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Nuclear Waste Fund Fee Adequacy: An Assessment

May 2001

U.S. Department of Energy
Office of Civilian Radioactive Waste Management
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LETTER FROM THE DIRECTOR

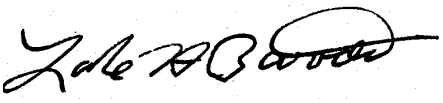
The *Nuclear Waste Fund Fee Adequacy: An Assessment* presents the Office of Civilian Radioactive Waste Management's most recent estimate of the adequacy of the Nuclear Waste Fund (NWF) fee. The NWF is a separate account, established in the Treasury of the United States by the Nuclear Waste Policy Act (NWPA). It consists of receipts, proceeds and recoveries realized by the U.S. Department of Energy (DOE) under the NWPA, any appropriations made by the Congress into the NWF, and any unexpended balances that were transferred to the NWF on the date of enactment of the NWPA. Fees paid by owners and generators of civilian spent nuclear fuel are deposited directly into the NWF. The fee is 1 mill (0.1 ¢) per kilowatt-hour of electricity generated and sold.

The NWF Fee Adequacy report considers only the costs associated with disposal of commercial spent nuclear fuel (SNF). Costs for the disposal of Government-managed nuclear materials, including DOE and naval SNF, vitrified high-level radioactive waste (HLW) glass, and "can-in-canister" immobilized plutonium, are not paid for with the fees assessed to commercial nuclear utilities.

The assessment is based on the *Analysis of the Total System Life Cycle Cost (TSLCC) of the Civilian Radioactive Waste Management Program* [DOE/RW-0533], which is available on the Office of Civilian Radioactive Waste Management's Home Page [http://www.rw.doe.gov]. The TSLCC analysis projects costs through the year 2119 for a surrogate, single potential repository, expanded to accommodate all the SNF and HLW projected. The analysis includes all Program costs, including disposal, acceptance and transportation, program management, and institutional categories. The NWF Fee Adequacy assessment uses the same commercial SNF projections and annual costs that are used in the TSLCC to determine the fee-generated income and earned interest.

The assessment identifies key uncertainties in projecting NWF balances, including variability in Program costs, NWF revenues, and economic conditions. The results indicate that the fee charged to utilities is adequate under the assumptions used in the analysis.

Sincerely,



Lake Barrett, Acting Director
Office of Civilian Radioactive
Waste Management

Dated: May 2001

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ACRONYMS AND ABBREVIATIONS

CPI	Consumer Price Index
CRWMS	Civilian Radioactive Waste Management System
DOE	U.S. Department of Energy
FY	Fiscal Year
HLW	High-Level Radioactive Waste
IPWF	Immobilized Plutonium Waste Form
NRC	U.S. Nuclear Regulatory Commission
NWF	Nuclear Waste Fund
NWPA	Nuclear Waste Policy Act
OCRWM	Office of Civilian Radioactive Waste Management
SNF	Spent Nuclear Fuel
TSLCC	Total System Life Cycle Cost
YOE	Year-of-Expenditure

Abbreviations

kWh	Kilowatt-hour
yr	year
M	Million

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1. INTRODUCTION AND EXECUTIVE SUMMARY

1.1 FEE ADEQUACY RECOMMENDATIONS

This analysis finds that the current 1.0 mill ($0.001) per kilowatt-hour (kWh) fee charged for electricity generated and sold using commercial spent nuclear fuel (SNF) is adequate, and recommends that the fee not be changed. This recommendation is based on examination and analysis of the revenue forecasts and estimated costs detailed in the *Analysis of the Total System Life Cycle Cost for the Civilian Radioactive Waste Management Program* (DOE 2001), and on the uncertainties associated with economic assumptions, program revenues, and cost estimates. It should be noted that this assessment of fee adequacy does not include the potential effects on the solvency of the Nuclear Waste Fund (NWF) that may result from future settlements, court awards, and/or scope changes. The reduction in the fee income resulting from U.S. Department of Energy (referred to as the Department) settlement with PECO Energy Company, however, has been included. Subsequent to the initiation of this analysis, the Nuclear Regulatory Commission granted 20-year life extensions for five commercial reactors. This analysis does not assume any service life extensions, which would increase projected quantities of SNF and fee revenues. Future analyses will evaluate the impact of reactor life extensions on the adequacy of the fee.

The costs assumed for this analysis are based on the 2000 Civilian Radioactive Waste Management System (CRWMS) Total System Life Cycle Cost (TSLCC) (DOE 2001) estimate. The 2000 TSLCC report estimated the costs for a reference system scenario that assumed that closure and decommissioning activities begin 100 years after the beginning of waste emplacement.

Although the estimated costs in the 2000 TSLCC report (DOE 2001) have increased by 26 percent from those in the 1998 TSLCC (DOE 1998a) report, the NWF is projected to have a positive balance at the end of waste emplacement activities, and sufficient capital to fund the remaining program activities through the end of closure and decommissioning. Despite this increase in program costs, the 1.0 mill per kWh fee charged on generators of commercial SNF remains adequate, since the bulk of the system cost increase occurs late in the program life cycle. The program cost increase will require more capital to be available in the NWF at the end of emplacement. This result is based on an analysis using current fee revenue projections, independent projections of inflation, and a range of independent projections and historical interest rates.

Sufficient capital in the NWF at the end of the emplacement period is the equivalent of a sinking fund that will provide future decision-makers with the flexibility to defer prompt closure. A sinking fund in excess of the net present value of the future costs provides a margin of safety for uncertainties and changes in program scope, costs, revenues, and economic assumptions.

The margin of adequacy of the 1.0 mill per kWh fee charged on generators of SNF for this assessment is dependent on the assumed future real interest rate. This assessment provides analyses using a range for long-term real interest rates. The real interest rates used in this fee adequacy assessment, approximated by the difference between the nominal interest rate and the inflation rate, are discussed in Section 3.3.1.

1.2 BACKGROUND

The purpose of this report is to present an analysis of the adequacy of the 1.0 mill per kWh fee being paid by the nuclear power utilities for the permanent disposal of their SNF. In accordance with the Nuclear Waste Policy Act of 1982 (NWPA), the costs for disposal of commercial SNF in a potential geologic repository are to be funded by a fee levied on electricity generated and sold. For SNF or solidified high-level civilian radioactive waste derived from SNF generated prior to enactment of the NWPA, utilities were required to pay a one-time fee equivalent to an average charge of 1.0 mill per kWh. The fee provides for intergenerational equity; i.e., it ensures that the beneficiaries of nuclear power pay for the costs of disposal of the wastes. These fees are deposited in the NWF. The NWF is to be used for development and implementation of a radioactive waste management system in accordance with the NWPA, including a potential permanent geologic repository. Any fees received in excess of annual funding requirements are invested in U.S. Treasury obligations at prevailing rates. Management of the NWF (also referred to as "the Fund") is an important element of the program, considering that the Fund must cover the cost of activities that extend far beyond the operating life of current nuclear power plants.

Pursuant to Section 8 of the NWPA, President Reagan decided in 1985 to use the disposal capacity of the CRWMS for the disposal of high-level radioactive waste, including DOE and naval SNF, resulting from atomic energy defense activities. The Department is required to pay its fair share of costs for disposal of defense-related materials such as DOE SNF, which includes naval SNF, and high-level waste (HLW) generated by weapons production activities. HLW includes Immobilized Plutonium Waste Form (IPWF). Costs for disposal of government-managed nuclear materials are currently paid through the Defense Nuclear Waste Disposal appropriations, in lieu of direct payment of defense fees into the Nuclear Waste Fund, as directed by the NWPA. A methodology for allocating costs between government-managed nuclear materials and commercial wastes was developed by public rulemaking in the August 20, 1987, Federal Register Notice (52 FR 31508). This rulemaking provided a vehicle for computing each party's fair share of total costs.

This assessment assumes that the Department will pay its full share of past and future costs, and therefore addresses only the continuing adequacy of the 1.0 mill per kWh nuclear utility fee to fund the civilian cost share.

1.3 PROGRAM STATUS

Significant changes have occurred in the program since the last Fee Adequacy Assessment was published (DOE 1998b). The estimate of program costs increased due to these changes; however, the bulk of the cost increase occurs late in the program life cycle, resulting in the need for a larger NWF balance at the end of emplacement to fund post-emplacement costs.

Through fiscal year (FY) 1999, the program had spent $6.3 Billion in year-of-expenditure (YOE) dollars. Of the $6.3 Billion in YOE dollars, $4.4 Billion was spent on the first potential repository, and $0.1 Billion on a second potential repository. Approximately $0.4 Billion was spent on plans for a proposed monitored retrievable storage facility, engineering development, transportation system development, waste acceptance, project integration, and spent fuel storage. Program support, consisting of Quality Assurance, Human Resources and Administration, and

Program Management and Integration, including all costs for Federal employees, cost $1.1 Billion. Transfer appropriations for the U.S. Nuclear Regulatory Commission (NRC), the Nuclear Waste Technical Review Board, and the Office of the Nuclear Waste Negotiator cost $0.3 Billion.

1.4 STATUS OF THE NUCLEAR WASTE FUND

The NWF balance results from fee receipts and investment income. From FY 1983 to the end of FY 1999, ongoing fee payments (excluding one-time fee payments) accounted for $8.3 Billion (DOE 2000) in YOE dollars ($10.1 Billion in 2000 dollars). Utilities had accrued, but not yet paid, $0.1 Billion in 1.0 mill per kWh fees at the end of the accounting period. Cumulative one-time fee payments accounted for $1.5 Billion in program revenues, with $0.9 Billion in principal still owed. Interest received from fees and returns on the NWF investments accounts for $5.9 Billion, with outstanding receivables of $1.5 Billion, primarily from interest on one-time fees. Based on projections of nuclear power generation, using a no-new-orders scenario, the last fee revenue will be received in 2035, which is 84 years prior to the anticipated completion date for repository closure and decommissioning.

Defense Nuclear Waste Disposal Appropriations through FY 1999 totaled $1.1 Billion (DOE 2000). These appropriations are not currently deposited in the NWF, nor are they counted as disbursements from the NWF. Through FY 1999, an additional $1.3 Billion of principal and interest was due to OCRWM from the Department of Energy for their disposal cost share for DOE SNF and HLW.

The NWF balance, investment income, and future Defense Nuclear Waste Disposal Appropriations must cover program expenditures after the fee revenues have ended. Figure 1 shows the percentage of revenue supplied by Defense Nuclear Waste Disposal appropriations, annual fees, one-time fees with accrued interest from the utilities, and the interest earned by the NWF. These sources of revenue, except for Defense Nuclear Waste Disposal appropriations, are used in assessing the adequacy of the fee.

1.5 FACTORS AFFECTING THE ADEQUACY OF THE FEE

There are several factors that could affect fee adequacy and result in a need for adjustments to the ongoing 1.0 mill per kWh fee. Changes to program costs are a determinant of fee adequacy. Fee revenue projections affect the income that covers program costs. Economic assumptions affect program costs through cost escalation and interest income.

1.5.1 Program Cost Basis

The fee adequacy assessment is sensitive to changes in program costs. Program cost estimates may change as a result of estimating uncertainty and changes in scope. Estimating uncertainty is addressed in the reference design cost estimate through the use of contingency factors applied to the estimate.

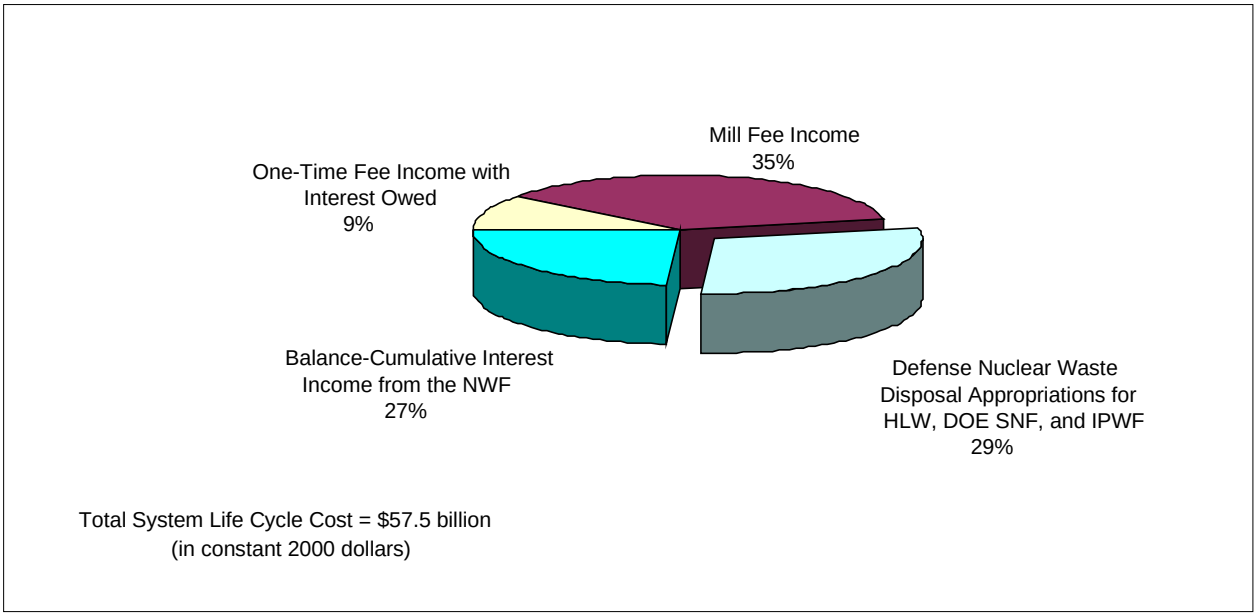

Figure 1. Revenue Sources Required to Fund the 2000 TSLCC (in Percentages of 2000$)

The relative shares between civilian and government-managed nuclear materials are sensitive to program changes. The civilian share allocation decreased from the 1998 assessment (DOE 1998b). The share allocation depends upon the relative quantity of waste packages and underground space allocated between commercial and government-managed nuclear material. The current system design reduced the relative number of civilian waste packages, and the civilian proportion of the underground space allocation. The 2000 TSLCC (DOE 2001) provides a more detailed explanation of system design differences from the previous assessment.

1.5.2 Projected Fee Revenues

In the near term, fee revenue projections are known with a high degree of certainty based on projections by the DOE Energy Information Administration. Future projections based on reactor characteristics, known spent fuel discharges, and operating licenses also can be closely estimated. Uncertainty is introduced by the potential for early reactor shutdowns, or by service life extensions. Reductions or increases in electricity generated and sold by nuclear power plants will impact both disposal costs and the amount of revenue paid into the NWF. The fee projections for this report were compiled before the NRC granted 20-year life extensions for five commercial reactors. The net increase in disposal capacity needed for these five reactors is approximately 1,460 metric tons of heavy metal (or a 1.7 percent increase). The disposal costs associated with this increase can be assumed to be balanced by the additional ongoing fees for the electricity generated and sold that will be paid into the NWF. Consequently, the conclusion on fee adequacy given earlier in this report remains valid. However, if additional reactor extensions are granted, further analysis will be required to assess the impacts on revenues and costs.

1.5.3 Economic Projections

As a result of the long duration of the program, economic factors such as interest and inflation rates, and near-term expenditure profiles have significant impacts on the adequacy of the ongoing 1.0 mill per kWh fee. Unforeseeable periods of either lower or higher real interest rates than used in this report would significantly decrease or increase the interest earned on the balance in the NWF. The opposite is true for inflation during the life cycle of the program. Increased inflation would cause higher costs, resulting in a lower NWF balance and less interest income. However, since inflation typically affects the nominal interest rate, the effects of higher inflation on outlays may be partially offset by higher nominal interest earnings.

In the 1998 fee adequacy analysis (DOE 1998b), the principal economic driver used was the projection of the real interest rate on the 10-year U.S. Treasury Note. Updating the 1998 projection for current economic conditions (CRWMS M&O 2000) led to an average future real interest rate of 4.2 percent, which significantly exceeds the 40-year historical average of 2.6 percent for all long-term government bonds. Using a real interest rate higher than historical averages could potentially distort the financial model results, as the model extends far into the future. Consequently, the 2000 fee adequacy assessments were calculated using two real rates of return. The current projection of the real interest rate on the 10-year U.S. Treasury Note was used as an upper reference benchmark and the 40-year historical average of the real return on long-term government bonds was used as a lower reference benchmark.

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2. METHODOLOGY

This section describes the methodology used in this analysis, the key assumptions, and the data that provide the basis for the assessment. The methods used for this analysis are identical to those employed in the 1998 fee adequacy assessment (DOE 1998b).

The evaluation of fee adequacy is based on the principle of full-cost recovery presented in Section 302 of the NWPA, under which all costs related to Office of Civilian Radioactive Waste Management (OCRWM) waste disposal services will be paid for by the owners and generators of SNF and HLW. This principle of full-cost recovery underlies the basic analytical methodology used by the Department. The methodology for projecting the adequacy of the fee uses a forecasted revenue stream of fees paid into the NWF by the utilities, along with interest earned by the Fund, and compares it to the disbursement forecast to determine the sufficiency of funds. Annual surpluses are invested in Treasury securities. Annual shortfalls in revenue will be met by redeeming securities held by the NWF or by borrowing from the U.S. Treasury, if necessary.

A cash flow analysis was used. This utilizes projections of the ongoing kWh fees and projections of when deferred one-time fee payments will be received into the NWF. In addition, this analysis uses the estimated expenditure profile, escalated to YOE dollars, from the 2000 TSLCC analysis (DOE 2001). For each year, the cash flow technique takes the previous year's fund balance, adds the current year revenues, and subtracts the escalated expenditures. This provides an annual analysis of cash flows, in YOE dollars, and annual NWF balances. It also calculates the interest income from the NWF Treasury Bond portfolio, using a forecasted nominal rate of return. This technique also takes into account interest expenses, if required, from borrowing for cases where the balance becomes negative. Results are de-escalated to constant 2000 dollars, consistent with the TSLCC (DOE 2001), using the Consumer Price Index (CPI) to eliminate the effects of escalation and the distortions resulting from erosion of purchasing power of distant future dollars.

The investment portion of the model starts with the projected coupon and maturity cash flows from the investments held by the NWF as of September 30, 1999. At that time, the Fund had a market value of $8.5 Billion and a cash balance value, on which the flows are based, of $7.2 Billion. The starting balance of the NWF includes the face value of bills, notes, and bonds, and the purchase price plus the amortized discount of zero-coupon bonds. The NWF also properly reflects the net effect of all fees paid, interest earned, and disbursements made to fund historical program costs. The NWF balance provides the starting point for the forward-looking analysis of program cash flows used to determine fee adequacy. The cash balance value is used instead of the market value because all investments are assumed to be held to maturity. Using the projected cash flows adds realism to the model, although some investments will be redistributed based on the cost projections in the 2000 TSLCC (DOE 2001). It is assumed that all future investments are purchased at 100 percent of the face value and are held until maturity.

This cash flow analysis methodology produces the same results as a net present value analysis when the same interest rates are used. The cash flow analysis provides more visibility into how fee revenues, investment income, costs, and the NWF balance vary by year. This methodology allows cash flow modeling for the current fund portfolio of U.S. Treasury instruments, using the actual investment returns. In addition, this methodology for the 2000 Fee Adequacy Assessment

uses a series of interest and inflation rates, during the period 2000 through 2042, for investment of income and reinvestment of maturing securities for one set of analyses, and applies a single average historical rate for another set of analyses.

This analysis uses a series of forecasted interest and inflation rates, provided by Standard and Poor's DRI, which were extracted from the *Cost Escalation and Interest Rates for 2000* (CRWMS M&O 2000). The single average historical interest rate used in this analysis was extracted from *Stocks, Bonds, Bills, and Inflation 2000 Yearbook* (Ibbotson Associates 2000). The cash flow modeling of investment returns used the 10-year and 1-year Treasury Note series to approximate the investment returns on the matching and contingency portions of the NWF portfolio. The 10-year rate was used for modeling the matching portfolio, as the actual average maturity on this portfolio is closer to 10 years than 30 years. It should be noted that the rate differential between the 10-year and 30-year Treasury Notes is small. The 1-year Treasury Note was used for modeling the contingency fund. This rate was chosen as a conservative approximation of the average maturity of the current contingency fund (see Section 3.3.2 for a discussion of the contingency fund).

3. ASSUMPTIONS

The principal underlying assumptions for this fee adequacy analysis fall into three categories: (1) cost assumptions, (2) revenue assumptions, and (3) economic assumptions. Cost assumptions are based upon the 2000 TSLCC (DOE 2001). Revenue assumptions are based on projections of nuclear power generation and on Defense Nuclear Waste Disposal appropriations. Interest and inflation rate forecasts are described in the economic assumptions section. Unless otherwise indicated, all dollar values in the remainder of this report are given in constant 2000 dollars in order to be consistent with the 2000 TSLCC report.

3.1 COST ASSUMPTIONS

The 2000 TSLCC (DOE 2001) estimate provides the cost basis utilized in this assessment. The program costs obtained from the 2000 TSLCC analysis are based on the reference design. However, this analysis differs from the 2000 TSLCC in categorizing future costs. The 2000 TSLCC includes Fiscal Year 2000 costs as part of the program historical costs, and starts future costs in 2001. This analysis includes $0.4 Billion in 2000 costs as future costs to enable the use of the OCRWM fiscal year 1999 audited financial statements (DOE 2001) as the starting point for the NWF balance.

The repository concept consists of a one-repository system without interim storage. This concept should be viewed as representative of the system that will ultimately be developed. Program costs will vary from the current estimate if future design approaches differ from the reference design. Costs may be higher or lower. Uncertainties will be reduced over time as the program moves through licensing and implementation. Future generations will make the ultimate decision on whether it is appropriate to continue to maintain the potential repository in an open, monitored condition or to close the potential repository.

The significant cost changes, resulting from new program scope, incorporated into the 2000 TSLCC (DOE 2001) include the following:

- addition of titanium drip shields
- additional underground development
- increased ventilation
- new waste package designs (including third waste package lid)
- increased surface fuel pool capacity to facilitate blending
- addition of solar power.

The cost estimates have increased from the 1998 TSLCC (DOE 1998a) by $11.8 Billion (in Contract 2000 dollars) This large increase has not affected the adequacy of the NWF. The reason for this result is that most of the large cost increase occurs at the end of the program when the drip shields are procured and installed. These costs occur more than 50 years after the end of emplacement, allowing the balance in the NWF to grow to cover these large costs.

Estimated total system life cycle costs, in constant 2000 dollars, are organized into three major categories: (1) Monitored Geologic Repository, (2) Waste Acceptance, Storage and Transportation, and (3) Program Integration and Institutional. Program future costs are estimated to be $49.7 Billion. Table 1 shows the combined government-managed nuclear materials and civilian share allocations of estimated future total system cost for the 2000 TSLCC scenario. As

this assessment assumes that Defense Nuclear Waste Disposal appropriations will be adequate to cover the defense cost share, the determination of fee adequacy is based only on the civilian share of costs.

Table 1. Summary of Allocations of TSLCC Future Costs (Millions of 2000$)

Category	Future Cost Allocation[a] (2000-2119)		
	Government-Managed Nuclear Material	Civilian	Total[c]
Monitored Geologic Repository	11,590	29,690	41,280
Waste Acceptance, Storage and Transportation (including Nevada Transportation)	1,310	4,600	5,910
Program Integration and Institutional	660	1,790	2,450
Total	13,560	36,080	49,640
Aggregate Allocation Percent[b]	27.3 %	72.7%	100%

NOTES: [a] These future cost allocations differ from the 2000 TSLCC (DOE 2001) since estimated 2000 costs are included for forward-looking analysis.
[b] Percentages are based on allocating total system life cycle costs.
[c] Totals differ slightly from those reported elsewhere due to rounding.

3.1.1 Reduction in Cost Uncertainty

Cost uncertainties will be reduced as the program progresses from licensing to construction and finally to waste emplacement. Scope uncertainties will be eliminated as design issues are closed during licensing and major decisions are finalized. Summarized below are major decisions that will affect program scope, which drives system costs, and a schedule for their anticipated resolution.

Table 2. Major Decisions Affecting Program Scope

Decisions	Date of Resolution
Site Recommendation - determines suitability of Yucca Mountain	2001
License Application – recommends design to the NRC	2003
Nevada rail transportation route selection - narrows route choices from five to one	2003-2005
Construction Authorization - NRC authorizes construction of the chosen design	2006
Determination of need for a second repository	2007-2010
Decision to close the repository	2060-2110
Repository closed	2119

3.2 REVENUE ASSUMPTIONS

The 1.0 mill per kWh fee revenue used in this analysis was derived from the Nuclear Fuel Data Form RW-859 (CRWMS M&O 1996). This data was collected from the utilities for historical discharges and includes a forecast of future discharges, calculated by extending utility projections to end of reactor life. It is assumed in this projection that commercial units will

operate for 40 years from the issuance of their operating licenses, without extensions, and reactor performance will not be affected by aging. RW-859 SNF projections and the resulting fee projections have been adjusted for cancellation of three planned nuclear power units (Bellefonte 1 and 2, and Watts Bar 2), and early shutdowns of Zion 1 and 2, Big Rock Point, Maine Yankee, and Haddam Neck. The cumulative discharge of civilian SNF is estimated to be approximately 83,800 metric tons of heavy metal. The actual and predicted burnup of this discharged fuel was used to obtain an estimate of electrical generation, taking into account plant efficiencies, and to derive the fee revenue.

This evaluation incorporates the revenue losses resulting from an amendment to the Standard Contract for Disposal. The amendment was required by two District of Columbia Circuit Court decisions: one in 1985 and one in 1989 (Wisconsin Electric Power Co. v. U.S. Department of Energy, 778 F. 2d 1; Consolidated Edison v. U.S. Department of Energy, 870 F. 2d 694). These decisions determined that ongoing nuclear utility fees should be based on electricity generated and sold. In FY 1995, the Department made its final reimbursement to the utilities as a result of this revision to fees collected through FY 1990. For this analysis, the Department assumed a 6 percent reduction in future net generation to account for transmission and distribution losses.

In July 2000, the Department entered into a settlement agreement with the PECO Energy Company (now merged into the Excelon Corporation) that amends the standard disposal contract. The agreement allows the utility to offset the costs incurred, due to the Department's delay in taking its waste, by reducing the fees it pays into the NWF. The reference case includes the effect of the PECO Energy Company settlement.

It is assumed that funds paid by the Department for the disposal of DOE SNF and HLW will be sufficient to cover its full cost share, including accrued interest. Any outstanding balances for prior year shares will be paid prior to initial waste acceptance. Annual budget request levels for the disposal of DOE SNF and HLW will be developed according to the Department's memoranda of agreement (DOE 1998c, DOE 1998d) and subject to Congressional appropriations. After initial waste acceptance, it is assumed that the Defense Nuclear Waste Disposal appropriations will match the annual share for government-managed material.

Table 3 presents the amount of assumed annual appropriations used in this report for government-managed nuclear materials through 2015. It was assumed, based on OCRWM budget planning, that annual appropriations of $200, $310, $350, $450, and $540 Million YOE dollars for Defense Nuclear Waste Disposal will be appropriated from 2001 through 2005. From 2005 through 2010, it was assumed that the annual appropriation is increased to $660 Million. This level of appropriation would reduce the prior outstanding financial obligation for government-managed nuclear materials to $0 by the start of waste acceptance. Assumed annual defense amounts are included in this analysis since defense appropriations supplement expenditures from the Fund.

This analysis calculated the outstanding balance, owed for government-managed nuclear materials, to be $1.3 Billion at the end of fiscal year 1999. The 2000 TSLCC (DOE 2001) recalculated the civilian and government shares based on the updated estimate of total program costs, from inception through closure and decommissioning. Changes to prior year cost shares resulted in a decrease in the outstanding obligation for government-managed materials.

The calculation of the outstanding obligation for government-managed materials takes into account both the annual share of prior year costs, and the interest accrued on outstanding obligations. The annual share factor is determined using constant dollars and by applying the methodology published in the Federal Register and described in the 2000 TSLCC (DOE 2001).

Table 3. Assumed Annual Appropriation for Government-Managed Nuclear Materials (Millions of YOE Dollars)

Fiscal Year	Assumed Annual Appropriations for Government-Managed Nuclear Materials
2001	200
2002	310
2003	350
2004	450
2005	540
2006	660
2007	660
2008	660
2009	660
2010	660
2011	370
2012	410
2013	500
2014	510
2015	540

NOTE: Actual payment schedules will be developed in accordance with the Department's Memoranda of Agreement and subject to Congressional Appropriations.

If the disposal fee remains unchanged at 1.0 mill per kWh of electricity generated and sold, the cumulative future fee revenues, using the lower and higher reference benchmark economic assumptions, would fall in a range of $9.9 to $11.5 Billion in 2000 dollars for the reference case, which includes the PECO Energy Company settlement.

The standard contract for disposal between the Department and utilities provided two deferred payment options for one-time fees. Deferred fees can be paid either as 40 quarterly payments in the 10 years prior to acceptance of fuel, or as a lump-sum payment prior to waste acceptance. At the end of FY 1999, $0.9 Billion of principal remained deferred and continues to accrue interest at the 13-week Treasury bill rate. For this analysis, it was assumed that lump-sum payments of deferred one-time fees begin in 2010, and are paid by each utility prior to the first pickup of SNF from that utility.

In addition to the fees and interest on deferred one-time payments discussed above, the interest on unexpended NWF balances provides revenue. NWF balances are invested by the Secretary of the Treasury in obligations of the United States with maturities appropriate to the needs of the program. The analysis in Section 4.2 addresses the sensitivity of the fee adequacy assessment to future combinations of nominal interest rates and inflation.

3.3 ECONOMIC ASSUMPTIONS

Economic assumptions used in this fee adequacy report consist of interest rate and inflation forecasts, and an assumed investment strategy.

3.3.1 Projected Interest and Inflation Rates

The forecasted interest and inflation rates, provided by Standard and Poor's DRI, used in this analysis were extracted from the *Cost Escalation and Interest Rates for 2000* (CRWMS M&O 2000). A 40-year historical average of the real return on long-term government bonds was extracted from *Stocks, Bonds, Bills, and Inflation 2000 Yearbook* (Ibbotson Associates 2000).

- 10-Year and 1-Year Treasury Note Series - The 10-year rate forecast provided the annual nominal interest rate earned on future investment portfolio holdings, excluding current investments. This forecast was used as an upper reference benchmark for these analyses. The 1-year note rate forecast provided the annual nominal interest rate earned on the contingency portion of the fund. For purposes of simulating the investment strategy, current investments, held as of September 30, 1999, were assumed to be held until maturity and earn their actual coupon return until maturity. It should be noted that this rate is the same given for 30-year bonds in OMB Circular A-94.

- 13-Week Treasury Series - This forecast provided the rate used in the calculation of the interest portion of the deferred one-time fees and outstanding balance on government-managed nuclear materials.

- 40-year Historical Average of Long-Term Government Bonds - This rate was used as a lower reference benchmark forecast for annual nominal and real interest rates earned on future investments. Use of this series is conservative, as current economic forecasts are likely to prevail in the near term.

- Consumer Price Index - All Urban Consumers - This forecast provided the discount rate used to convert YOE fees and income to current year dollars.

3.3.2 Investment Strategy

This analysis simulates the expected results of the program's investment strategy. The objectives of the strategy are to: (1) ensure that investment income is available when needed; (2) support the adequacy of the fee paid into the NWF by waste owners and generators; and (3) hedge against uncertainty and unplanned funding requirements. To achieve these objectives, the NWF is managed as two portfolios: a contingency portfolio and a match portfolio. The purpose of the contingency portfolio is to hedge against reasonable contingencies such as unexpected near-term expenditures. The purpose of the match portfolio is to provide reliable funding for expected program expenditures. It serves to bring into balance the program's assets and liabilities and to maintain that balance. The contingency portfolio is highly liquid and consists of Treasury securities whose average maturity is approximately 3 years. The match portfolio consists of a mix of Treasury bills, notes, bonds, and zero-coupon bonds. The durations and present values are matched or will be matched, year-for-year, to the durations and present values of the program's projected liabilities. Matching investments to planned spending reduces the sensitivity of the fee adequacy balance to changing interest rates. Each month, near-term cash flow

expectations and current asset and liability values are re-assessed and used as the basis for investment selection. The portfolio is re-balanced, as required, upon completion of each new total system life cycle cost analysis or when changes in program assumptions warrant.

4. FEE ADEQUACY

This analysis finds that the current 1.0 mill per kWh fee charged on generators of commercial SNF is adequate, and recommends that the fee remain unchanged. This recommendation is based on the examination and analysis of revenue forecasts and estimated costs for the reference design as described in the 2000 TSLCC estimate (DOE 2001). The NWF is projected to have a positive balance at the end of waste emplacement activities based on current program cost estimates, fee revenue projections, a range of interest rates, and independent projections of inflation. This balance is expected to be sufficient to fund the planned program and to allow for contingencies. Ending the emplacement period with sufficient capital in the NWF will retain alternatives for future decision-makers. A NWF balance in excess of the minimum requirement provides a margin of safety for uncertainties or changes in program scope, costs, revenues, and economic assumptions.

Projected balances in the NWF are highly sensitive to the economy's real rate of return, approximated by the difference between the nominal interest rate and the inflation rate. This current assessment is based on economic assumptions that have changed from the previous assessment (DOE 1998b). The previous assessment used in its analysis an average real interest rate of 2.3 percent (Standard and Poor's DRI 1998) on the 10-year U.S. Treasury Note. The current forecasted series averages 4.2 percent (Standard and Poor's DRI 2000). Current economic forecasts are strongly influenced by the current economic environment and are much more favorable than recent United States historical experience. Given the long duration of the CRWMS program and the sensitivity of fee adequacy to changes in economic assumptions, this analysis also considers a second real interest rate series to provide a lower benchmark. The lower reference benchmark series utilized a constant 2.6 percent real interest rate. The 2.6 percent is the historical average over the past 40 years of the real rate on long-term government bonds (Ibbotson Associates 2000). This analysis finds that even if the more conservative 40-year historical average economic assumptions are utilized, the fee remains adequate.

4.1 FEE ADEQUACY RESULT

This analysis finds the current 1.0 mill per kWh fee is adequate for the reference design contained in the updated 2000 TSLCC (DOE 2001) estimate. The NWF balance in 2042 ranges from $9.1 to $45.6 Billion in constant 2000 dollars for the two different sets of economic assumptions. The target balances in 2042, after the completion of waste emplacement, to provide for a sinking fund for the remainder of program activities are $6.6 Billion for the 40-year historical real average rate case (Figure 2) and $3.2 Billion for the forecasted 10-year Treasury real rate (Figure 3). Results of this analysis are presented in Figures 2 and 3. The black lines on Figures 2 and 3 represent the boundary between the Fee Adequate/Fee Not Adequate areas, with current costs and economic assumptions.

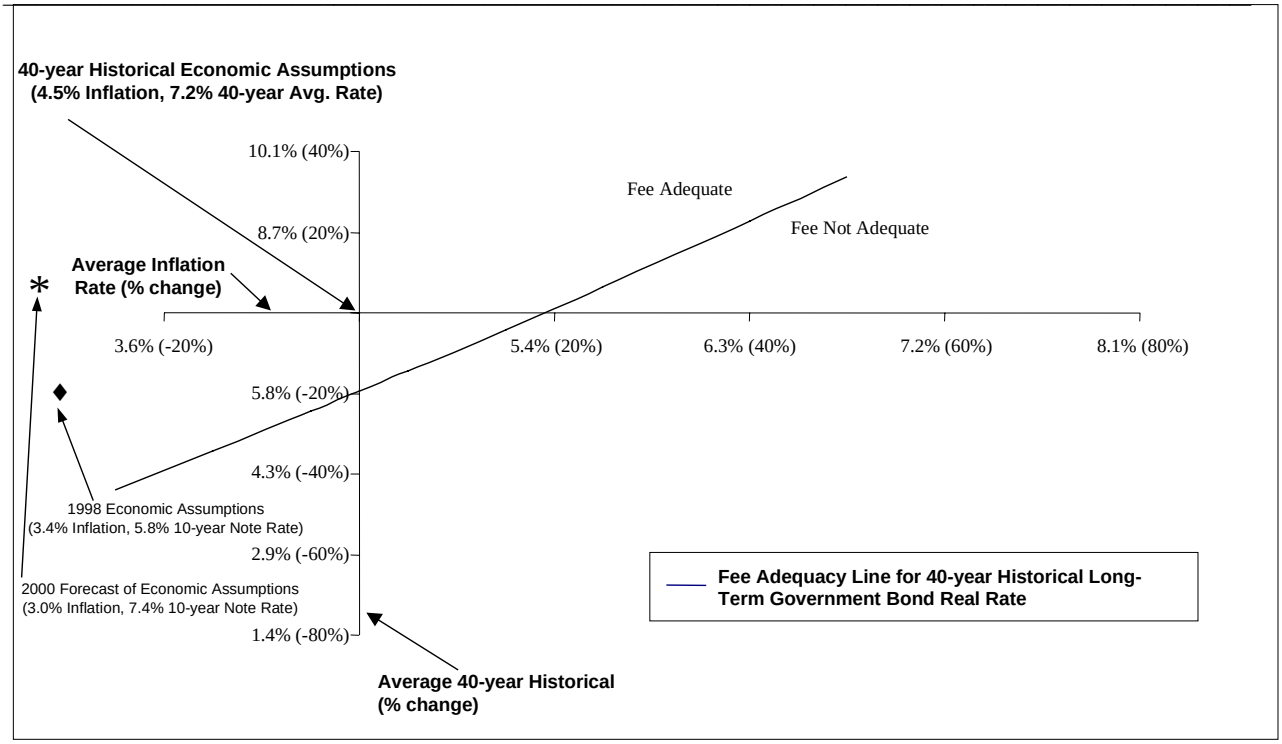

Figure 2. Fee Adequacy Sensitivity to Changes in Economic Assumptions for 40-year Historical Average of Long-Term Government Bond Rates

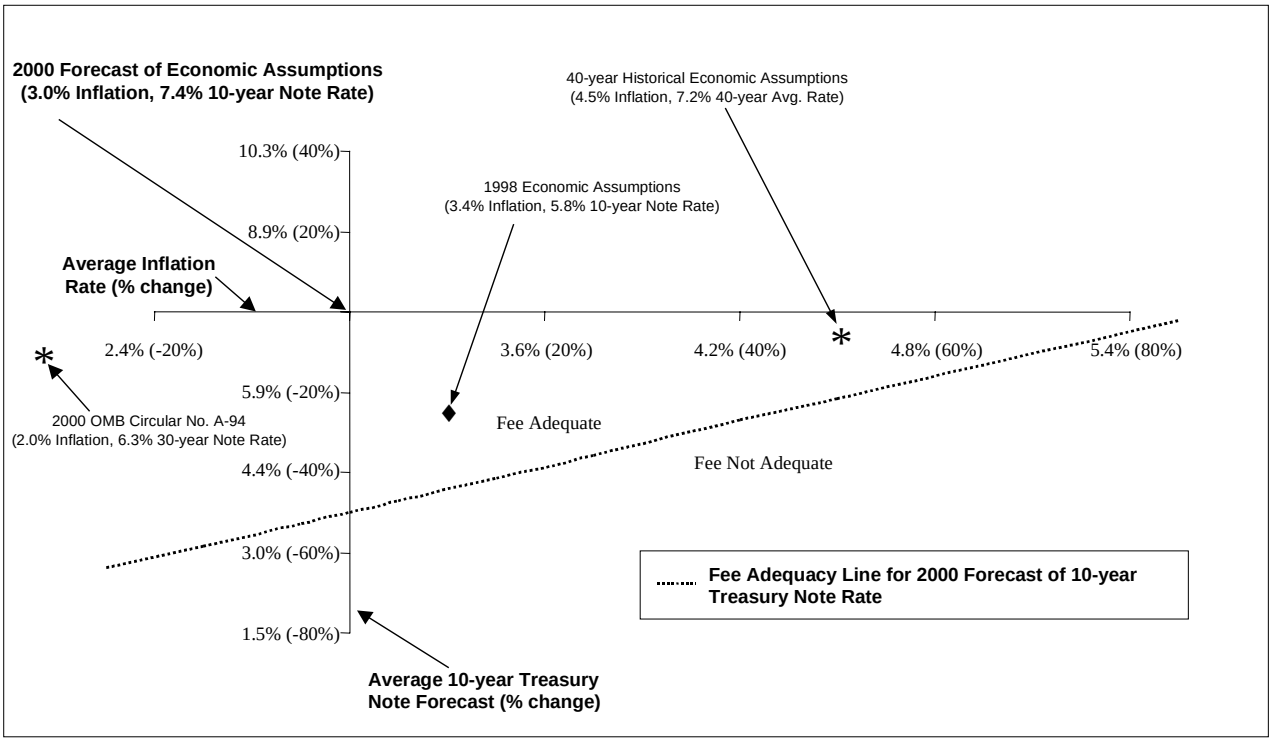

Figure 3. Fee Adequacy Sensitivity to Changes in Economic Assumptions for 2000 Forecast of 10-year U.S. Treasury Note Rate

The target balance in 2042 was calculated as the net present value of the future costs for the monitoring, closure, and decommissioning activities in 2000 constant dollars. The discount rate for the net present value calculation for estimating the capital required in 2042 was the average nominal interest rates for the period 2043 to 2119, decreased by 25 percent for economic uncertainty.

The slope of the lines represents the percentage increase in the inflation rate for a percent change in the nominal interest rate that keeps the program on the fee adequacy boundary. If the intersection point of the axes of percentage changes in the nominal interest rate and the CPI inflation rate falls below the line, the balance of the NWF after emplacement is too small to fund remaining projected costs. The zero intercept (origin) in Figure 2 represents the past 40-year average of inflation and interest on long-term government bonds. The zero intercept in Figure 3 represents the current forecast of inflation and interest on 10-year Treasury Notes. The diamonds in Figures 2 and 3 illustrate the economic assumptions used in the 1998 Fee Adequacy Report (DOE 1998b).

4.2 FEE ADEQUACY SENSITIVITY

Fee adequacy is sensitive to changes in economic assumptions on interest and inflation rates, future settlements with utilities, and costs. Figure 4 presents the fee adequacy boundaries for the Reference Case, using the 40-year historical average and the current forecast of the 10-year Treasury Note. These two economic assumption cases most likely will provide reference low and high benchmarks for where actual real rates of return will fall. The area between the two lines represents the most likely range of outcomes.

A rate of return sensitivity analysis was performed utilizing the reference system costs with a PECO style settlement with all of the utilities. The Department believes that the PECO Energy Company settlement adequately limits the liabilities that may be incurred as a result of the delay in beginning waste acceptance. Employing the current Standard and Poor's DRI forecasted series, full implementation of the PECO style settlement does not adversely affect fee adequacy for the analysis. For the Ibbotson Associates historical average of the real rate on long-term government bonds, the fee was found to be adequate.

Section 8 of the 2000 TSLCC (DOE 2000a) addresses the life cycle costs for a potential flexible repository that could be operated over a range of thermal modes. In general, a repository design that operates at a lower temperature than the reference design will result in an increase in the total life cycle costs. The magnitude of the increase (and the resulting fee adequacy determination) depends on the particular thermal conditions chosen and the design and/or operations changes made to the potential repository to achieve those conditions. At the current time, a specific thermal operating mode has not been selected. Engineering evaluations are being conducted to evaluate how the potential repository will perform under a variety of operating modes and subsurface temperatures. Once these evaluations are completed, an appropriate range of operating modes will be selected to represent the flexible design. Cost estimates will then be prepared and these estimates will be used as input to a fee adequacy analysis of the flexible design.

4.3 ANNUAL DATA

Table 4 provides a detailed breakout of representative annual cash flows in constant 2000 dollars for the reference program cost estimate, using the economic assumptions for the 40-year historical average (Ibbotson Associates 2000). Table 5 provides a detailed breakout of representative annual cash flows in constant 2000 dollars for the reference program cost estimate, using the economic assumptions for 10-year U.S. Treasury Notes (Standard and Poor's DRI 2000).

The civilian cost shares in Tables 4 and 5 are less than the calculated annual shares, prior to 2010, due to assumed repayment of prior outstanding government financial obligations, including interest, for government-managed nuclear materials. The repayment of outstanding balances offsets the civilian cost share in the early years since this receipt of funds, greater than the annual cost share, reduces the need to withdraw funds from the NWF. For a given year, the current Fund balance equals the previous year's Fund balance less the civilian cost share, plus fee payments, one-time fee payments, and income from investments.

4.4 FEE ADEQUACY ANALYSIS CONCLUSION

This assessment concludes that the 1.0 mill per kWh fee based on the reference design is sufficient at this time. However, future economic conditions may vary from the forecasts used in this analysis, and costs may vary due to future changes in program scope. In all sensitivity cases analyzed, if the current forecast of the real return on 10-year Treasury Notes (Standard and Poor's DRI 2000) is used, the fee is adequate.

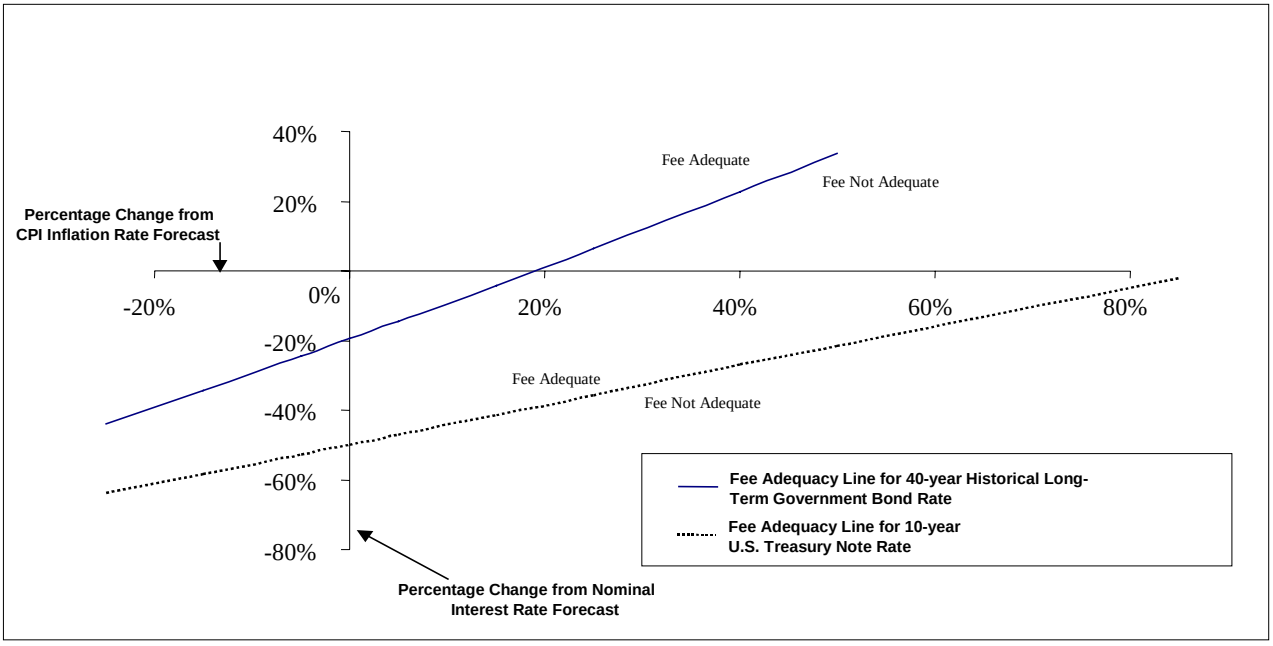

Figure 4. Comparison of Fee Adequacy for Different Economic Assumptions

Table 4. Detailed Nuclear Waste Fund Cash Flows for Reference Cost Estimate Using Historical 40-Year Real Average Economic Assumption (Millions of 2000$)

Fiscal Year	Civilian Cost Share	Fee Payments	One-Time Fee Payments	Income from Investing	Balance in Nuclear Waste Fund
2000	260	700	0	450	9,580
2001	210	670	0	270	10,300
2002	160	630	0	270	11,050
2003	200	610	0	260	11,720
2004	270	590	0	290	12,320
2005	320	560	0	290	12,850
2006	240	530	0	310	13,450
2007	920	510	0	330	13,370
2008	990	490	0	350	13,220
2009	1,120	470	0	320	12,890
2010	650	440	1,200	300	14,180
2011	630	410	980	340	15,280
2012	680	380	0	360	15,350
2013	770	350	610	390	15,930
2014	750	300	0	410	15,890
2015	780	260	30	400	15,810
2016	800	240	0	410	15,660
2017	770	220	0	430	15,540
2018	770	200	0	400	15,370
2019	750	190	0	420	15,230
2020	750	180	0	420	15,080
2021	730	160	0	420	14,930
2022	730	140	0	400	14,740
2023	730	20	0	390	14,420
2024	710	0	0	390	14,100
2025	790	0	290	400	14,000
2026	760	0	0	380	13,620
2027	770	0	0	370	13,220
2028	730	0	0	360	12,850
2029	710	0	0	340	12,480
2030	680	0	0	330	12,130
2031	720	0	0	320	11,740
2032	690	0	0	310	11,350
2033	610	0	0	300	11,040
2034	600	0	0	290	10,730
2035	600	0	0	280	10,410
2036	590	0	0	270	10,100
2037	590	0	0	260	9,770
2038	590	0	0	260	9,440
2039	570	0	0	250	9,110
2040	360	0	0	240	8,990
2041	240	0	0	240	8,990
2042	120	0	0	240	9,110
Total[a] (2000-42)	**26,400**	**9,260**	**3,120**	**14,450**	**9,110**

NOTE: [a]Totals may not add due to independent rounding.

Table 5. Detailed Nuclear Waste Fund Cash Flows for Reference Cost Estimate Using Current Forecasted 10-Year Real Treasury Note Economic Assumption (Millions of 2000$)

Fiscal Year	Civilian Cost Share	Fee Payments	One-Time Fee Payments	Income from Investing	Balance in Nuclear Waste Fund
2000	260	700	0	450	9,570
2001	210	690	0	480	10,530
2002	150	660	0	470	11,500
2003	180	650	0	460	12,430
2004	240	630	0	480	13,290
2005	280	620	0	510	14,150
2006	180	600	0	580	15,140
2007	850	590	0	620	15,500
2008	910	570	0	670	15,820
2009	1,040	550	0	660	16,000
2010	560	530	1,450	650	18,070
2011	630	500	1,200	760	19,900
2012	670	480	0	880	20,590
2013	780	440	780	960	21,990
2014	750	400	0	1,010	22,640
2015	780	350	40	1,010	23,260
2016	790	320	0	1,040	23,830
2017	760	300	0	1,070	24,440
2018	770	280	0	1,070	25,010
2019	750	260	0	1,150	25,670
2020	750	250	0	1,160	26,320
2021	720	220	0	1,200	27,010
2022	730	190	0	1,210	27,690
2023	730	30	0	1,240	28,230
2024	710	0	0	1,300	28,820
2025	790	0	420	1,250	29,700
2026	760	0	0	1,270	30,210
2027	770	0	0	1,290	30,740
2028	730	0	0	1,310	31,320
2029	710	0	0	1,340	31,940
2030	680	0	0	1,360	32,630
2031	710	0	0	1,390	33,310
2032	690	0	0	1,420	34,040
2033	610	0	0	1,450	34,880
2034	600	0	0	1,490	35,760
2035	590	0	0	1,520	36,700
2036	590	0	0	1,560	37,670
2037	590	0	0	1,600	38,690
2038	590	0	0	1,650	39,750
2039	570	0	0	1,690	40,860
2040	360	0	0	1,740	42,250
2041	240	0	0	1,810	43,820
2042	130	0	0	1,870	45,560
Total[a] (2000-42)	**25,900**	**10,000**	**3,900**	**48,100**	**45,560**

NOTE: [a]Totals may not add due to independent rounding.

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5.2 CODES, STANDARDS, REGULATIONS, AND PROCEDURES

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