues.

Under the three delayed schedules, however, as under the current program schedule, a fixed fee of 1 mill per kwh would not finance all program costs. The associated program deficits would range from -$2.2 billion to -$13.7 billion, depending on the schedule of future nuclear-electricity generation and the length of the program delays. Thus, the fee would have to be increased at some time in the future.

The Effect of Higher than Anticipated Inflation

If unadjusted over the program's duration, the current fee would be inadequate if the long-term inflation rate were higher than 3 percent, because program costs are assumed to rise at the same rate as the GNP deflator. If inflation were 6.3 percent annually over the long term (the CBO February 1984 high economic growth projection), the final program deficit would range from -$7.4 billion to -$23 billion, depending on the rate of nuclear growth and any delays in repository schedules. If the fee were fully adjusted by this annual rate of inflation, fund revenues as well as costs would be higher, resulting in final balances that would differ little from those under the reference inflation rate assumption of 4.3 percent.

The Effect of Alternative Interest Rates

Interest rates are critical in projecting fee adequacy. Under the baseline assumption of a 3.5 percent real interest rate over the long run

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(based on the 91-day Treasury bill rate), a fully inflation-adjusted fee beginning in 1984 would produce net interest income of $11 billion to $31 billion, depending on the schedule of future nuclear-power growth (see the Summary Table). Alternatively, if the fee remains fixed at its current rate, total interest penalties owed on borrowed funds could exceed the interest earned on any invested revenues.

If the annual interest rate were 1 percent higher than the baseline projection, the subsequent higher interest income would offset the higher interest penalties, resulting in more income for the final trust fund under both a fixed and inflation-adjusted fee. A fixed fee, however, would still be unable to finance the current program, even with the higher long-term real interest rate of 4.5 percent.

Lower interest rates would reduce the final trust fund balance, since interest income generally outweighs interest penalties, as funds are built up early in the program and disbursed at a later time. If the real long-term rate is assumed to be 2.5 percent rather than 3.5 percent, the program would end with a deficit of -$4 billion to -$14 billion if the fee is not increased. If the fee were fully increased for inflation, however, the fund surplus would be $8 billion to $31 billion, even under this lower real interest rate.

FEE ADJUSTMENT PROBLEMS

If future costs and disposal requirements could be known with certainty, assessing the proper fee would be straightforward. But the history of this and similar programs suggests wide deviations from planned scenarios. This raises the problem of the appropriate mechanism for revising the fee: when and how to adjust the fee to account for uncertainties in costs, schedules, future nuclear-electricity generation, inflation, and interest rates.

Under current policy, the Department of Energy must review the fee annually and propose adjustments to the Congress when necessary. The Congress must then determine whether the fee revision is justified, and if so amend the NWPA to specify the new rate. This report evaluates current policy and two alternatives that would reduce the DOE discretion in selecting the timing and magnitude of fee adjustments. The alternatives are as follows:

o Increase the Fee Only at Specific Intervals. Rather than allowing for annual revisions, the Congress could amend the NWPA so that the fee could be adjusted only at specific intervals. This could limit fee revisions more than current policy, but it could subsequently result in large rate jumps if costs increase significantly.

- Automatically Adjust the Fee Through Indexation. The Congress could require the DOE to maintain the fee at a real rate of 1 mill per kwh by indexing it to some measure of inflation. Annually increasing the fee's nominal rate would account for the effects of inflation on program costs and revenues, and would also provide insurance for probable cost overruns. The inflation index that has been proposed is the Composite Cost Index, published by the Department of Commerce.

Concern over the optimal method for revising the fee arises because of the high degree of uncertainty in current cost projections and future patterns of nuclear-generated electricity. Choosing how to reflect these uncertainties in the fee schedule requires balancing the financial risks of the program between present and future electricity users. Indexing the fee to some measure of inflation would ensure against substantial cost increases (or revenue shortfalls), thus assigning much of the risk of program cost overruns to current nuclear-electricity users. (If the cost increases did not materialize, the fee would be decreased in later years.) Adjusting the fee either annually or at regular intervals to reflect the latest cost and revenue revisions, however, would assign greater risk to future beneficiaries of the program who would pay a larger share of the disposal costs.

In terms of economic efficiency, adjusting the fee in response to new information about revenues and costs would more closely match the rate to the financial realities of the waste disposal program. By contrast, linking the fee to changes in some predetermined inflation index would weaken this coupling. An inflation-increased fee beginning in 1984 probably would overcharge consumers of electricity, and even though any overcharges might eventually be refunded, the refunds would probably not go to those who originally contributed. On the other hand, an indexed fee would most likely ensure full cost recovery unless program cost growth became quite high. In addition, it would relieve the Congress of possibly having to act on frequent proposals to change the fee.

CHAPTER I. INTRODUCTION

Since electric utilities started to operate commercial nuclear reactors in the late 1950s, they have been accumulating high-level radioactive waste, the principal by-product of nuclear-generated electricity. 1/ Utilities have been storing these wastes on-site in temporary facilities, awaiting development of a federal program for permanent disposal. In 1982, the Congress passed the Nuclear Waste Policy Act (NWPA) establishing such a program for the permanent, safe disposal of high-level radioactive wastes. 2/

The NWPA calls for the federal government to develop and manage permanent underground repositories to dispose of the nation's commercially generated radioactive wastes, and for owners and generators of these wastes (the utility companies) to pay all program costs. Fees levied on electricity generated by nuclear power will finance the Nuclear Waste Fund, which will pay for the development, construction, and management of the disposal sites. The current fee is set at 1 mill (one-tenth of a cent) per kilowatt-hour (kwh)--about 1.5 percent of the average cost of residential electricity in 1983--and applies to electricity produced from all commercial nuclear plants since April 7, 1983.

SOURCES OF RADIOACTIVE WASTE AND DESIGNS FOR DISPOSAL

Because of the potential public health and environmental hazards of radioactive waste and the rigorous isolation required, the federal government has assumed responsibility for providing safe and permanent disposal. The radiation emitted from the decaying nuclei of atoms in the wastes can damage human tissue and other biological material by breaking or altering the chemical structures of molecules, causing cancer or genetic mutation.

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1. High-level radioactive wastes comprise both spent nuclear fuel (fuel removed from nuclear reactors once its useful life is exhausted) and "reprocessed" spent fuel (from which the reusable materials have been removed).

2. The Congressional Budget Office first evaluated the financing of this program in a report entitled, Financing Radioactive Waste Disposal (September 1982).

Because elements contained in nuclear wastes decay extremely slowly--remaining active over 10,000 years--the wastes must be permanently isolated from the environment.

Sources of Radioactive Waste

Most radioactive wastes, in the form of spent fuel or "reprocessed" spent fuel, are the by-products of commercial nuclear-generated electricity and nuclear defense activities. Small amounts of radioactive material are also produced in medical research and treatment. Almost all the high-level radioactive wastes to be placed in the federal repositories will consist of spent fuel from commercial reactors, unless commercial reprocessing becomes a profitable enterprise in the near future, which now seems unlikely.

Currently, about 10,000 metric tons of spent nuclear fuel from civilian power reactors are kept under water in storage pools at the reactor sites. Small amounts are stored at two closed reprocessing plants at West Valley, New York, and Morris, Illinois; and a small amount of reprocessed commercial waste remains at the West Valley facility. The Department of Energy (DOE) estimates that, by the turn of the century, roughly 50,000 metric tons of spent nuclear fuel will have accumulated from civilian reactors. All will require permanent disposal.

In contrast to civilian radioactive waste, the waste from defense reactors typically has been reprocessed to extract the useful materials. The residue is shipped to three federal facilities for storage: the Idaho National Engineering Laboratory near Idaho Falls, Idaho; the Savannah River Plant near Aiken, South Carolina; and the Hanford Reservation near Richland, Washington. According to the NWPA, the President must decide by January 1985 whether high-level radioactive wastes from defense-related activities should be permanently placed in the commercial waste repositories. This report assumes that military wastes will be disposed of in a separate facility. If the President decides to dispose of military waste in the commercial repositories, the Department of Energy would be responsible for that portion of the costs.

Disposal Design

The NWPA specified mined geologic repositories as the preferred means of permanent waste disposal--a method DOE had selected as the safest and most environmentally sound. Use of such underground facilities, which rely on natural and man-made barriers to prevent human contact with the waste, does not require continuous human surveillance and maintenance as do current storage facilities at civilian reactor sites. Permanent disposal sites will house the wastes, enclosed in cannisters, in a suitable host rock (salt, basalt, or tuff--compacted volcanic ash) below the earth's surface. When filled, the repositories will be sealed from all surface access.

In addition to the geologic repository concept specified in the NWPA, the DOE is continuing its research into alternative means of disposal, including: [3]

- o Identifying and evaluating additional rock forms suitable for underground waste disposal, and
- o Continuing the development of the subseabed disposal program, an option that would isolate radioactive wastes within the stable sedimentary formations of the ocean floor.

If the DOE determines that subseabed disposal is safe and environmentally sound, this method could serve as a back-up to the geologic repositories should they prove infeasible, or function as an international repository. By 1990, the DOE should decide if this concept can provide a viable method of permanent waste disposal.

THE CURRENT WASTE DISPOSAL PROGRAM

The NWPA established the Office of Civilian Radioactive Waste Management (OCRWM) within the DOE to manage the federal waste disposal program. The office's current program--called the **reference program** for this analysis--plans to build two geologic repositories, each with a capacity of 72,000 metric tons of high-level radioactive waste in the form of either spent nuclear fuel or solidified reprocessed waste. The two facilities are supposed to begin to accept wastes in 1998 and 2002, respectively, each at a rate of 1,800 metric tons a year for the first five years of operation and up to 3,000 metric tons a year thereafter, until decommissioned. [4] Depending on the schedule of future electricity

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3. These research efforts are funded by the DOE, and not from the Nuclear Waste Fund revenues.

4. The DOE is expected to revise its repository program, however. The new program, outlined in the draft "Mission Plan for the Civilian (Continued)

generation and the subsequent accumulation of spent nuclear fuel, the first repository will be filled between 2020 and 2025 and the second repository between 2027 and 2037.

Total disposal costs are projected to range from $15 billion to $20 billion (in 1983 dollars), depending on the rate of nuclear-power growth. 5/ Table 1 enumerates the components of these costs. The appendix describes how these estimates, under the different nuclear-growth scenarios, were derived from OCRWM's reference program costs.

The construction costs for the two repositories ($3.5 billion) account for about 20 percent of the total. The bulk of program outlays will go toward operating and filling each repository; it will cost almost $7 billion to unload and repackage the waste at the site, place it in the underground shafts, and monitor and safeguard the closed facilities. 6/ Shipping the utilities' spent fuel inventories to the repositories will require another $2 to $4 billion, accounting for roughly 15 to 20 percent of total program costs.

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4. (Continued)

   Radioactive Waste Management Program" that was released by DOE in May 1984, would decrease the amount of spent fuel the first repository will accept from 1,800 to 400 metric tons a year for the first three years, and to 900 metric tons in 2001. Also, the second repository would not open until 2005, three years behind schedule, but would have the same waste-acceptance schedule as originally planned. The capacity of the two repositories would be reduced to 70,000 metric tons each, rather than the present 72,000 metric tons. The conclusions reported in this paper would not be notably affected by the changes contained in the draft plan.

5. The cost estimates are based on a Department of Energy study, Report on Financing the Disposal of Commercial Spent Nuclear Fuel and Processed High-Level Radioactive Wastes, DOE/S-0020/1, NTIS (July 1983). The DOE costs were adjusted for four nuclear-power growth cases to reflect different schedules of electricity generation and spent fuel accumulation.

6. Under the no nuclear-growth scenario, the total spent fuel generated would not fill the two repositories. The total operating costs would be only $4 billion, compared to $6.9 billion under the three growth projections.

TABLE 1. REFERENCE PROGRAM COSTS FOR WASTE DISPOSAL

Cost Category	Program Cost (In billions of 1983 dollars)	Percentage of Total Program Cost
Two 72,000 Metric Ton Capacity Repositories a/		
Construction	3.5	23--17 b/
Operating c/	4.0--6.9	26--34
Decommissioning	0.7	5--4 b/
Transporting Spent Nuclear Fuel d/	2.3--4.0	15--20
Site Selection, Evaluation, and Licensing	1.3	8--6 b/
Test and Evaluation Facility	0.2	1
Technological Development	1.5	10--8 b/
Administration e/	1.8--2.2	12--11
Total f/	15.3--20.3	100

SOURCE: Congressional Budget Office, based on cost projections from Department of Energy, Report on Financing the Disposal of Commercial Spent Nuclear Fuel and Processed High-Level Radioactive Waste, DOE/S-0020/1 (July 1983).

a. These costs refer to two repositories built in a salt medium. The costs of building and operating two hard-rock repositories would be roughly 2 percent higher. All CBO analyses assume the development of salt repositories.

b. Although the specific program cost remains the same under different growth patterns, its corresponding share of total program costs will differ.

c. The total operating cost for the two repositories depends on the schedule of nuclear electricity generation. The annual operating cost for each repository is $48 million per thousand metric tons of spent fuel received.

d. Total shipping costs also depend on the nuclear-growth forecast; the annual cost per thousand metric tons of spent nuclear fuel shipped is $28 million. The no-growth scenario assumes that only 82,000 metric tons will be disposed of at a cost of $2.3 billion; the $4.0 billion projection refers to the three growth forecasts.

e. Administrative costs include aid payments to state and local governments and to Indian tribes affected by repository development and fund management costs. Administrative costs continue until the second repository is decommissioned, and thus depend on the schedule of nuclear-electricity growth.

f. The range of total cost estimates reflects the repository schedules under the different nuclear-growth forecasts.

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These cost projections differ somewhat from the estimates reported in CBO's earlier study, Financing Radioactive Waste Disposal (September 1982). Total construction costs were then estimated at $2.3 billion, 52 percent lower than the current projection of $3.5 billion. Total operating costs, however, were 22 percent higher, at $8.4 billion, compared to the present $6.9 billion estimate. Total program costs ($15.4 billion), which did not then include shipping the spent fuel, were roughly 6 percent lower than the currently estimated program costs, if transportation costs are excluded. The earlier estimates were derived before passage of the NWPA and did not include many requirements contained in the act. The new costs reflect these new requirements and changed economic conditions.

THE NUCLEAR WASTE FUND

The Nuclear Waste Fund--designed to finance all costs of the federal waste disposal program--consists of the fee payments collected on nuclear-generated electricity. It operates on the principle that the beneficiaries of the repositories--the customers of the nuclear electric utilities--should pay all related costs. The OCRWM has signed disposal contracts with all commercial nuclear utilities, charging a fee currently set at 1 mill per kilowatt-hour on all electricity generated by nuclear-power plants on or after April 7, 1983. This fee is quite small as a percentage of the total costs of generating electricity at nuclear-power plants, which averaged roughly 3.1 cents per kilowatt-hour in 1982 prices. A 1 mill per kwh fee represents about 3 percent of the total generating costs, and just 1.5 percent of the average residential price of electricity (which totaled 6.49 cents per kwh in 1983). In return for this fee, the DOE must transport and accept title to the utilities' spent fuel inventories beginning in 1998. 7/

Fee payments will also be made on 9,300 metric tons of spent nuclear fuel that were generated before April 7, 1983. The one-time fee, based on the kilograms of spent nuclear fuel generated by utilities before the cut-off date, will average 1 mill per kwh fee for the electricity generated from that

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7. The NWPA requires the nuclear utilities to store their spent fuel inventories on-site in interim facilities until the repositories begin accepting the wastes in 1998. Recognizing that some utilities will exceed their storage capacities before 1998, the NWPA also established a separate federal interim storage program whereby the federal government will provide up to 1,900 metric tons of spent fuel storage capacity, if necessary, to be paid for by the utilities that use the off-site interim storage.

spent fuel. The OCRWM expects receipts totaling about $2.3 billion (in nominal dollars) between now and 1998 from the utilities holding this spent fuel. The appendix describes assumed payment schedule for these fees.

If the fee remains fixed at 1 mill per kwh, the payments collected on nuclear-generated electricity for the first 144,000 metric tons of spent fuel (the total amount to be disposed of in the two repositories), will total roughly $14 billion to $19 billion in 1983 dollars, or $37 billion in nominal dollars. (This amount includes the $2.3 billion in payments for the spent fuel generated prior to April 7, 1983). If, however, the fee is increased annually by the inflation rate, fee payments will be about $34 billion in 1983 dollars. 8/

Full cost recovery does not require that fee payments cover outlays every year. If outlays exceed the fund's accumulated balance in any year, the OCRWM may borrow funds from the U.S. Treasury, to be repaid with interest from future fund revenues. Alternatively, any excess revenues not needed to cover immediate outlays will be invested in U.S. Treasury bills, providing additional revenues to finance outlays in later years. 9/

The history of this program--and indeed of any long-term, technology-intensive venture--suggests that fees set in advance are unlikely to provide revenues that exactly match costs. The mechanism for adjusting the fee to reflect changes in program costs or revenues is, therefore, central to responsible fund management.

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8. Under a no nuclear-growth projection, only 82,000 metric tons of spent fuel would be generated, resulting in total fee collections of $10.7 billion (in 1983 dollars) if the fee remains at its current rate, and $17.7 billion if the fee is increased by the rate of inflation beginning in 1984.

9. This analysis uses the interest rate for 91-day Treasury bills found in CBO's February 1984 forecast for 1984 and 1985 and its projections for 1986-1989 to determine the interest either earned or owed on fund investments or borrowings. After 1989, the long-term real interest rate is assumed to remain constant at 3.5 percent. Congressional Budget Office, The Economic Outlook: A Report to the Senate and House Committees on the Budget--Part I (February 1984).

CHAPTER II. ADEQUACY OF THE CURRENT FEE UNDER DIFFERENT ASSUMPTIONS ABOUT NUCLEAR-POWER GROWTH

This chapter examines whether the current fee will raise enough revenues to cover all projected outlays of the nuclear waste disposal program, under various assumptions about the growth of nuclear power. The results indicate that, if the current fee of 1 mill per kilowatt-hour (kwh) were increased annually by the rate of inflation, it would be more than sufficient to cover program costs under the full range of nuclear-growth forecasts. If the fee is not adjusted over the fee collection period, however, revenues would fall short of covering program costs, considering the inflation rates projected for this period.

PROJECTIONS OF NUCLEAR-POWER CAPACITY AND ELECTRICITY GENERATION

The revenue and outlay projections associated with the current waste disposal program are based on forecasts of nuclear-electricity generation over the next 40 to 50 years. Total fund revenues reflect the schedule of fee payments, which, in turn, is based on the level of nuclear-generated electricity. While the development and construction costs of the two planned repositories are identical under different nuclear-growth forecasts, the outlays required to transport the nuclear wastes to the repositories and to fill and decommission them are governed by the rate at which spent nuclear fuel is accumulated. Low nuclear growth would require the repositories to remain open longer--until their capacity to hold spent fuel is filled--and would provide lower annual revenue collections. The fee would remain in effect over a longer period, however, and thus would be able to pay the full costs of the spent fuel disposal, assuming inflation-related increases.

The solvency of the Nuclear Waste Fund was examined under four scenarios of nuclear-power growth, prepared by the Energy Information Administration (EIA). 1/ The EIA projections reflect high, medium, low, and no growth in nuclear-generated electricity through the year 2020. The four scenarios are summarized below; the appendix provides tables showing

1. U.S. Department of Energy, "EIA Projections of Nuclear Power Capacity through 2020 and Associated Electricity Generation and Spent Fuel Arisings," Memorandum (September 19, 1983).

the corresponding levels of annual nuclear-power capacity and electricity generation forecasts.

High-Growth Case

The high-growth case projects that U.S. nuclear capacity would be 140 gigawatts-electric (GWe) in 2000, rising to 350 GWe in 2020, a 440 percent increase from the 1983 level of 64.5 GWe. Since each power reactor discharges roughly 25 to 30 metric tons of spent nuclear fuel each year, this schedule of electricity generation would produce 144,000 metric tons of spent fuel (the combined capacity of the two repositories) by 2018. This case assumes that the utilities' estimates of commercial operation dates for new reactors are met, except for those few instances in which schedules are known to be unrealistic. In addition to the new reactors included in the utilities' projections, this scenario assumes eight more reactors are ordered in the late 1980s and become operational by 2000. Considering that many nuclear utilities are now experiencing financial problems, this high-growth scenario seems very improbable at this time.

Medium-Growth Case

Under this case, U.S. nuclear capacity would be 130 GWe in 2000, rising to 230 GWe in 2020, a 255 percent increase from 1983 levels; this would produce 144,000 metric tons of spent fuel by 2022. The EIA medium-growth forecast revises the estimates of commercial operation dates provided by utilities to reflect past delays in reactor construction schedules, regulatory or financial constraints, and EIA's projections of electricity demand growth. This schedule bases total installed capacity on the number of reactors projected by the nuclear utilities, but includes delays in some of the utilities' assumed start-up schedules. It also assumes that any future plant cancellations will be matched by new reactor orders through 2000.

Low-Growth Case

The low-growth case projects that U.S. nuclear capacity would be 109 GWe in 2000, rising to 145 GWe in 2020, a 125 percent increase from 1983 levels. The spent fuel produced would total 144,000 metric tons in 2032. While this EIA schedule assumes that all reactors now less than 30 percent completed or for which construction has been indefinitely deferred would be cancelled, it does include the construction of new reactors projected by utilities to come on-line beginning in the year 2000. The EIA forecast adjusts the estimated commercial operation dates for new reactors, however, to reflect the current financial problems of electric utilities.

No-Growth Case

This case projects that U.S. nuclear capacity would be 109 GWe in 2000, then decrease steadily until 2020 when electricity generation from nuclear-power reactors would cease. Under this scenario, only 82,000 metric tons of spent fuel would be produced. It is similar to the low-growth case up to the year 2000, but further assumes that no new reactor orders are placed to increase capacity through 2020. Since nuclear reactors have operating lives of roughly 30 years, net nuclear capacity would decline steadily after the late 1990s as reactors are retired and not replaced.

Which Growth Estimate to Use?

The Office of Civilian Radioactive Waste Management (OCRWM) uses the EIA medium-growth forecast to predict annual revenue collections and the amount of spent fuel that will be generated and require disposal in the repositories. The OCRWM's annual assessment of the adequacy of the current fee to provide sufficient revenue to pay for the program thus reflects the medium-growth assumptions, a rather optimistic scenario for nuclear power since it assumes that any nuclear projects cancelled through the year 2000 would be replaced by new orders. 2/ Future plant cancellations are likely, considering the severity of the financial problems confronting many nuclear utilities, and it is improbable that an equal number of new reactors will be ordered to meet the total capacity projections.

Furthermore, the EIA has consistently revised downward its projections for nuclear reactor capacity and electricity generation. In early 1981, EIA projected that total nuclear generating capacity in the year 2000 would reach 175 Gwe, the level that was used in the earlier CBO report, Financing Radioactive Waste Disposal (September 1982). In late 1981, EIA lowered this estimate to 165 GWe by 2000. The corresponding nuclear capacity projection assumed in this report is only 131 GWe, based on EIA's September

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2. The Department of Energy's most recent report on the fee adequacy does evaluate the waste disposal cost and revenue projections under alternative nuclear electricity generation forecasts, but continues to use the EIA medium-growth scenario as the reference case. Department of Energy, Nuclear Waste Fund Fee Adequacy: An Assessment (July 1984).

1983 medium-growth projection. This represents a 26 percent decrease in the forecast over just a two-year period, and future nuclear capacity forecasts are likely to continue this downward trend.

Projecting future revenues on nuclear reactor units that are not yet operational involves some risk to the solvency of the waste disposal fund, especially given the history of the EIA nuclear-growth revisions and the financial problems facing many nuclear reactors now being constructed. Since the bulk of the construction outlays for the two repositories will not occur until the 1990s, the revenues that are now projected through the early 1990s should earn substantial interest income to finance construction and operating costs in later years. If these expected revenues do not materialize, however, the program might have to be financed by raising the fee significantly. And if the projected costs of the program increase substantially over the next decade while revenues decline, the impact on the program's fiscal solvency would be even greater, requiring earlier and more dramatic fee revisions.

In light of the current status of the nuclear utility industry, it might be prudent for OCRWM to base its revenue projections on the low or no nuclear-growth scenarios, which at this time seem more probable than the medium-growth case. Underestimating future revenue collections involves little financial risk, since it is quite probable that the program cost estimates will increase significantly, more than accounting for unforeseen revenues that might accrue.

Figure 1 shows the pattern of electricity generation that determines how much spent fuel will be produced and how much revenue collected under the alternative growth projections. Fee payments used to finance the two repositories would end when the last of the 144,000 metric tons of spent fuel to be disposed of emerges from the reactors-- between 2018 and 2032, depending on the level of future electricity generation.[3] Under the no-growth case, fee payments would end in 2020 when the last of the 82,000 metric tons of spent fuel would be produced.

Once the spent fuel is removed from the reactor core, it must be cooled for at least five years before it can be placed in a repository. In

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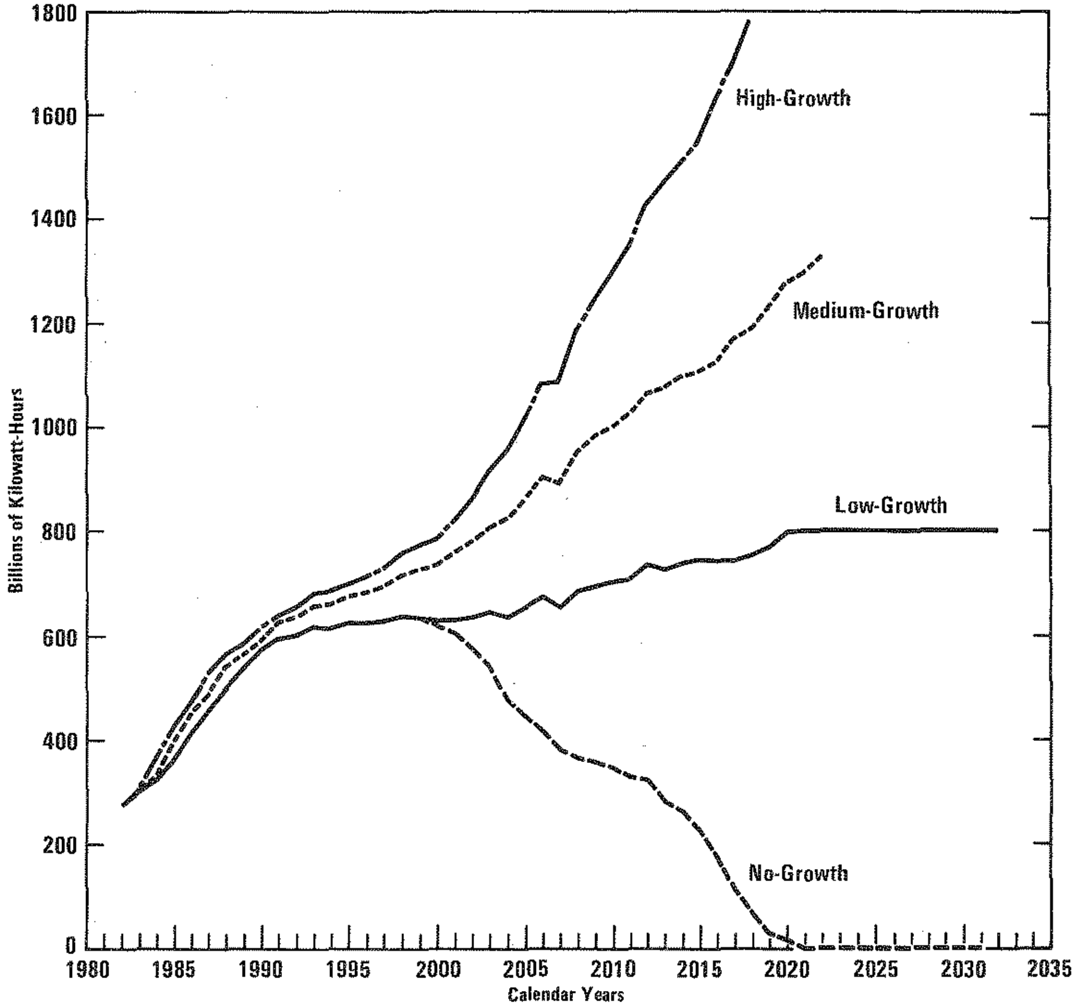
3. This amount includes about 9,300 metric tons of spent fuel generated before April 7, 1983, which will be subject to a one-time fee. Fees collected on nuclear-power generation after the first 144,000 metric tons of spent fuel have been accumulated would be used to build and operate additional repositories. The analysis does not consider the potential costs or need for any additional repositories beyond the first 144,000 tons of spent fuel.

Figure 1.
Annual Nuclear Electricity Generation Under Alternative Scenarios for Nuclear-Power Growth



SOURCE: Congressional Budget Office, based on data from Department of Energy, Energy Information Administration (September 1983).

NOTES: This figure shows the schedule of nuclear electricity generation over the fee collection period for each of the alternative nuclear-growth projections. This report assumes that fees are collected only until the first 144,000 metric tons of spent fuel have been produced, except under the no-growth case. Fees would be levied until 2020 under this growth scenario, since nuclear electricity generation would cease in that year, with a total spent fuel inventory of 82,000 metric tons.

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addition, the maximum waste-receiving rate of each repository is 3,000 metric tons per year, prolonging the disposal of the last of the spent fuel to 2026 to 2037.

The spent fuel inventory of 144,000 metric tons would be produced earliest, in 2018, under high nuclear growth, and the two repositories filled by 2027 (see Table 2). At the other extreme, the low-growth schedule would require fee payments through 2032 and the repositories would not be filled until 2037.

TABLE 2. FINAL FEE COLLECTION YEAR AND REPOSITORY OPERATING SCHEDULES

	High Nuclear Growth	Medium Nuclear Growth	Low Nuclear Growth	No Nuclear Growth
Final Fee Collection Year	2018	2022	2032	2020
Year First Repository Is Filled	2023	2025	2033	2012 a/
Year Second Repository Is Filled	2027	2029	2037	2026 a/

SOURCE: Congressional Budget Office.

NOTES: Fees are collected on the first 144,000 metric tons of spent nuclear fuel that are generated; under the no-growth schedule, fees are collected on the total 82,000 metric tons of spent fuel that would be produced. The operating schedules assume that two 72,000 metric ton capacity repositories are built, which begin to accept wastes in 1998 and 2002. Decommissioning each repository begins the year after it is filled and takes five years to complete.

a. Under no nuclear growth, neither of the two 72,000 metric ton capacity repositories will be filled. The first repository is assumed to close after receiving 39,000 metric tons of spent fuel, and the second repository will contain the remaining 43,000 metric tons.

PROJECTING THE NUCLEAR WASTE FUND BALANCE

In projecting annual trust fund balances, CBO compared annual program costs and revenues, inflated into nominal dollars assuming an inflation rate based on the CBO projections of the gross national product (GNP) implicit price deflator. 4/ The assumption for the long-term inflation rate is 4.3 percent. Excess revenue in any year is used first to pay off previously accumulated debts, including interest penalties compounded annually on the debt. Any subsequent excess revenue is invested in U.S. Treasury securities and the accrued annual interest is added to the fund until the invested revenue is used.

The fund balance in any given year thus reflects the current year's fee collections and outlays and the past years' outstanding balance plus interest payments either owed or earned on that amount. The balance is deflated into constant 1983 dollars by dividing the nominal balance each year by the appropriate compound inflation rate. If the final fund balance (the balance remaining when the second repository is decommissioned) is zero or positive, the fee is considered adequate to cover all program costs. An optimal fee would result in total revenues that exactly match program costs, leaving a final balance of zero.

IS THE CURRENT FEE ADEQUATE TO FINANCE THE REFERENCE PROGRAM COSTS?

Based on current estimates, the fee of 1 mill per kwh would not generate sufficient revenue to finance the waste disposal program unless it is increased to account for inflation. 5/ If the fee remains fixed at 1 mill per kwh, program costs would exceed total revenues by $0.6 billion to $8.5

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4. This report uses the CBO inflation rate forecasts and projections in Congressional Budget Office, The Economic Outlook: A Report to the Senate and House Committees on the Budget--Part I (February 1984).

5. In the Department of Energy report, Nuclear Waste Fund Fee Adequacy: An Assessment (July 1984), the current 1 mill per kwh fee is shown to be insufficient to recover all projected program costs if the annual inflation rate is 3 percent or higher. DOE concludes that the fee may therefore have to be indexed to the rate of inflation some time between 1985 and 2000, again depending on program cost and revenue revisions.

billion, depending on future electricity generation. 6/ An optimal fixed fee of 1.02 (under high growth) to 1.22 mills per kwh (under low growth), however, would provide enough revenues to cover program costs exactly, leaving a final balance of zero in the fund under the different growth scenarios. Alternatively, if the fee is increased each year by the rate of inflation to maintain a real rate of 1 mill per kwh, the fund would have a final balance in excess of $12.9 billion to $45.0 billion from over-collections. Table 3 shows the total revenue and cost projections and final fund balances under the four nuclear-growth forecasts.

Effect of Nuclear Growth Assumptions on the Fund Balance

Assuming a fixed fee of 1 mill per kwh, the high nuclear-growth forecast would generate the greatest revenue ($19.4 billion in 1983 dollars, including interest earnings). High annual electricity generation and fee payments in the early program years would produce higher total real revenues than other options. (The real fee value would decline over time, given the effects of inflation, thus decreasing real revenues under the lower-growth projections.) High nuclear growth would, therefore, result in the smallest program deficit (-$0.6 billion), while the largest deficit (-$8.5 billion) would occur under low nuclear growth (see Table 3).

The no nuclear-growth scenario would generate the lowest total fee payments--$10.7 billion--since less total electricity would be produced. Although program costs would also be lower--$15.3 billion--a fixed rate of 1 mill per kwh would still be insufficient, resulting in a fund deficit of -$5.8 billion by 2031 when the second repository would be completely decommissioned. 7/

Increasing the fee annually by the rate of inflation, beginning in 1984, would generate excessive revenue under any nuclear-growth forecast, assuming that the current program cost projections are reliable (see Table 3). By 2020 the fee would be 4.9 mills per kwh, assuming a long-term inflation rate of 4.3 percent, although the real rate would be 1 mill per kwh. The low nuclear-growth scenario would have the largest final balance, with excess

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6. The fee would fall to 0.20 mills per kwh in real terms by 2020, assuming a long-term inflation rate of 4.3 percent.

7. The two repositories would be closed in 2012 and 2026 under the no-growth projection even though they would not be filled, since no reactors would operate past 2020.

TABLE 3. NUCLEAR WASTE FUND PROJECTIONS UNDER THE REFERENCE PROGRAM SCHEDULE (In billions of 1983 dollars)

	High Nuclear Growth	Medium Nuclear Growth	Low Nuclear Growth	No Nuclear Growth
Fixed Fee of 1 Mill per Kilowatt-Hour				
Total Program Costs	20.0	20.1	20.3	15.3
Total Fee Collections a/	16.2	15.4	14.2	10.7
Net Interest b/	3.2	1.3	-2.4	-1.2
Final Fund Balance	-0.6	-3.4	-8.5	-5.8
Optimal Fee for Zero Final Balance (In mills per kilowatt-hour)	1.02	1.10	1.19	1.22
Fee Increased by Annual Inflation Rate c/				
Total Program Costs	20.0	20.1	20.3	15.3
Total Fee Collections a/	34.8	34.2	34.3	17.7
Net Interest b/	27.1	26.1	31.0	10.5
Final Fund Balance	41.9	40.2	45.0	12.9
Optimal Fee for Zero Final Balance (In mills per kilowatt-hour)	0.5	0.52	0.55	0.72

SOURCE: Congressional Budget Office.

NOTES: The long-term inflation and real interest rate assumptions are 4.3 percent and 3.5 percent, respectively.

a. Total fee collections include the one-time payments made for spent fuel generated before April 7, 1983, estimated at $2.3 billion (in nominal dollars).

b. Net interest includes earnings on invested fund revenues and payments on borrowed funds.

c. This fee design would increase the current fee by the annual percent change in the gross national product price deflator, beginning in 1984. The optimal fee under this schedule refers to the rate the fee should have been set at in 1983 in order to leave a final fund balance of zero.

revenues of $45.0 billion. Since its repository operating and decommissioning schedules would be most prolonged compared to the other nuclear-growth forecasts, its accumulated fund revenue would remain invested longer. Under the no nuclear-growth forecast, the final fund balance would be smallest, but total revenues would still exceed costs by $12.9 billion.

A fee design that results in such excessive fund balances would overcharge the nuclear electric utility ratepayers, who are legally required to pay only for the direct costs associated with the program. If the fee is increased annually by the rate of inflation beginning in 1984, the real (1983) rate should have been originally set at 0.5 to 0.72 mills per kwh, depending on the expected nuclear growth. This fee schedule would leave a zero balance in the trust fund, assuming that projections for the current program costs, revenues, and financial arrangements are correct. Instead of increasing the fee by the annual inflation rate beginning in 1984, the fee could be indexed to inflation at a later date or adjusted only when necessary to account for program cost and revenue revisions and actual inflationary effects. These alternative options for revising the fee to match closely total revenues to projected costs are examined in Chapter IV.

Alternative Repository Design for No Nuclear-Growth Scenario. The no nuclear-growth scenario would leave the two repositories with 62,000 metric tons of unfilled capacity. If nuclear-power growth seems to be following this path and no new reactors are ordered by the early 1990s, the DOE could build two smaller repositories at lower costs than the reference program would entail. Two 42,000 metric ton capacity repositories could be built to contain all the total spent fuel requirements under the no-growth case at a total program cost of $13.5 billion (in 1983 dollars), compared to $15.3 billion under the reference program. 8/

Because the construction costs of this alternative would be almost 40 percent lower, excess revenues that are collected over the next decade could remain invested longer; this would provide extra funds to cover program costs in later years and after the fee payments stop. If the fee was increased annually by the current inflation rate, the final fund balance would be $18.7 billion, compared to $12.9 billion if the full-scale 72,000 repositories were built (see Table 3). In fact, even a fixed fee of 1 mill per

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8. The two smaller-scale repositories would open in 1998 and 2002, as in the reference program. The waste-receiving rate of each repository would be 1,800 metric tons per year, rather than 3,000 metric tons, and the repositories would be decommissioned in 2021 and 2027, respectively. The appendix contains the assumptions and cost components associated with this alternative program.

kwh would be adequate under this alternative program, providing revenues that exactly cover program costs.

Annual Fund Balance Over Time

Since costs are not incurred evenly over the program, fee payments in some years would not cover yearly outlays even if the fee were increased annually by the inflation rate. Figure 2 shows the annual fee collection and outlay schedules, in 1983 dollars, under medium nuclear growth and a fully inflation-increased fee. Annual costs would exceed fee collections until 1985 and after 2022, when the fee payments would cease. But more important, as Figure 2 shows, the fund balance would be positive from 1985 on, ending with excess revenues of $40.2 billion. Although this fee indexing schedule would have to be adjusted to reduce total fee payments, the scenario illustrates the intent of the Nuclear Waste Fund: years of negative cash flow can be supported so long as sufficient revenues are collected to cover total program costs.

Figure 3 projects the fund balance, under medium nuclear growth, both with and without inflation adjustments to the fee. A fully inflation-increased fee would result in a final fund surplus of $40.2 billion, while a fixed fee of 1 mill per kwh would produce a program deficit of -$3.4 billion.

This suggests that the current fee, if not increased over the program's duration, is insufficient to cover current program costs.[9] Alternatively, a fee indexed to the current inflation rate from 1984 on would generate excess revenues of $13 billion to $45 billion. No fee that is set now is likely to match costs exactly with revenues. Thus, efficient fee management depends upon adjustments in response to changes in actual costs, schedules, inflation, and interest rates.

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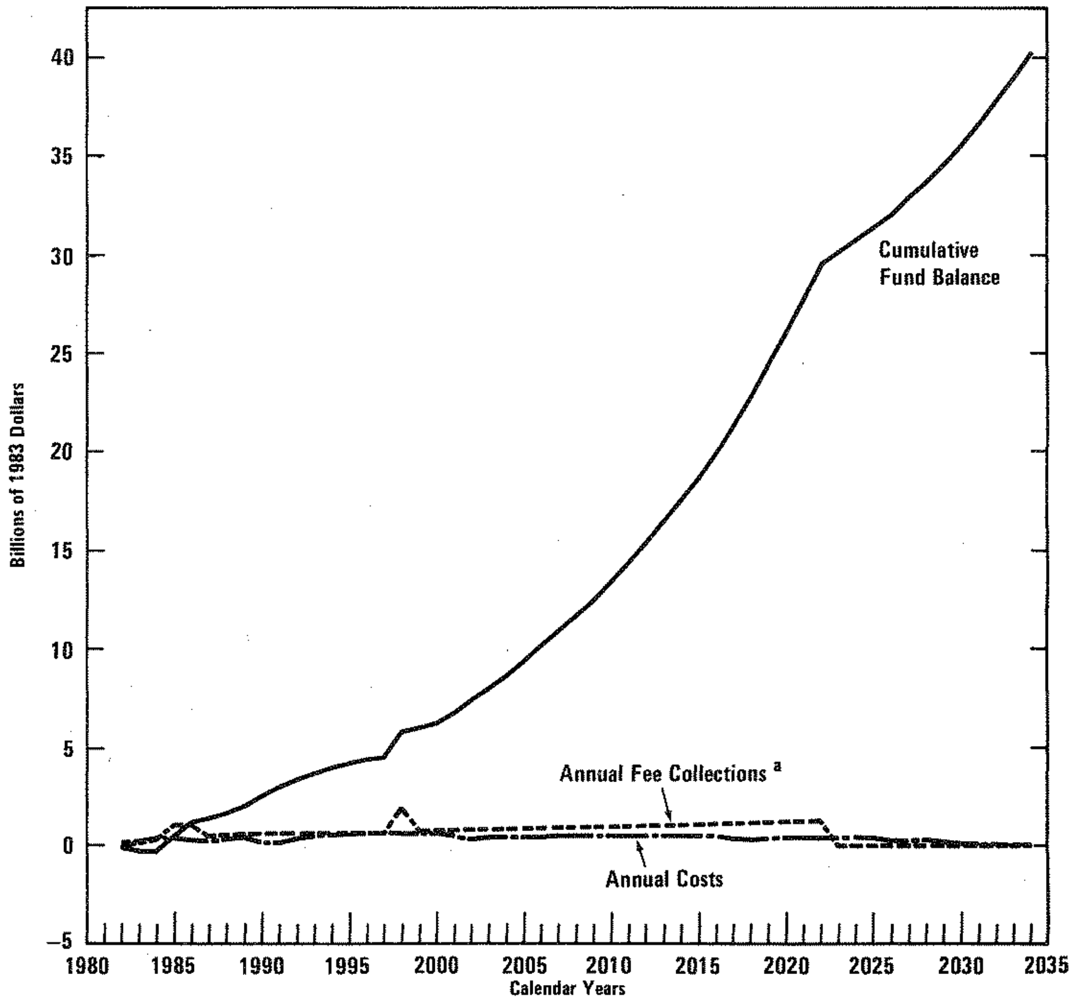
9. If electricity generation follows the no-growth forecast and DOE reduces the repository design capacity to 42,000 metric tons each, a fixed nominal fee of 1 mill per kwh would ensure full cost recovery under current cost estimates.

Figure 2.

Nuclear Waste Fund Projections, Assuming Medium Nuclear-Generated Electricity Growth and a Fee Increased Annually by the Rate of Inflation

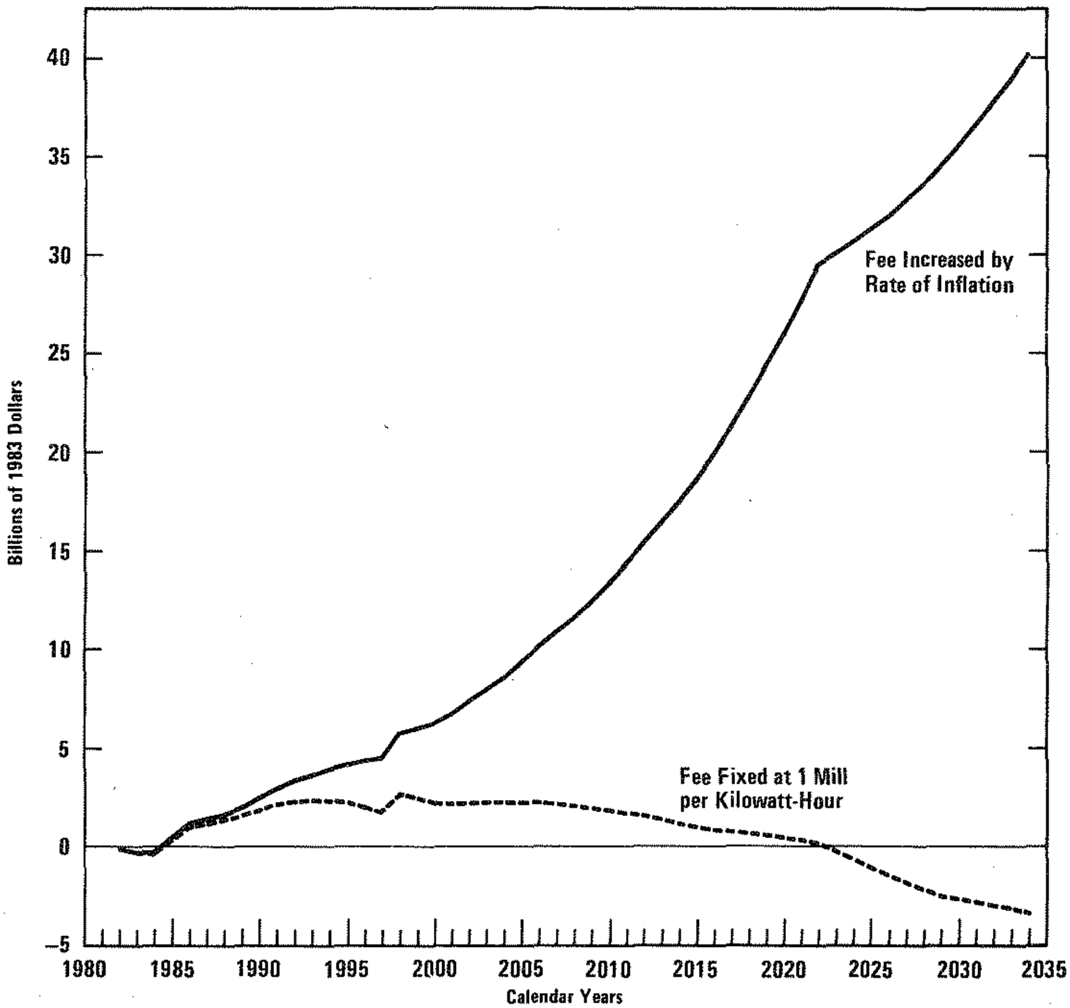


SOURCE: Congressional Budget Office.

NOTES: Annual fee collections do not include interest earned on fund revenue invested in U. S. Treasury bills. Similarly, annual costs do not account for any interest charged on money borrowed from the U.S. Treasury. The cumulative fund balance, however, does reflect interest payments either received or owed on fund investments or borrowings. The long-term inflation and real interest rate assumptions are 4.3 percent and 3.5 percent, respectively.

[a] The large revenue projections in 1984, 1985, and 1988 represent utility payments for the spent fuel inventory that existed prior to April 7, 1983.

Figure 3.
Cumulative Fund Balance Projections Under Alternative Fee Schedules



SOURCE: Congressional Budget Office.

NOTES: The fund balances reflect annual fee collections and outlays and include interest payments on borrowed or invested funds. The projections assume medium nuclear-generated electricity growth, and long-term inflation and real interest rate assumptions of 4.3 percent and 3.5 percent, respectively.

CHAPTER III. THE EFFECT OF ALTERNATIVE ASSUMPTIONS ABOUT THE WASTE DISPOSAL PROGRAM

Changes in program costs or financial assumptions would affect total revenue requirements and thus the appropriate fee charged for nuclear waste disposal. This chapter examines the adequacy of the fee, both at the fixed current rate and increased for inflation, under four alternative assumptions:

- Delays in the repository siting and construction schedules, requiring the development of temporary storage facilities;

- Project cost overruns;

- Higher inflation rates; and

- Alternative real interest rates.

As discussed earlier, maintaining the current 1 mill per kilowatt-hour rate would not generate enough revenues to finance projected costs under current inflationary expectations. Higher program costs or inflation rates would exacerbate the projected deficits, as would lower interest rates. Delays in the repository schedules would also result in a program deficit, although the final balance would not necessarily be lower than it would be with scheduled completion. (With delays, outlays would be spent more slowly and more interest would be earned on unused revenues.) Alternatively, higher interest rates would provide additional revenues through increased interest earnings. In fact, under several delayed repository scenarios, a fixed fee would be adequate to cover costs under higher interest rate assumptions.

If the fee is increased fully for inflation beginning in 1984, revenues could finance program cost overruns of between 30 percent and 80 percent, depending on nuclear-growth assumptions. The inflation-increased fee structure would also be more than adequate to cover delays under most assumptions about repository schedules, and again could produce even higher balances in the Nuclear Waste Fund than the reference program. Higher than projected rates of inflation would not affect the final fund balances significantly, since the inflation-increased fee structure would account for the increased program costs. Higher real interest rates, however, would increase the fund's balance because of the effect on interest income, while lower interest rates would decrease total revenues, although all program costs could still be fully recovered.

HOW DELAYS COULD AFFECT THE PROGRAM

In the latest draft Mission Plan report (April 1984), the Department of Energy confirms that its reference program calling for an operating repository by 1998 is "aggressive but achievable," and that "the potential for schedule delays is significant." 1/ If both repositories open three to ten years behind schedule, total costs could exceed revenues by $2.2 billion to $13.7 billion if the fee remains at its current rate, but revenues would more than cover projected outlays if the fee is fully increased for inflation. This section discusses several delayed repository schedules and the effects on the program's solvency, assuming that a temporary storage facility is built to store the utilities' spent fuel until the repositories are opened.

Facilities for Temporary Monitored Retrievable Storage

Current DOE contracts with commercial nuclear utilities call for disposal to begin in 1998. Although the Office of Civilian Radioactive Waste Management is committed to meeting this goal, the DOE draft Mission Plan of April 1984 outlines several phases in the repository schedule that could delay the 1998 opening date. These include more extensive site testing requirements, state and local government opposition to proposed repository sites, and delays in obtaining licensing and permit approvals.

If delays do occur in repository construction, the DOE intends nevertheless to meet its obligation to begin accepting civilian radioactive spent fuel in 1998. It would possibly do so by constructing an above-ground monitored retrievable storage (MRS) facility, financed by the Nuclear Waste Fund, to provide backup storage for spent nuclear fuel. 2/ An MRS facility

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1. In fact, DOE has already proposed changes in the reference program. The revised reference program assumes that the amount of spent fuel that the first repository will accept between 1998 and 2002 will be 5,100 metric tons less than previously planned. It also delays the opening of the second repository three years, to 2005. See U.S. Department of Energy, Mission Plan for the Civilian Radioactive Waste Management Program, Volume I: Overview and Current Program Plans, Draft Report (April 1984).

2. Since all nuclear utilities pay into the Nuclear Waste Fund that would finance the MRS concept, MRS should not be used as a federal interim storage facility to serve only a few utilities. The NWPA established a second fund to provide federal interim storage to utilities which run short of storage for spent nuclear fuel before 1998. If an MRS facility is designed for interim storage before 1998 and then used as a backup repository beginning in 1998, part of its funding should come out of this separate fund.

would store spent nuclear fuel and other high-level radioactive waste under continuous monitoring and maintenance, until a repository was ready to accept the waste for permanent disposal.

In 1984, the Congress appropriated $12 million from the fund to develop alternative MRS designs. The DOE selected sealed storage casks as the optimal MRS design, with the field drywell concept as an alternative, and will present a detailed description of both in the MRS proposal due to the Congress by June 1, 1985.[3] The Congress then will decide whether to authorize the construction of one or more MRS facilities, depending on if and how long the repository schedule is expected to be delayed. Three delayed repository schedules are discussed below; all assume the sealed cask method of storage is used.

Three-Year Delay Under Medium Nuclear Growth. This scenario assumes that both repositories open three years behind schedule--in 2001 and 2005, respectively.[4] This delay could result from minor slippages in the siting and licensing phases of the repository development or from state and local opposition to the site selection decisions.

As a result of the delay, this analysis assumes that the DOE requests and the Congress authorizes the construction of an MRS facility with a capacity of 15,000 metric tons. From 1998 through 2000, this sealed storage cask facility would accept 5,400 metric tons of spent nuclear fuel at a rate of 1,800 metric tons per year. The accumulated waste would be stored at the MRS facility until 2010 and then transferred to the repositories at the same rate. The MRS facility would be fully decommissioned by 2017 and the two repositories would be decommissioned in 2027 and 2031.

Ten-Year Delay Under Medium Nuclear Growth. This alternative assumes that the two repositories open ten years behind schedule, in 2008 and 2012, respectively, because of licensing and construction delays. To meet the spent fuel disposal schedule that would have occurred if the

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3. The sealed storage cask would store wastes in above-ground containers (similar to the silo design), built of either concrete or metal (lead, steel, and ductile iron). The field drywell would consist of cylindrical holes drilled into the ground into which sealed metal canisters containing the waste packages would be inserted.

4. In fact, the April 1984 draft Mission Plan delays the opening of the second repository three years, until 2005. It maintains the 1998 opening date for the first repository; the amount of waste that it will accept in the first five years, however, is decreased.

repositories opened on schedule, a 72,000 metric ton MRS facility would be constructed. The MRS facility would accept 3,000 metric tons of spent fuel per year from 1998 to 2016. Beginning in 2018, the spent fuel would be transferred to the repositories at the same rate of 3,000 metric tons a year, and the MRS facility would be decommissioned by 2041. Under this schedule, the two repositories would be fully decommissioned by 2037 and 2042.

Ten-Year Delay Under No Nuclear Growth. Again, the two repositories are delayed for ten years, until 2008 and 2012. In response to the smaller amount of spent nuclear fuel produced under no nuclear growth, the planned capacities of the two repositories would be reduced to 42,000 metric tons each. A ten-year delay in the repository construction schedule would allow the DOE to assess more reliably the future of the nuclear power industry and storage requirements for spent nuclear fuel. This additional assessment period would permit the DOE to reduce the combined capacity to 84,000 metric tons.

A ten-year delay under no nuclear growth would require an MRS facility of 30,000 metric tons to allow the DOE to maintain its spent fuel shipments according to the disposal schedule of the reference program. It would accept 1,800 metric tons of spent nuclear fuel in both 1998 and 1999 and 3,000 metric tons annually from 2000 through 2008, when the first repository would open. The spent fuel would then be transferred to the repository at a rate of 1,800 metric tons per year from 2015 to 2019 and 3,000 metric tons annually from 2020 through 2026. The MRS facility would be fully decommissioned by 2030 and the two repositories filled by 2023 and 2028, with the final decommissioning completed in 2032.

Effects of Delays on Costs

If no additional activities such as an MRS facility were financed, a delay in the repository schedule probably would result in a larger final fund balance, since delaying the construction and operating outlays would allow unused revenues to remain invested over a longer period. But the additional costs of an MRS facility could negate these savings, depending on the size of the facility and the number of years it would have to be maintained. The MRS cost estimates used in this analysis were derived from two DOE reports on alternative MRS designs.[5] Table 4 provides the cost assumptions for

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5. At this time, these cost figures are intended only to indicate the likely magnitude of the outlays that an MRS facility would require. The MRS cost estimates are based on: Battelle Pacific Northwest (Continued)

TABLE 4. COST PROJECTIONS FOR AN MRS FACILITY UNDER ALTERNATIVE REPOSITORY DELAY SCHEDULES (In millions of 1983 dollars) a/

Costs	15,000 Metric Ton MRS (3-Year Repository Delay Medium Growth)	30,000 Metric Ton MRS (10-Year Repository Delay No Growth)	72,000 Metric Ton MRS (10-Year Repository Delay Medium Growth)
Construction Costs	323	841	2,202
Operating Costs			
Waste loading and unloading b/	180	923	1,710
Waste storage only c/	20	30	5
Transportation Costs for Shipping Waste to the MRS d/	161	894	1,699
Decommissioning	25	67	176
Total Costs	709	2,755	5,791

SOURCE: Congressional Budget Office, based on cost estimates from Battelle Pacific Northwest Laboratory, "Comparison of Cask and Drywell Storage Concepts for a Monitored Retrievable Storage/Interim Storage System," prepared for the U.S. Department of Energy under contract number DE-AC06-76RLO 1830 (December 1982); and a Battelle Pacific Northwest Laboratory Draft Report, "Monitored Retrievable Storage Conceptual System Study: Concept Normalization Summery Report," prepared for the U.S. Department of Energy under contract number DE-AC06-76RLO 1830 (October 1983).

a. All scenarios assume the sealed storage cask design is used.

b. The waste loading and unloading costs apply in the years when the MRS facility is either receiving spent nuclear fuel from the nuclear utilities or unloading the spent fuel to ship it to the repositories for permanent disposal. Annual operating costs are $30 million and $45 million for a waste-handling rate of 1,800 and 3,000 metric tons per year, respectively.

c. The waste storage costs cover maintaining and monitoring the spent fuel in the MRS facility; the costs do not apply in the waste loading and unloading years. The annual storage costs are $5 million. The 72,000 metric ton capacity MRS would only have one year in which wastes were being stored and not loaded or unloaded, while the 30,000 metric ton facility would have to store its waste inventory for six years before unloading it to a repository.

d. The fund would also finance transferring the spent fuel from the MRS facility to the repositories. This would cost approximately $10.4 million per thousand metric tons of spent fuel shipped.

the three MRS facilities. Total MRS costs range from about $700 million for the three-year delay schedule to nearly $6 billion for a ten-year delay scenario, both assuming medium growth. 6/

Like the reference program schedules, the current fee of 1 mill per kwh would not ensure sufficient revenues to cover repository delays and MRS-related costs unless it was increased for inflation. Table 5 shows the final balances for the delayed repository programs compared to the reference schedule (no delay) programs.

If the fee is increased annually by the inflation rate beginning in 1984, a substantial positive fund balance would remain after the second repository was decommissioned. In fact, the three delayed scenarios would produce higher balances at the end of the program than would result under the respective reference schedules, because the revenues generated by the inflation-increased fee would earn interest longer.

Alternatively, if the fee remained at its current rate over the life of the program, a ten-year delay in the repository schedule under medium growth would result in a $10.3 billion lower balance than the reference program--for a total program deficit of -$13.7 billion--because of the large costs of the 72,000 metric ton MRS facility. The three-year program delay under medium growth and the ten-year delay under no growth would have deficits of -$2.2 billion and -$3.7 billion, respectively, but these deficits would be lower than those of the reference programs--again because of the delays in the repository-related outlays and the increased interest earnings.

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5. (Continued)
Laboratory, "Monitored Retrievable Storage Conceptual System Study: Concept Normalization Summary Report," prepared for the DOE under Contract DE-AC06-76 RLO 1830, Draft Report (October 1983); and Battelle Pacific Northwest Laboratory, "Comparison of Cask and Drywell Storage Concepts for a Monitored Retrievable Storage/Interim Storage System," prepared for the DOE under Contract DE-AC06-76 RLO 1830 (December 1982).

6. This analysis assumes that the delayed program development costs are 25 percent higher than those of the reference program. The development costs include the repository siting, licensing, testing, and demonstration costs. The construction and operating costs of the delayed repositories, however, equal those of the reference schedule (in 1983 dollars).

TABLE 5. FINAL NUCLEAR WASTE FUND BALANCES UNDER ALTERNATIVE REPOSITORY DELAY SCHEDULES AND ALTERNATIVE FEES (In billions of 1983 dollars)

	Medium Nuclear Growth			No Nuclear Growth a/	
	No Delay	Three-Year Delay	Ten-Year Delay	No Delay	Ten-Year Delay
Fixed Nominal Fee					
Final Balance	-3.4	-2.2	-13.7	-5.8	-3.7
Net Interest b/	1.3	3.1	-2.7	-1.2	2.6
Fee Increased by Annual Inflation Rate c/					
Final Balance	40.2	42.9	43.1	12.9	15.6
Net Interest b/	26.1	29.4	35.3	10.5	14.9
Total Costs	20.1	20.7	26.4	15.3	17.0

SOURCE: Congressional Budget Office.

NOTES: Under the medium nuclear-growth forecast, the three-year delayed repository program requires a 15,000 metric ton MRS facility and the ten-year delay requires a 72,000 metric ton MRS facility. Under the no nuclear-growth forecast, the ten-year delayed program requires a 30,000 metric ton MRS facility. The total cost figures do not include interest payments on funds borrowed from the U.S. Treasury. The final balances, however, do reflect interest payments either received or owed on fund investments or borrowings. The long-term inflation and real interest rate assumptions are 4.3 percent and 3.5 percent, respectively.

a. The nondelayed program assumes that two 72,000 metric ton capacity repositories are built. The ten-year delay schedule, however, assumes two smaller-scale 42,000 metric ton repositories, since DOE would have a longer period over which to base the expected spent fuel storage requirements.

b. Net interest includes earnings on invested fund revenues and payments on borrowed funds.

c. These final balance projections assume that the fee is increased annually by the percentage change in the GNP implicit price deflator beginning in 1984.

It is important to stress that the MRS program would also require licensing expenses and financial aid to state and local governments and Indian tribes affected by an MRS facility. These and any additional development costs that the OCRWM does not account for in its current research and program development budget would add to the total cost requirements of a delayed program. Thus, the final balances projected for the three delayed repository programs probably underestimate actual total outlays.

These results indicate that the financial implications of delays in the repository schedule are not significant, and in some cases, may even result in net savings. Therefore, while the DOE must attempt to meet the 1998 repository completion deadline specified in the utility waste disposal contracts and the Nuclear Waste Policy Act, failing to do so would not necessarily require larger fee revisions than needed under the reference program, unless the current cost projections are raised substantially.

An Alternative to MRS: Increasing the Capacity to Store Spent Fuel at Reactor Sites

Until the repositories are ready to accept fuel shipments, all commercial nuclear utilities must store their spent fuel in facilities at the reactor sites. If the repository deployment schedule is delayed past 1998, the spent fuel could be kept at the reactor sites as an alternative to developing a large-scale centralized MRS facility. The advantages of using on-site storage rather than developing an MRS facility are twofold:

- To eliminate safety risks associated with shipping spent fuel to an MRS facility. Using and increasing on-site storage would eliminate the intermediate shipping and unloading/repackaging steps required to transfer spent fuel from reactor on-site storage to a central MRS location. The NWPA requires the OCRWM to minimize the transfer of spent nuclear fuel to reduce public exposure to high-level radioactive wastes.

- To reduce overall costs of the waste disposal program. By eliminating the costs of designing, building, operating, and decommissioning an MRS facility, providing storage on a reactor-by-reactor basis could substantially reduce the outlay requirements from the trust fund. Providing additional on-site storage facilities probably would cost less than constructing large MRS waste-receiving, packaging, and storage facilities. Furthermore, the additional transportation costs associated with an MRS facility would be eliminated.

The DOE is now carrying out cooperative demonstration programs with several utilities facing imminent storage shortages for spent fuel. These demonstrations provide technical and financial assistance to (1) increase the efficient use of existing storage facilities through consolidating spent fuel rods, and (2) develop alternative dry storage technologies, including both storage cask and drywell designs, for licensing at commercial reactor sites. Since these dry storage methods have been selected as the preferred MRS designs, the DOE could incorporate these on-site facilities into the overall waste management system by using them instead of an MRS facility. This report did not project spent fuel inventories and the associated on-site storage costs on a reactor-by-reactor basis. It seems quite probable, however, that this alternative to MRS would reduce total program expenses, especially since the additional MRS-related transportation and licensing costs would be eliminated. 7/

PROJECT COST OVERRUNS

The OCRWM must estimate the various program costs it will incur in order to determine if the current fee will provide sufficient revenues to cover these future costs. It is unrealistic, however, to expect actual costs to mirror these current projections, especially since the program will span 40 to 50 years. The DOE's draft Mission Plan of April 1984 stresses the uncertainty of the cost projections by noting, "As new and more refined information becomes available, repository designs will be modified and cost estimates will be adjusted." Thus, it is important to evaluate the current fee's adequacy in light of probable program cost revisions.

Under the current OCRWM reference program, construction of the first repository would not start until 1993, with the bulk of the construction outlays occurring in the mid- to late 1990s. The cost projections of these future outlays almost certainly underestimate the actual costs of building the two repositories, especially since no repository of this size or design has ever been built. Furthermore, the program is still in the repository

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7. Under this arrangement, the DOE could take over the management of the dry storage facilities already existing at reactor sites in 1998, and continue to store spent fuel inventories until a repository opened. The DOE could reimburse the utilities on a prorated basis for their construction costs for the dry storage facilities, since these would serve as alternatives to MRS. The DOE would also provide any additional dry storage capacity needed at reactor sites until a repository is operable, using fund revenues to construct and maintain the on-site facilities.

development and siting phase, and costs are likely to increase substantially as the testing, licensing, and construction phases proceed. It is conceivable that actual program costs could exceed projections by up to 100 percent or more. [8] Instead of estimating the likelihood of a single cost overrun of a certain percentage, this analysis projects by how much actual costs could exceed current estimates and still be financed by projected revenues. To estimate the effect of a specific cost overrun, the analysis multiplied annual costs by the same percentage increase in every year.

Since the fixed 1 mill per kwh fee was shown to be insufficient under current cost projections for all nuclear-growth scenarios, it would also fall short of covering any cost overruns. Increasing the fee each year by the rate of inflation, however, would provide some insurance that actual program costs would be covered even if they grew significantly (see Table 6). For example, if the repositories open on schedule in 1998 and 2002, costs could exceed current estimates by 30 percent under no nuclear growth and by 75 percent under medium nuclear growth and still be covered by revenues (see Columns 1 and 4 of Table 6). If the repositories open three to ten years behind schedule and an MRS facility is built, costs could exceed projected levels by 37 percent to 78 percent without requiring further increases in the fee beyond indexing for inflation.

The fee will have to be increased eventually to cover all program costs even without any cost overruns, given current estimates. The likelihood of revised and increased cost estimates suggests that the fee may have to be increased either earlier or more substantially than the current cost projections suggest. If the fee is increased annually by the current rate of inflation beginning in 1984, resulting revenues could finance from 30 percent to 78 percent more outlays than the current costs predict, thus covering all contingencies discussed above. Increases of this magnitude are not at all unlikely.

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8. The DOE "Report on Financing the Disposal of Commercial Spent Nuclear Fuel and Processed High-Level Radioactive Waste" concedes that "the history of past major projects of this magnitude has demonstrated that the potential for unanticipated cost increases is very high . . . actual costs of technology-intensive programs often exceed initial estimates by a large amount." In the earlier CBO study, two reports by the Rand and Mitre Corporations were used to determine a plausible worst-case cost overrun factor of 160 percent for the entire program. Merrow, Phillips, and Myers, Understanding Cost Growth and Performance Shortfalls in Pioneer Process Plants (The Rand Corporation, September 1981); and The Mitre Corporation, Analysis of Nuclear Waste Disposal and Strategies for Facilities Deployment (April 1980).

TABLE 6. ALLOWANCES FOR COST OVERRUNS ASSUMING THE FEE IS FULLY INCREASED BY THE ANNUAL INFLATION RATE BEGINNING IN 1984 a/

	Medium Nuclear Growth			No Nuclear Growth b/	
	No Delay	Three-Year Delay	Ten-Year Delay	No Delay	Ten-Year Delay
Final Fund Balance (In billions of 1983 dollars)	40.2	42.9	43.1	12.9	15.6
Maximum Allowable Cost Overrun (In percents) c/	75	78	55	30	37

SOURCE: Congressional Budget Office.

NOTES: Under the medium nuclear-growth forecast, the three-year delayed repository program requires a 15,000 metric ton MRS facility and the ten-year delay requires a 72,000 metric ton MRS facility. Under the no nuclear-growth forecast, the ten-year delayed program requires a 30,000 metric ton MRS facility.

a. The inflation rate is the percentage change in the GNP implicit price inflator.

b. The nondelayed program assumes that two 72,000 metric ton capacity repositories are built. The ten-year delay schedule, however, assumes two smaller-scale 42,000 metric ton repositories, since DOE would have a longer period over which to base the total expected spent fuel storage requirements.

c. The maximum allowable cost overrun factor is the maximum percent by which actual costs could exceed current projections and still be completely covered by revenues.

ALTERNATIVE INFLATION RATE ASSUMPTIONS

The rate of inflation will influence the solvency of the waste disposal program, affecting both future costs and revenues. High inflation rates would increase projected costs, because of inflated price levels in the economy, and would decrease the value of revenue receipts if the fee remains fixed at 1 mill per kwh, since its real rate would decline with inflation. If the annual fee increases by the current rate of inflation, however, real revenues would not be affected by inflation.

The fund balance in nominal dollars, reflecting annual revenues and costs and interest payments levied or earned on any funds, is deflated (by the GNP deflator) to constant 1983 dollars to enable comparisons of the fund balances between the different programs. The GNP deflator projection rises from 4.2 percent in 1983 to 5.1 percent in 1985, and then decreases to 4.3 percent by 1989, the assumed long-term rate.

If inflation rises by more than the CBO February 1984 projection, the costs of the waste disposal program would be higher than current reference program projections described in Chapter 1. Table 7 shows the final fund balances assuming a long-term inflation rate of 6.3 percent per year after 1988. 9/ This corresponds to CBO's high-growth alternative contained in its February 1984 projections. 10/ The table shows the projected fund balances assuming either that the fee remains at 1 mill per kwh or that the fee increases by the annual inflation rate beginning in 1984.

If the fee is annually adjusted for inflation, both fee payments and costs would be affected similarly by higher inflation, and the resulting final fund balances would be only slightly lower than under the reference inflation rate. (This difference results from a decrease in the real value of payments made on "old" spent fuel in 1985 and 1986, which this analysis assumes are made without incurring interest penalties.) Assuming medium nuclear growth and no delays, the fund balance would be $39.3 billion if the long-term rate of inflation is 6.3 percent, compared to $40.2 billion if the inflation rate is 4.3 percent (see Table 5 for comparisons). Under this fee design, the rate charged on nuclear-generated electricity would be 9 mills per kwh in 2020.

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9. This analysis maintains the long-term real interest rate assumption of 3.5 percent.

10. Congressional Budget Office, The Economic Outlook: A Report to the Senate and House Committees on the Budget--Part I (February 1984).

TABLE 7. FINAL NUCLEAR WASTE FUND BALANCES UNDER HIGH INFLATION RATE ASSUMPTIONS AND ALTERNATIVE FEES (In billions of 1983 dollars)

	Medium Nuclear Growth			No Nuclear Growth a/	
Fee	No Delay	Three-Year Delay	Ten-Year Delay	No Delay	Ten-Year Delay
Fixed Nominal Fee	-10.6	-9.7	-23.0	-9.2	-7.4
Fee Increased by Annual Inflation Rate b/	39.3	41.9	41.7	12.4	15.0

SOURCE: Congressional Budget Office.

NOTES: Under the medium nuclear-growth forecast, the three-year delayed repository program requires a 15,000 metric ton MRS facility and the ten-year delay requires a 72,000 metric ton MRS facility. Under the no nuclear-growth forecast, the ten-year delayed program requires a 30,000 metric ton MRS facility. The final fund balance reflects interest payments either received or owed on fund investments or borrowings. The long-term inflation and real interest rate assumptions are 6.3 percent and 3.5 percent, respectively.

a. The nondelayed program assumes that two 72,000 metric ton capacity repositories are built. The ten-year delay schedule, however, assumes two smaller-scale 42,000 metric ton repositories, since DOE would have a longer period over which to base the total expected spent fuel storage requirements.

b. These final balance projections assume that the fee is increased annually by the percentage change in the GNP implicit price deflator beginning in 1984.

If the fee is not increased over the collection period, the fund deficit could be as high as -$23 billion, assuming medium nuclear growth and a ten-year repository delay, compared to a -$14 billion deficit under the reference inflation assumptions. Unless the fee is increased for inflation, higher inflation would increase program costs and decrease the fee in real dollars, resulting in large program deficits under all growth scenarios and repository schedules.

ALTERNATIVE INTEREST RATE ASSUMPTIONS

Interest rates are an important factor in the OCRWM's fiscal management of the Nuclear Waste Fund, affecting the fund's balance in two ways. Interest can be earned on excess revenues not needed to finance immediate costs, and interest penalties must eventually be paid from the fund for money borrowed to cover outlays that exceed accumulated revenues. Net interest (total interest earnings less interest payments) can account for a substantial part of total revenues or outlays, particularly revenues if the fee is increased every year by the current inflation rate. For example, under medium nuclear growth and a ten-year delay in the repository schedules, total revenue would be $69.5 billion and interest earnings would account for over half of this, or $35.3 billion (see Table 5).

The Nuclear Waste Policy Act specifies that the Secretary of the Treasury will determine the appropriate interest rate on fund investments or borrowings. This analysis assumes a rate based on the CBO's projections of the 91-day Treasury bill rate. The CBO baseline economic outlook (February 1984) projects this rate at 8.6 percent and 7.8 percent in 1985 and 1989, respectively, equal to a 3.5 percent real rate after subtracting projected inflation from the nominal rate. The long-term real rate was assumed to remain at 3.5 percent over the program's duration.

To examine how sensitive the fund's solvency is to interest rates, annual interest rate projections were increased and decreased by 1 percent, compared to the baseline assumption. The fund balances then were projected for both a fixed fee and a fee increased for inflation each year (see Table 8).

If the long-term real interest rate averages 4.5 percent per year, compared to the baseline 3.5 percent projection, increased interest earnings would offset higher interest penalties, resulting in greater fund balances under both a fixed and inflation-increased fee design. The increase in total revenues would be substantial if the fee were adjusted for inflation beginning in 1984: under medium nuclear growth assuming a ten-year repository delay, total revenues would exceed costs by $68.2 billion,

TABLE 8. FINAL NUCLEAR WASTE FUND BALANCES UNDER ALTERNATIVE REAL INTEREST RATES AND ALTERNATIVE FEES (In billions of 1983 dollars)

Fee	Medium Nuclear Growth			No Nuclear Growth a/	
	No Delay	Three-Year Delay	Ten-Year Delay	No Delay	Ten-Year Delay
High Real Interest Rate Assumptions					
Fixed Nominal Fee	-0.6	2.1	-10.7	-4.8	0.1
Fee Increased by Annual Inflation Rate b/	55.6	60.7	68.2	20.1	26.1
Low Real Interest Rate Assumptions					
Fixed Nominal Fee	-4.6	-4.3	-14.0	-5.8	-5.6
Fee Increased by Annual Inflation Rate b/	29.5	30.6	27.1	8.2	8.8

SOURCE: Congressional Budget Office.

NOTES: The fund balances under higher interest rate projections assume a long-term real annual rate of 4.5 percent compared to 3.5 percent under the reference interest rate assumptions. Alternatively, the lower interest rate projections assume a long-term real annual rate of only 2.5 percent.

Under the medium nuclear-growth forecast, the three-year delayed repository program requires a 15,000 metric ton MRS facility and the ten-year delay requires a 72,000 metric ton MRS facility. Under the no nuclear-growth forecast, the ten-year delayed program requires a 30,000 metric ton MRS facility. The final fund balance reflects interest payments either received or owed on fund investments or borrowings. The long-term inflation rate assumption is 4.3 percent.

a. The nondelayed program assumes that two 72,000 metric ton capacity repositories are built. The ten-year delay schedule, however, assumes two smaller-scale 42,000 metric ton repositories, since DOE would have a longer period over which to base the total expected spent fuel storage requirements.

b. These final balance projections assume that the fee is increased annually by the percentage change in the GNP implicit price deflator beginning in 1984.

compared to $43.1 billion under the baseline interest rate projection. Even if the fee remains at its 1 mill per kwh rate, a 1 percentage point increase over the current interest rate projections could increase total revenues by $4 billion, resulting in positive final fund balances under medium and no growth if the repository schedules were delayed three and ten years, respectively.

Alternatively, lower real interest rates (2.5 percent per year) would negatively affect projected revenues, resulting in lower final fund balances for all program scenarios. If the fee stays at its current rate over the program's duration, total costs would exceed revenues by $4.3 billion to $14 billion, while a fully inflation-increased fee would provide excess revenues of $8.2 billion to $30.6 billion.

CHAPTER IV. FUND MANAGEMENT ISSUES: OPTIONS FOR FEE ADJUSTMENTS AND IMPLICATIONS OF FUND LENDING

The responsibilities of the Office of Civilian Radioactive Waste Management include handling all finances of the nuclear waste disposal program, ensuring an equal balance between total program costs and revenues from a correctly set fee, and guaranteeing the proper spending of the collected revenues. Chapters II and III examined the adequacy of the current fee to finance the OCRWM's reference program, and evaluated the effects of uncertainties associated with the current cost and revenue projections. The results suggest that the 1 mill per kilowatt-hour fee will have to be increased at some point, although not necessarily in the immediate future. This chapter presents current policy and two options for revising the fee and discusses the implications of the different designs to adjust fees.

A related issue of proper fund management concerns the appropriate use of the fees that are collected from the utilities. The Nuclear Waste Policy Act requires the OCRWM to use the fees to fund only activities of the waste disposal program. Although the NWPA requires that all excess fund revenues be invested in U.S. Treasury securities until needed for future outlays, other federal programs have allowed trust fund monies to be diverted to other activities.[1] This chapter, therefore, also examines the effects on the fund's solvency if lending was permitted.

THE CURRENT APPROACH TO FEE REVISION

It is almost inevitable that the projected schedules for costs and nuclear-generated electricity will change because of cost growth and program modifications. The NWPA, therefore, included provisions for altering the fee to ensure that the program remains solvent. Each year the OCRWM must review its future outlay and receipt schedules and determine whether the current fee is still appropriate. If it appears that projected revenues will either exceed or fall short of total costs, the OCRWM must request Congressional approval for a fee change. Although this approach

1. Specifically, funds are borrowed between the Old-Age and Survivors Insurance (OASI), the Disability Insurance (DI), and the Health Insurance (HI) Trust Funds under the Social Security system.

could allow the fee to match closely actual program costs, it also allows the Department of Energy (DOE) full responsibility to propose the timing and magnitude of fee revisions.

This latitude could raise two kinds of difficulties for the Congress. Frequent requests by the DOE for fee changes could force the Congress to choose between a speedy decision, which would give time for the program managers and the electric utilities to react to the fee change, and a more deliberate decision, which could lead to administrative difficulties as the DOE and the utilities attempted to react to fee changes on short notice. Conversely, the DOE could propose fee changes too infrequently, possibly leading to large and unpalatable increases in the fee and electricity rates. These potential problems have prompted Congressional consideration of ways to restrict some of the DOE's discretion to modify the fee. 2/

ALTERNATIVE DESIGNS FOR FEE ADJUSTMENT

If the Congress wishes to reduce DOE's discretion to determine the timing and magnitude of requested fee changes, it could consider the following options:

- Increase the Fee Only at Specific Intervals. Rather than continuing annual reviews and revisions, the Congress could amend the NWPA so that the fee would be adjusted only at specific intervals. This would limit fee revisions more than current policy, but it could subsequently result in large rate jumps if cost or revenue projections change significantly.

- Automatically Adjust the Fee Through Indexation. The Congress could maintain the real rate of the fee at 1 mill per kwh by amending the NWPA to index the fee to some measure of inflation. Annually increasing the fee's nominal rate would account for the effects of inflation on program costs and revenues and would also provide insurance for probable cost overruns. The amendment to the NWPA proposed by the Subcommittee on Rules

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2. For example, Mr. Moakley, Chairman of the House Subcommittee on Rules, proposed a bill to amend the Nuclear Waste Policy Act of 1982 (H.R. 4690) on January 31, 1984. The amendment would index the fee to the Department of Commerce's Composite Cost Index as soon as the Nuclear Regulatory Commission approves the DOE's application for a full construction authorization for the first repository. (The DOE now expects to obtain this permit in August 1993.)

of the House (H.R. 4690, January 1984) specifies the Composite Cost Index, published by the Department of Commerce, as the measure of inflation by which the fee would be automatically adjusted.

Multi-Year Increases in the Fee

The Congress could restructure the fee revision process so that the rate could be adjusted only at multi-year intervals--periods of three and five years are the options now under discussion. 3/ The appropriate length of the interval between fee revisions depends on the probable need for higher fees, based on the perceived uncertainty in the current cost and revenue projections.

As the program develops and becomes better defined, the costs of certain program activities are likely to change. These include many cost components that are specifically related to the repository site: "site characterization" (thorough testing of proposed repository locations), repository design and construction, waste preparation and facility operation, and fuel shipments. The costs of these program phases can be estimated only roughly until the exact design and location of each repository has been selected. Furthermore, the degree of state and local opposition to proposed repository sites cannot be foreseen; such opposition could delay the program and increase costs considerably. Since there is a good chance that program costs will change substantially until the first repository is built and operating, it might be appropriate for the DOE to be able to propose fee revisions at least every three years during this period.

Permitting fee revisions every three years while the program is still in the siting, design, and construction stages would probably result in fairly modest adjustments each period. It would also ensure that the fee would reflect major program changes relatively quickly. A three-year fee interval would coincide with the three-year budget request that the OCRWM submits to the Office of Management and Budget. 4/ Since this request would be based on cost projections that should be fairly reliable, it might be efficient to set the fee for a three-year period also.

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3. The House Subcommittee on Rules has considered proposing legislation to amend the NWPA to provide for fee revisions at regular multi-year intervals based on the current best estimate of the new fee level needed to recover all federal costs.

4. Congressional appropriations and authorizations for the nuclear waste disposal program are made annually, however, not triennially.

When the first repository opens--around the year 2000 under current schedule projections--the cost estimates of shipping the nuclear wastes and maintaining the repository facilities should become more reliable. Moreover, the DOE will be able to assess better the future of the nuclear utility industry and to forecast more accurately the fee receipts. These considerations might warrant extending the revision interval to five years later in the program. This longer interval would be especially justified if program performance has not required erratic and substantial changes in the fee in the interim.

If the Congress amends the NWPA to establish fee revision intervals of three (or five) years, the OCRWM would still be required to review annually the fee's adequacy to maintain program cost control and to assess its progress. If cost and revenue projections change radically every three (or five) years, requiring large fee revisions, the Congress could then shorten the fee revision interval to ensure more gradual rate increases.

Automatic Fee Revisions Through Indexing

Rather than revising the fee through Congressional legislation, the fee could be structured so that its rate would be adjusted automatically for inflation. An amendment to the NWPA, proposed by Chairman Moakley, House Subcommittee on Rules, would base indexing on the Composite Cost Index (CCI).[5] The CCI, published by the Department of Commerce, is a weighted index of changes in the costs of all types of construction.

Several arguments favor this fee adjustment design. First, if the real rate of the fee remains constant over time, all users of nuclear-generated electricity would pay the same rate for the disposal of spent fuel. Second, indexing the fee to an annual rate of inflation would provide some insurance against future cost increases in the program and lower than anticipated fee receipts. The rationale for indexing the fee is the need to account for the effects of inflation on program costs and revenues, and the expectation that actual program costs will substantially exceed their current projections. If the fee were increased annually by the rate of inflation (measured by the GNP deflator) beginning in 1984, the subsequent revenue could fully cover costs from 30 percent to 80 percent higher than the current projections, in addition to accounting for the inflationary effects on costs. Considering the

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5. See H.R. 4690, proposed amendment to the Nuclear Waste Policy Act of 1982, 92:2 (January 31, 1984). The amendment specifies that the fee be indexed to the CCI when the Nuclear Regulatory Commission approves DOE's application for a full construction authorization.

probability of program changes and cost increases, an indexed fee would provide higher revenues to cover additional outlays. If current cost estimates are fairly accurate, however, and the adjusted fee results in excess revenues, the fee could be reduced at some later time.

Table 9 shows how the fund would be affected if the fee were increased by the annual percentage change in the CCI, beginning in 1984, 1988, or 1994. The DOE expects to receive a full construction authorization license from the Nuclear Regulatory Commission (NRC) by late 1993, when the initial construction of the first repository could begin. In projecting future fee receipts, the long-term rate of the CCI is assumed to be 5.6 percent, based on its historical relationship with the GNP deflator.

If the fee is indexed to the CCI in 1984, estimated revenue collections would exceed program outlays by $21.6 billion to $76.3 billion, depending on nuclear-power growth and the repository schedules. (These excessive fund balances in part reflect the fact that the projected rate of the CCI index is 1.3 percent higher than that of the GNP deflator.) If the fee remains at 1 mill per kwh until 1994 and is then indexed, the projected fund balance would be between $1.1 billion and $23.1 billion. Thus, this fee indexing schedule would still finance some program cost overruns, depending on nuclear growth and actual repository schedules.

Under medium nuclear growth, indexing the fee to the CCI in 1984 would finance program cost overruns of over 200 percent. Indexing the fee in 1994, when full-scale construction actually would begin, would still cover cost increases of about 20 percent. Under the different ranges of nuclear growth, indexing the fee in 1994 would probably ensure a fully user-financed program, assuming only moderate program cost and revenue revisions.

Comparing the Options for Fee Revisions

Concern over the optimal method for revising the fee arises because of the high degree of uncertainty in current cost projections and future patterns of nuclear-generated electricity. Choosing how to reflect these uncertainties in the fee schedule requires assigning the financial risks of the program either to present or to future electricity users. Indexing the fee to some measure of inflation would provide insurance in case of substantial cost increases (or revenue shortfalls), thus assigning the risks of program cost overruns to current users. (If the cost increases did not materialize, the fee would be decreased in later years.) Adjusting the fee either annually or at regular intervals, however, would penalize future users if they had to pay much higher fees than current users.

TABLE 9. FINAL NUCLEAR WASTE FUND BALANCES UNDER ALTERNATIVE FEE SCHEDULES
(In billions of 1983 dollars)

Fee	Medium Nuclear Growth			No Nuclear Growth a/	
	No Delay	Three-Year Delay	Ten-Year Delay	No Delay	Ten-Year Delay
Fee Fixed at 1 Mill Per Kilowatt-Hour	-3.4	-2.2	-13.7	-5.8	-3.7
Fee Indexed to Composite Cost Index b/ Beginning in					
1984	65.8	69.3	76.3	21.6	25.2
1988	41.4	44.1	44.7	10.2	12.8
1994	21.1	23.1	18.2	1.1	3.4

SOURCE: Congressional Budget Office.

NOTES: Under the medium nuclear-growth forecast, the three-year delayed repository program requires a 15,000 metric ton MRS facility and the ten-year delay requires a 72,000 metric ton MRS facility. Under the no nuclear-growth forecast, the ten-year delayed program requires a 30,000 metric ton MRS facility. Final fund balances reflect interest payments either received or owed on fund investments or borrowings. The long-term inflation and real-interest rate assumptions are 4.3 percent and 3.5 percent, respectively. The long-term annual rate of the CCI is 5.6 percent.

a. The nondelayed program assumes that two 72,000 metric ton capacity repositories are built. The ten-year delay schedule, however, includes two smaller-scale 42,000 metric ton repositories, since the DOE would have a longer period over which to base the total expected spent fuel storage requirements.

b. These fund balances assume that the fee is increased by the annual percentage change in the Composite Cost Index beginning in either 1984, 1988, or 1994. Before indexing, the fee is 1 mill per kilowatt-hour.

The main argument against indexing the fee is that changes in costs and receipts will not correspond exactly to any measure of inflation, but rather to developments in the program's progress and more accurate cost information. Thus, adjusting the fee based on actual program revisions might result in revenues that would more closely match outlays. Because of the likelihood of much higher costs than now projected, however, and the discretionary nature and time required for fee changes through the current legislative process, indexing the fee would more probably permit the DOE to meet its mandate for full cost recovery. Furthermore, maintaining equity among consumers of nuclear-generated electricity would require a constant real fee. Indexing the fee would not preclude the DOE and the Congress from further amending the rate, if necessary, to keep revenues in line with total program costs.

EFFECTS OF LENDING ON PROGRAM SOLVENCY

It is crucial to the solvency of the waste disposal program that all fee receipts are invested in Treasury securities until they are needed to finance direct program activities. Some concern has been raised that excess fund balances would instead be diverted to finance other programs with cash flow problems.

Allowing excess funds to be borrowed could require the OCRWM to increase the fee earlier or by a greater percentage than if all excess funds were invested and earning interest. Even if interest payments were made on any borrowed funds at a rate equal to the Treasury bill rate, any loan to a high-risk program would be a form of subsidy since such a program would have to pay a risk premium in addition to the Treasury bill rate if it borrowed from capital markets instead. This might penalize the nuclear-generated electricity customers, who would be financing programs from which they might not directly or solely benefit. More important, diverting fund revenues would violate the terms of the waste disposal contracts signed between the nuclear utilities and the DOE and the provisions and the intent of the NWPA.

APPENDIX

APPENDIX. METHODOLOGY AND ASSUMPTIONS

The projected balance of the Nuclear Waste Fund at the end of the waste disposal program is determined by the fee payment and cost schedules and the inflation and interest rate assumptions. This appendix describes the methodology and assumptions CBO used to evaluate the adequacy of the current 1 mill per kilowatt-hour (kwh) fee levied on nuclear-generated electricity.

Annual Revenue Projections

Fund revenues consist of the fees paid by nuclear electric utilities on all electricity generated on or after April 7, 1983, plus the one-time fee charges on spent nuclear fuel produced before that time. To determine annual fee receipts, the projected annual electricity generated (in kilowatt-hours) was multiplied by the fee--which is either set at a fixed rate of 1 mill per kwh or increased annually by the rate of inflation starting in 1984. This report evaluated the fee's adequacy under alternative revenue schedules assuming the Energy Information Administration's (EIA) high, medium, low, and no nuclear-growth projections. The corresponding schedules of annual nuclear reactor capacities and electricity generation are provided in Table A-1 through the year 2020.

Determining When the Fee Payments Cease

To determine the revenues that would be available to finance the current waste disposal program, it was assumed that the fee would apply only until the first 144,000 metric tons of spent fuel--the waste disposal capacity of the two repositories--have been generated. [1] This would occur by 2018 under the high nuclear-power growth scenario. Under medium- and low-growth scenarios, only 133,800 and 108,500 metric tons, respectively, would be produced by 2020, the last year for which EIA extends its

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1. The Department of Energy would actually continue to collect fees on subsequent nuclear-generated electricity to pay for building additional repositories as needed. This report, however, does not include the additional storage costs and fee payments for spent fuel inventories beyond the first 144,000 metric tons.

TABLE A-1. PROJECTIONS OF NUCLEAR-POWER CAPACITY AND ELECTRICITY GENERATION UNDER ALTERNATIVE NUCLEAR-GROWTH FORECASTS

	High Nuclear Growth		Medium Nuclear Growth		Low Nuclear Growth		No Nuclear Growth	
Year	Capacity (GWe)	Generation (billions of kwh)	Capacity (GWe)	Generation (billions of kwh)	Capacity (GWe)	Generation (billions of kwh)	Capacity (GWe)	Generation (billions of kwh)
1983	66	309	65	303	65	303	65	303
1984	80	368	71	336	68	322	68	322
1985	94	428	84	399	74	362	74	362
1986	100	476	95	452	84	412	84	812
1987	110	529	100	486	95	458	95	458
1988	113	563	110	541	103	500	103	500
1989	115	585	113	565	109	541	109	541
1990	121	619	114	590	112	572	112	572
1991	122	641	120	627	114	597	114	597
1992	125	656	122	636	114	605	114	605
1993	127	682	124	661	114	617	114	617
1994	127	686	123	662	113	614	113	614
1995	127	700	122	676	113	623	113	623
1996	131	714	125	681	113	623	113	623
1997	132	730	126	698	112	628	112	628
1998	135	760	129	718	112	637	112	637
1999	138	775	130	728	111	633	111	633
2000	141	788	131	735	111	629	109	619
2001	151	823	138	759	113	631	106	605
2002	162	864	144	780	116	635	101	577
2003	174	916	151	809	120	645	95	541
2004	182	954	156	824	121	637	84	478
2005	192	1,016	163	864	122	655	78	445
2006	203	1,081	168	902	125	673	73	417
2007	208	1,085	168	892	122	653	67	380
2008	218	1,183	173	952	124	684	64	364
2009	227	1,241	177	982	124	696	63	359
2010	235	1,292	180	1,003	125	703	61	348
2011	246	1,347	185	1,024	127	708	58	330
2012	261	1,423	194	1,065	133	734	57	324
2013	270	1,465	196	1,074	132	726	50	282
2014	280	1,504	201	1,098	134	738	46	263
2015	290	1,548	205	1,103	135	743	40	225
2016	302	1,626	210	1,123	137	741	30	173
2017	314	1,693	215	1,164	140	740	19	110
2018	327	1,780	220	1,188	141	752	11	63
2019	338	1,857	225	1,230	143	771	5	26
2020	350	1,921	230	1,274	145	798	2	13

SOURCE: Department of Energy, Energy Information Administration (September 1983).

NOTES: Under high nuclear growth, 144,000 metric tons of spent fuel would be generated by 2018. Under medium and low nuclear growth, the EIA electricity-generation forecasts were extrapolated to 2022 and 2032, respectively, to estimate fee collections until the first 144,000 metric tons of spent fuel would have been produced. The no-growth schedule assumed electricity generation from nuclear power would cease after 2020, when the last of the total 82,000 metric tons of spent fuel would have been produced. The annual rate of spent nuclear fuel generation averages roughly 20 to 25 metric tons per gigawatt-electric of nuclear capacity.

projections. Beyond 2020, CBO assumed a steady-state waste generation rate of 3,000 metric tons per year; under this schedule, 144,000 metric tons of spent fuel would be accumulated by 2022 under medium growth and by 2032 under low growth. The no-growth projection assumed that nuclear electricity generation and fee payments would cease after 2020 when the last nuclear reactor would be shut down.

Payments for "Old" Spent Nuclear Fuel

The Department of Energy (DOE) should receive supplemental payments of about $2.3 billion (in 1983 dollars) for spent fuel produced before April 7, 1983. The utility owners of this old spent fuel (about 9,300 metric tons) may choose from among three payments plans offered by the DOE:

- **Option 1.** The total amount owed will be prorated evenly over 40 quarters and will include the fee charge on the kilograms of spent fuel generated before April 7, 1983, plus interest on the unpaid fee balance. From April 7, 1983 until the date of the first payment, the interest charged will be based on the 91-day Treasury bill rate, and on the 10-year Treasury note rate thereafter. The utility must make the final payment before the spent fuel is transferred to the repository.

- **Option 2.** The utility will make a single payment to the DOE consisting of the actual fee per kilogram of waste plus interest on that amount compounded quarterly from April 7, 1983 to the date the full payment is received, based on the 91-day Treasury bill rate. The payment can be made any time before the delivery of the spent fuel to the repository.

- **Option 3.** The utility will pay in a single payment by June 30, 1985, or within two years after the disposal contract between the utility and the DOE is executed, whichever is later. The utility will not pay any interest charges under this option.

For simplicity, this report assumed that the nuclear utilities pay the fees for the old spent nuclear fuel according to the following schedule:

- Two-thirds of the total $2.3 billion owed is paid according to Option 3. Half of this amount ($767 million) is paid in 1985 and the other half in 1986.

- The remaining $767 million is paid according to Option 2. The analysis assumed that the utilities choosing this option deferred payment until 1998, the year the first repository is scheduled to open, paying $2,265 million which includes interest payments based on a long-term nominal interest rate of 7.8 percent.

ANNUAL PROGRAM COSTS

The annual costs for developing and operating the two repositories under the different nuclear-growth scenarios were derived using the DOE's July 1983 cost projections for their reference program.[2] Total annual costs reflect the sum of the various cost components in each year, multiplied by the compound rate of inflation for that year.

Reference Program Costs Under Different Nuclear-Growth Projections

Program costs under the alternative growth scenarios include both fixed and variable cost components (see Table 1 in Chapter I). The outlays for repository development, testing, and construction would be the same under all growth projections. The variable operating, decommissioning, and waste shipping costs, however, would depend on the rate of electricity generation and spent fuel accumulation. The schedules at which the two repositories are filled reflect two critical assumptions:

- All spent fuel must be cooled for at least five years after its removal from the nuclear reactor core, before being placed in the repository; and,

- The maximum waste-receiving rate at each repository is 1,800 metric tons per year for the first five years of operation and 3,000 metric tons per year thereafter.

These factors determine when the two repositories will be filled and decommissioned, signifying the end of the waste disposal program (see Table 2 in Chapter II). The annual cost components provided in Table A-2 reflect the reference program schedule assuming medium nuclear-power growth.

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2. This assumed two 72,000 metric ton capacity facilities, built in a salt foundation, that would open in 1998 and 2002, and be filled by 2023 and 2027, respectively. The DOE cost figures are taken from its study entitled, "Report on Financing the Disposal of Commercial Spent Nuclear Fuel and Processed High-Level Radioactive Waste," DOE/S-0020/1 (July 1983). These costs were reported in 1982 dollars and were converted to 1983 dollars for this analysis.

TABLE A-2. ANNUAL COSTS FOR TWO REPOSITORIES, ASSUMING MEDIUM NUCLEAR GROWTH
(In millions of 1983 dollars)

Year	Construction	Operating	Fuel Shipping	Decom- missioning	Development, Testing, and Administration	Total
1983	0	0	0	0	244.6	244.6
1984	0	0	0	0	361.2	361.2
1985	0	0	0	0	384.1	384.1
1986	0	0	0	0	302.9	302.9
1987	0	0	0	0	273.8	273.8
1988	41.6	0	0	0	257.1	298.7
1989	0	0	0	0	240.5	240.5
1990	0	0	0	0	144.7	144.7
1991	0	0	0	0	197.8	197.8
1992	128.4	0	0	0	222.8	351.2
1993	260.1	0	0	0	180.1	440.2
1994	346.9	0	0	0	150.9	497.8
1995	381.5	0	0	0	144.7	526.2
1996	485.6	0	0	0	144.7	630.3
1997	520.3	0	0	0	155.1	675.4
1998	346.9	86.6	50.6	0	143.7	627.8
1999	381.5	86.6	50.6	0	140.5	659.2
2000	398.9	86.6	50.6	0	127.0	663.1
2001	260.1	87.6	50.6	0	65.6	462.9
2002	0	173.3	101.2	0	64.5	339.0
2003	0	231.1	134.9	0	29.1	395.1
2004	0	231.1	134.9	0	29.1	486.6
2005	0	231.1	134.9	0	29.1	486.6
2006	0	231.1	134.9	0	29.1	486.6
2007	0	288.9	168.6	0	29.1	486.6
2008	0	288.9	168.6	0	29.1	486.6
2009	0	288.9	168.6	0	29.1	486.6
2010	0	288.9	168.6	0	29.1	486.6
2011	0	288.9	168.6	0	29.1	486.6
2012	0	288.9	168.6	0	29.1	486.6
2012	0	288.9	168.6	0	29.1	486.6
2013	0	288.9	168.6	0	29.1	486.6
2014	0	288.9	168.6	0	29.1	486.6
2015	0	288.9	168.6	0	29.1	486.6
2016	0	288.9	168.6	0	29.1	486.6
2017	0	216.5	126.5	0	29.1	372.1
2018	0	211.7	123.7	0	29.1	364.5
2019	0	216.5	126.5	0	29.1	372.1
2020	0	245.4	143.5	0	29.1	417.8
2021	0	250.3	146.2	0	29.1	425.6
2022	0	221.3	129.3	0	29.1	379.7
2023	0	250.3	146.2	0	29.1	425.6
2024	0	255.0	149.0	0	29.1	433.1
2025	0	240.6	140.5	0	29.1	410.2
2026	0	144.4	84.3	33.0	25.0	286.7
2027	0	144.4	84.3	49.4	25.0	303.1
2028	0	144.4	84.3	82.4	25.0	336.1
2029	0	57.8	33.7	99.0	25.0	215.5
2030	0	0	0	99.0	0	99.0
2031	0	0	0	49.4	0	49.4
2032	0	0	0	82.4	0	82.4
2033	0	0	0	99.0	0	99.0
2034	0	0	0	66.0	0	66.0

SOURCE: Congressional Budget Office, based on the DOE's reference program costs reported in "Report on Financing the Disposal of Commercial Spent Nuclear Fuel and Processed High-Level Radioactive Waste," DOE/S-0020/1 (July 1983).

NOTES: This program includes two 72,000 metric ton capacity repositories in a salt medium. They begin operation in 1998 and 2002 and are filled in 2025 and 2029, respectively.

Alternative Program Costs Under the No-Growth Scenario

Since the two reference program repositories would have excess capacity of 62,000 metric tons if future nuclear-electricity generation followed the no-growth pattern, CBO examined the effects of reducing the size of the facilities to 42,000 metric tons each. The reference program repository development, licensing, and testing costs were not affected, but the construction and decommissioning costs were reduced to 58 percent of the full-scale repository costs.

The waste-receiving rate of each of the smaller repositories would be 1,800 metric tons per year. They would open in 1998 and 2002, as in the reference schedule, and would be filled in 2020 and 2026, respectively. The total operating and waste-shipping costs would be $3.9 billion and $2.3 billion, respectively.

Program Costs Assuming Delays in Repository Schedules

Delays in developing and constructing the two repositories would affect the fund in two ways:

- The current schedules and outlays for siting, testing, licensing, and constructing the two repositories would be extended, and the operating and decommissioning costs would be delayed; and

- If a monitored retrievable storage (MRS) facility were developed, it would require additional fund outlays.

The delayed program schedules examined in Chapter III included three- and ten-year delays under medium nuclear growth and a ten-year delay under no nuclear growth. Under medium growth, the total repository construction, operating, and decommissioning costs under both delays were assumed to be the same as those of the corresponding reference program, but the schedules were either extended or delayed. The delayed program under no nuclear growth assumed the smaller-scale repositories of the alternative no-growth program evaluated in Chapter II, with those same repository costs. For all cases, the repository development, siting, and testing schedules were also extended, and these associated costs were increased by 25 percent compared to the reference schedule. In addition to these changes in the delayed program costs, the analyses of these programs assumed the development of an MRS facility. The total program costs for the three delayed scenarios (shown in Table 5 in Chapter III) thus reflect both the alternative repository schedules and the additional MRS-related outlays detailed in Table 4 in Chapter III.

PROJECTING THE CUMULATIVE FUND BALANCE

The trust fund balance in a particular year reflects that year's balance of revenues and outlays and the prior year's accumulated balance plus interest on that amount. If the previous balance was positive, it was assumed that the full amount would have been invested and the annual interest added to the fund balance. Conversely, a negative fund balance in the previous year would reflect funds borrowed from the U.S. Treasury, a fund debt that would increase by the current interest rate.

CBO used an accounting algorithm to calculate the annual trust fund balances over the program's duration, consisting of three essential equations:

Equation 1. Annual Revenues

AR_t = electricity generation$_t$ x fee x compound inflation rate$_t$ + supplemental revenues$_t$

where

AR_t = annual revenues in year t (in millions of nominal dollars)

electricity generation$_t$ = electricity generated by commercial nuclear utilities in year t in billions of kilowatt-hours

fee = 1 mill per kilowatt-hour

compound inflation rate$_t$ = the fee adjustment to reflect revenues in nominal dollars 3/

supplemental revenues$_t$ = the payments made for the spent fuel inventories that existed before April 7, 1983, in year t (in millions of nominal dollars).

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3. If the fee is assumed to remain at a fixed rate of 1 mill per kilowatt-hour, the compound inflation rate adjustment factor is set to 1. Otherwise, it equals the rate of inflation as measured by the percentage change in the gross national product (GNP) implicit price deflator, compounded beginning in 1984.

Equation 2. Annual Costs

AC_t = (development $costs_t$ + site characterization and licensing $costs_t$ + test and evaluation facility $costs_t$ + administrative $costs_t$ + repository $construction_t$ + repository $operating_t$ + repository $decommissioning_t$ + waste $shipping_t$ + MRS $facility_t$) x compound inflation $rate_t$

where

AC_t = annual program costs in year t (in millions of nominal dollars)

development $costs_t$ = costs of repository technology development in year t (in millions of 1983 dollars)

site characterization and licensing $costs_t$ = costs of determining the suitability of candidate repository sites and of carrying out the tests necessary to obtain the appropriate Nuclear Regulatory Commission licenses, in year t (in millions of 1983 dollars)

test and evaluation facility $costs_t$ = the costs of developing and operating a Test and Evaluation Facility at one of the two selected repository sites, in year t (in millions of 1983 dollars)

administrative $costs_t$ = the DOE fund management costs and the aid payments to state and local governments and Indian tribes affected by a repository built in their area, in year t (in millions of 1983 dollars)

repository $construction_t$ = costs of building two repositories in a salt-medium foundation in year t (in millions of 1983 dollars)

repository $operating_t$ = costs of filling and maintaining the two repositories in year t (in millions of 1983 dollars)

repository $decommissioning_t$ = costs of decommissioning the two repositories in year t (in millions of 1983 dollars)

waste $shipping_t$ = costs of transferring spent fuel from the nuclear utilities to the repositories in year t (in millions of 1983 dollars)

MRS $facility_t$ = costs of constructing, operating, and decommissioning an MRS facility, plus the transportation costs of shipping spent fuel from the utilities to the MRS facilities (the costs that would be incurred in addition to shipping the fuel directly to the permanent repositories) in year t (in millions of 1983 dollars) 4/

compound inflation $rate_t$ = the inflation factor used to adjust annual costs in year t to nominal dollars, measured by the percentage change in the GNP deflator compounded annually from 1984.

The trust fund balance reflects nominal revenue and cost projections and interest on the prior year's balance, converted to 1983 dollars.

Equation 3. Annual Fund Balance

$$TFBALX_t = \frac{BAL_t}{\text{compound inflation rate}_t} + \frac{TFBALX_{t-1} \times \text{nominal interest rate}}{\text{annual inflation rate}_t}$$

where

$TFBALX_t$ = the annual trust fund balance in year t (in millions of 1983 dollars)

BAL_t = the difference between annual revenues and costs in year t (in millions of nominal dollars) = $AR_t - AC_t$

compound inflation $rate_t$ = the factor used to adjust the annual balance in year t to 1983 dollars

$TFBALX_{t-1}$ = the annual trust fund balance in year t-1 (in millions of 1983 dollars)

nominal interest $rate_t$ = the 91-day Treasury bill rate in year t, in nominal terms reflecting inflation

annual inflation $rate_t$ = the annual inflation rate measured by the percentage change in the GNP price deflator in year t.

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4. The MRS facility cost component is set to 0 except in the three delayed repository programs.

Financial Assumptions

The projections of the annual fund balance reflect inflation and real interest rate assumptions. The February 1984 CBO projections for these two rates, measured by the GNP implicit price deflator and the 91-Day Treasury bill rate, respectively, are presented in Table A-3. Also shown is the CBO GNP price deflator projection under high economic growth, used to evaluate the program's solvency under high inflation rates. The alternative real interest rate projections were chosen to test the fund's solvency if the baseline interest rate projections were either increased or decreased by 1 percent annually.

TABLE A-3. INFLATION AND REAL INTEREST RATE ASSUMPTIONS (In percents)

	Percentage Change in the GNP Price Deflator		Real 91-Day Treasury Bill Rate		
Year	Baseline Projection	High Economic Growth Projection	Baseline Projection	High Real Interest Rate Projection	Low Real Interest Rate Projection
1983	4.2	4.2	4.4	4.4	4.4
1984	4.7	4.7	4.2	5.2	3.2
1985	5.1	5.2	3.5	4.5	2.5
1986	4.9	5.2	3.5	4.5	2.5
1987	4.7	5.5	3.5	4.5	2.5
1988	4.5	5.9	3.5	4.5	2.5
1989	4.3	6.3	3.5	4.5	2.5
1990	4.3	6.3	3.5	4.5	2.5

SOURCE: GNP Deflator and Baseline Interest Rate Projections: Congressional Budget Office, The Economic Outlook: A Report to the Senate and House Committees on the Budget--Part I (February 1984). The alternative interest rate projections were chosen to evaluate the fund's sensitivity to the real interest rate assumptions.

NOTES: The projections from 1990 through the end of the program analysis period are held constant at the 1989 rate.

Fund Balances Under Alternative Fee Indexing Schedules

Chapter IV included a discussion of the effects on the program's solvency of indexing the fee to the Composite Cost Index (CCI) beginning in 1984, 1988, or 1994. The annual projections for the percent change in the CCI from 1983 until program's end were derived using the GNP price deflator projections, based on the relationship between these two inflationary indexes from 1964 to 1982. The long-term projection for the annual percent change in the CCI was 5.6 percent. For this fee adjustment design, revenues were calculated by adjusting the 1 mill per kwh fee each year by the annual percent change in the CCI, rather than the GNP deflator, beginning in 1984, 1988, or 1994.