Nuclear Waste Policy Act

Nuclear Waste Fund Fee Adequacy: An Assessment

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

INTRODUCTION AND SUMMARY

This is the third annual report [1,2/] in a series that evaluates the adequacy of the waste disposal fees to cover the Federal Government's costs for the disposal of commercial spent nuclear fuel (SNF) and high-level radioactive waste. These fees were established by the Nuclear Waste Policy Act of 1982 (NWPA) (Public Law 97-425) and consist of a one-time fee that was assessed on waste existing on April 7, 1983 and an ongoing fee assessed on subsequent nuclear-powered generation.

The principal recommendation of this year's analysis is that the ongoing disposal fee should remain at 1.0 mill per kilowatt-hour (kwh) for 1985, based on the following findings:

- The current 1.0 mill per kwh fee is projected to produce revenues sufficient to offset estimated total system life-cycle costs for a reasonable range of program cost, nuclear generation, and economic environment forecasts, as detailed later in this report. The margin of revenues over costs varies considerably among the cases analyzed. The bounding case shows that the present fee is barely adequate, while others show substantial margins.

- For the near term, program indebtedness due to 1983 appropriations cannot be repaid until payment of a substantial fraction of the utilities' $2.3 billion debt from the one-time fee is received. Utilities have expressed intent to pay a total of $770 million in 1985, which would enable full repayment of the appropriation.

- Many of the cost and revenue forecasts analyzed, particularly those for the U.S. Energy Information Administration's (EIA) Mid Case generation forecast, show margins of revenues over costs. These margins indicate that, if cost and generation estimates are correct, the cumulative program costs could be recovered by a reduced fee, or that program costs higher than the current estimates could be recovered by the 1.0 mill per kwh fee. However, these margins are within the uncertainty bounds of the electrical generation and program cost estimates, so a fee reduction is not warranted at this time. Fee revisions may be recommended within a few years, when more accurate program cost estimates will be developed as the program matures from its present conceptual design phase to the engineering design phase.

- Future program cost increases due to general inflation or real price increases could be recovered by indexing the fee to the inflation rate or another cost index. Based on current estimates, the margins of revenues over costs provided by the 1.0 mill per kwh fee could provide a buffer so that this indexing would not need to begin immediately. The date when indexing would be needed varies with the system configuration, with nuclear growth rates, and with the rate of inflation. The need to index the fee to correct for inflation could occur as early as 1986 if no additional nuclear plants will ever be ordered, but not until

1990 or later if the nuclear growth rate matches that portrayed by the Mid Case. Indexing is merely an alternative to larger, less frequent fee adjustments, so this analysis does not provide a compelling case for initiating indexing in 1986, especially since it will not be clear then that no new nuclear plants will be ordered in the future.

These findings are based on a cash flow analysis that utilized methods very similar to those employed in previous fee adequacy studies. Refinements were made in the areas of system logistics, repository acceptance schedules, repository operating profiles, real interest rates, and treatment of real cost increases.

Nuclear wastes produced from defense activities are not considered quantitatively in this report. Preliminary analyses have indicated that economies of co-emplacing defense and civilian wastes could be beneficial to both, but methods of allocating common costs appropriately will not be recommended until cost impacts have been determined more accurately.

BACKGROUND AND LEGAL REQUIREMENTS

The Act prescribed that the owners and generators of commercially generated nuclear waste will pay the full costs of its disposal, and established a Nuclear Waste Fund (NWF) to ensure the full cost recovery funding of a safe and environmentally acceptable program. This fund receives revenue from an adjustable ongoing fee charged quarterly for all electricity generated by commercial nuclear facilities beginning April 7, 1983, as well as a one-time fee, estimated to produce a total of $2.3 billion, for nuclear waste produced prior to April 7, 1983. Revenues generated from these two sources, as well as interest earned from the investment of any surpluses in U.S. Treasury securities, are deposited to the NWF, and disbursements are made to cover costs as the program progresses.

The Act (Section 302(a)(4)) calls for an annual review of the adequacy of the waste disposal fees to recover waste disposal program costs. Based on the results of the evaluation, the ongoing fee may be adjusted, if necessary. Fee adjustment requires Congressional approval.

The analysis summarized here examined both the costs and financing of the civilian nuclear waste management program described in the Department of Energy's (DOE) draft Mission Plan of April 1984[3/]. This draft Mission Plan has undergone public review, and DOE is currently reviewing facility deployment dates and roles stated therein in light of public comment. Also in progress is a general reassessment of the waste acceptance schedule required to meet program goals. Together, these efforts may dictate some change in the disposal system configuration. The results of this planning review will not be available until March, 1985. Although detailed cost estimates for the revised system configuration have not been developed, the Department anticipates that the estimated total system cost will not change enough to materially alter the conclusions of this report.

METHODOLOGY AND ASSUMPTIONS

This evaluation of fee adequacy is based on the principle of "full-cost recovery," which means that the federal government should be reimbursed for all costs related to the waste disposal services it provides to the signatories of DOE's "Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste."[4/] The principle of full-cost recovery underlies the basic analytic approaches used by DOE in 1978, 1980, 1983, and 1984 to evaluate financing methods suited to a federally administered program for the disposal of civilian nuclear waste.

The general methodology employed in this year's report projects Nuclear Waste Fund cash flows and resulting balances based on estimated program costs and revenues, including interest earnings and expenses. The reference real interest rate was assumed to be 3 percent; 2 and 4 percent also were evaluated for sensitivity. If the final program balance is projected to be positive, then the fee is judged adequate to ensure full cost recovery. If the projected final program balance is estimated to be negative, then the converse would be true.

The principal assumptions underlying the analysis summarized in this report are noted below:

o	Nuclear growth projections	EIA "Mid" Case EIA "No New Order" Case
o	Spent fuel cumulative discharge through year 2020	130,300 metric tons uranium (MTU), Mid Case-97,700 MTU, No New Orders Case
o	Number of geologic repositories	Two
o	Repository design capacity	70,000 MTU each
o	First repository receipt rates	400 MTU/year for 3 years 900 MTU in year 4 1800 MTU in year 5 3000 MTU/year thereafter
o	Second repository receipt rates	1800 MTU/year for 5 years 3000 MTU/year thereafter
o	Cooling time since discharge of spent fuel	5 year minimum
o	Operational startup dates for the repositories	First repository in 1998 Second repository in 2006
o	Retrievability period	50 years after the first emplacement

Several alternative program cases (i.e. sensitivity cases) were also studied to determine the sensitivity of the projected program balances to different programmatic assumptions. The assumptions for these alternative cases diverge from the assumptions noted above with respect to repository development schedules (five and ten year delays were considered) and variations in economic parameters. In the delay cases, a Monitored Retrievable Storage (MRS) facility was assumed to be deployed in 1998.

The revenue projections used in this analysis were derived from estimates of gross electricity generation prepared in September, 1984, by EIA[5/]. Two EIA nuclear growth projections were utilized. The Mid Case assumes that there will be no net future cancellations of present construction projects (i.e., any cancellations will be offset by resumption of previously deferred projects) and that commercial nuclear power will grow at a moderate rate between 1990 and 2020. This results in an approximate doubling of installed nuclear capacity, from 107 gigawatts electrical (GWe) in 1990 to 212 GWe in 2020. The No New Orders Case assumes that all reactors that are currently under construction but are less than 30 percent complete, are indefinitely deferred, or have a current work stoppage, will be cancelled, and that no orders for new reactors will be placed. The net effect is that after the reactors that are now more than 30 percent complete begin operation by about 1990, the installed nuclear capacity will be stable at 109 GWe for about ten years, and then will decline to 49 GWe in 2020 and zero soon after as plants are retired.

Together, the Mid and No New Orders growth projections are believed to furnish a reasonable basis for the fee adequacy evaluation. They are not intended to represent absolute bounding cases, but to illustrate the potential effects of a reasonable range of nuclear generation projections.

A discrete life cycle for waste disposal costs and revenues is required in order to bound the cash flow analysis. As in previous studies, the current analysis is based on the convention that costs and revenues are estimated for all SNF generated through the year 2020.

The total system life-cycle costs of the civilian nuclear waste management program analyzed in this report are organized into three major categories that retain the costing structure used in the previous fee analysis reports. These categories are: 1) development and evaluation; 2) geologic repository construction, operations, and decommissioning; and 3) waste transportation. MRS costs form a fourth major category in the alternate repository delay scenarios.

Basalt, salt, and tuff are being considered as possible geologic media for the first repository. Several potential salt sites and one site in each of the other two media have been identified for evaluation. The alternatives for the second repository are crystalline rock and those sites not selected for the first repository. Cost estimates were developed for several likely media combinations, and the high and low cost combinations were selected for cash flow analysis.

Significant Changes in Methodology and Assumptions

For the most part, the methods and assumptions used for this analysis are the same as those used in the previous fee adequacy reports. There are, however, a few significant changes that are briefly summarized below.

As in the previous analyses, the current estimates are based on a two repository waste disposal system. The current cost estimates are based on receiving spent fuel as soon as five years after discharge, compared with ten years in previous analyses. Therefore, the second repository can operate more nearly at design receipt rates over its emplacement period due to the availability of aged SNF. The first repository cost estimates are based on two operating phases: during the first three years, intact fuel assemblies are emplaced; during the second phase, consolidated fuel rods are emplaced. This would allow acceptance and disposal of SNF at an earlier date, but at a lower rate, while the consolidation facility is still under construction. The cost estimates for the second repository are based on emplacing consolidated fuel rods throughout its receiving lifetime, which was the assumed operating mode for both repositories in previous analyses.

The current analysis allocates repository costs over time assuming that there will be a caretaker period to allow retrievability of spent fuel for fifty years after the first emplacement. Previous analyses assumed that backfilling and decommissioning immediately followed the waste emplacement operations. This revised allocation of repository costs over time more accurately captures the retrievability requirements of the NWPA. This lengthens the system life cycle by more than twenty years, and the interest effects on the program balance over this longer life cycle are even more pronounced. Therefore, the final program balances in this report cannot be compared directly with those from previous reports.

This analysis assumed a real interest rate of 3 percent for the reference case, while previous analyses assumed 2 percent. Current real interest rates for short term U.S. Treasury securities are about 5 or 6 percent, which suggests that present trends have changed from the long term pattern of real interest rates in the 0 to 2 percent range. Such high real rates may not continue indefinitely, but prospects for inflation and nominal interest rates indicate that real rates above 2 percent are likely for some time.

Past analyses have calculated the adjustments to the fee to recover program cost increases due to inflation. Since the program is in a surplus position for much of its life cycle, and since inflation also affects the nominal interest rate, inflation is partially offset by higher interest earnings. To separate these effects, a calculation of the potential impact of real price increases is included in this years analysis. These results show the amount of real program cost increases that can be tolerated given the 1.0 mill per kwh fee.

ANALYSIS

This section discusses both revenue and program cost projections and describes the analysis used to assess the adequacy of the current 1.0 mill per kwh fee to fully recover program costs.

Revenues

If the disposal fee remains unchanged at 1.0 mill per kwh, the cumulative revenues (including the one-time fee) derived from the two EIA electricity generation projections, are $31.8 billion for the Mid Case and $22.5 billion for the No New Orders Case. The revenues from the disposal fee are distributed over time in proportion to annual gross electrical generation. In the No New Orders Case, this results in a pattern of revenues increasing at about 5 percent per year until 1998, then remaining stable for about 10 years, and then declining as plants are retired. The Mid Case revenues increase at about 6 percent per year until 1998, and at about 3 percent between 1998 and 2020. Interest earnings amounting to several billion dollars would also accrue to the Nuclear Waste Fund during those years when program revenues are expected to exceed program costs.

Life-Cycle Costs

Estimated total system life-cycle costs are organized into three major categories: 1) development and evaluation costs; 2) waste transportation costs; and 3) geologic repository construction, operations, and decommissioning costs.

Life-cycle costs associated with development and evaluation cover the program administration costs and all the siting, testing, design development, regulatory, and institutional activities relating to the two geologic repositories, monitored retrievable storage facilities, and the required transportation network. These costs are estimated at $7.6 billion (1984 dollars) from 1984 until closure of the second repository.

Life-cycle transportation costs reflect the use of currently licensed transportation packages, technology, and procedures to ship spent nuclear fuel from individual commercial reactor storage sites to regionally located repositories. For the Mid Case with the reference repository schedule, these costs range from $3.3 billion to $5.1 billion, depending on the assumed locations of the two repositories.

The candidate geologic media directly influence the activities, and hence the costs, associated with the construction and operation of the two repositories. As a result, total life-cycle cost estimates vary noticeably from host rock to host rock, with the overall difference amounting to about 60 percent for the first repository (from $6.7 billion to $10.8 billion). Table 1 displays the total system life-cycle cost estimates for a representative set of media combinations for the Mid Case with reference repository schedule.

Table 1. Summary of Total System Life-Cycle Costs for Reference Mid Case (Billions of 1984 dollars)

Host Rock First/Second Repository	Development and Evaluation	Transportation	First Repository	Second[a] Repository	Total[b]
Salt/C.R.[c]	$7.6	$3.3	$ 6.7	$6.0	$23.6
Salt/Salt	7.5	4.0	6.7	5.8	24.0
Tuff/C.R.	7.6	3.8	7.0	6.0	24.4
Tuff/Salt	7.5	4.4	7.0	5.8	24.7
Basalt/C.R.	7.6	3.9	10.8	6.0	28.3
Basalt/Salt	7.5	4.4	10.8	5.8	28.5
Basalt/Tuff	7.6	5.1	10.8	6.1	29.5

(a) Only 60,300 MTU is emplaced in the second repository.
(b) The sums of the components may not equal the totals due to rounding.
(c) C.R. - Crystalline rock

Cost sensitivity cases were analyzed for the two EIA spent fuel discharge and electricity generation forecasts and for the two repository delay cases described earlier in the report. For each system variation, total system life-cycle costs were estimated for the lowest- and highest-cost pairs of repository media. The ranges for estimated system life-cycle costs are shown in Table 2.

Table 2. Total System Life-Cycle Cost Ranges for Reference and Alternative Cases (Billions of 1984 dollars)

Alternate Program Assumptions	Low Cost Estimate	High Cost Estimate
Reference Mid Case	$23.6	$29.5
No New Orders Case	20.6	25.6
Mid Case - 5 year delay	26.9	32.9
Mid Case - 10 year delay	28.7	35.1

Nuclear Waste Program Cash Flow Analysis

The cost and revenue forecasts discussed above were combined in a series of cash flow analyses that simulate the financial status of the Nuclear Waste Program over time. This simulation was based on guidelines for fund management set forth in the NWPA. These guidelines state that annual surpluses will be invested in short-term U.S. Treasury securities or used to redeem outstanding debt, and that annual shortfalls in annual revenue will be met by redeeming short term securities held by the fund or by

borrowing from the U.S. Treasury. Various measures of performance for the program are available from the analysis, including the final program balance, near term program balances, and tolerance for program cost increases. These are discussed in the following subsections.

Final Program Balances The final program balances are very sensitive to the effects of the interest earned or paid by the program. In all but one of the cases examined, the final program balance is positive, but varies substantially depending on the program variations and on the interest rate. In the No New Orders Case, the 1.0 mill per kwh fee is not quite adequate to meet the high cost estimate if surplus funds earn 2 percent real interest. The final program balances (in constant 1984 dollars) are shown in Table 3 for various assumptions. These final program balances will result if program costs do not increase above the current estimates or if the fee is adjusted to compensate for future cost increases. Note that the final program balance is relatively insensitive to delays in repository availability, even though the incremental storage costs may increase the life-cycle cost estimate by more than 20 percent. This effect is due to delaying the repository construction and operating costs, thus allowing increased interest earnings by the fund during the period prior to repository construction.

Table 3. Final Nuclear Waste Program Balances
(Billions of 1984 dollars)

Alternate Program Assumptions	Program Cost Category	Annual Real Interest Rate (Percent) 2	3	4
Reference Mid Case	low	36	74	149
	high	18	42	93
No New Orders Case	low	15	35	79
	high	-1	7	30
Mid Case - 5 year delay	low	31	67	143
	high	14	40	97
Mid Case - 10 year delay	low	29	66	145
	high	12	39	101

Near Term Program Status In the near term (through 1990) the performance of the Nuclear Waste Program will not be altered substantially by either the nuclear industry growth rate or by the selection of repository media. At the start of FY 1984, the program had a balance of $73.6 million, and an appropriated debt of $254 million, for a net position of -$180.4 million. Funds will not be available to repay the appropriated debt until a substantial portion of the one-time fee revenue is received from the

utilities. The utilities owe about $2.3 billion of one-time fee to the Nuclear Waste Fund for disposal of the waste generated prior to April 7, 1983. Utilities have expressed to DOE their intent to pay $770 million of the one-time fee in 1985 with the early payment option, $184 million by the 40 quarterly payments option, $146 million by the payment prior to first delivery option; the form of payment for the remaining $1.22 billion is undecided. This expression of intent does not constitute a formal commitment at this time, but the near term projected fund balance for the No New Orders Case is shown in Table 4 based on that expression of intent. This projection illustrates that the appropriated debt can be repaid in 1985 but continuing inflation may again leave the program with a deficit by 1989 unless fee adjustments are made. The Mid Case has a slightly higher fee revenue and the program deficit would occur one year later in 1990.

Table 4. Near Term Nuclear Waste Program Projection, Based on No New Orders Case Electrical Generation Projection and 10 Percent Interest (Millions of current year dollars)[a]

Fiscal Year	Program Cost	One-time Fee Revenue	1 mill/kwh Fee Revenue	Interest Revenue	FY End Program Balance
1983					-180
1984	276	0	329	-18	-145
1985	324	770	350	-15	636
1986	566	0	401	63	534
1987	792	11[b]	454	53	260
1988	800	49[b]	493	26	28
1989	774	49[b]	532	3	-162
1990	733	49[b]	558	-16	-304

(a) Annual inflation rate of 4.7% assumed for 1985, 4.6% for 1985, and 4.5% for 1986 and beyond.
(b) Includes interest from April 7, 1983.

Tolerance to Cost Increases As shown by the positive ending program balances in Table 3, the 1.0 mill per kwh fee is adequate to meet costs that are somewhat higher than the projected costs, except for the high repository cost No New Orders Case with 2 percent real interest. Table 5 shows the percentage increase in real system life-cycle costs over the current estimates that could be recovered by the 1.0 mill per kwh fee. The percentages in Table 5 are expressed in terms of a fixed percentage applied uniformly over time. The 48 percent and 23 percent for the Mid Case correspond to an annually compounded real cost increase rate of 2.0 percent and 1.15 percent, respectively. For the No New Orders Case, the 24 and 4 percent increases translate to an annually compounded real cost increase rate of 1.3 and .3 percent, respectively. Thus, even very gradual real cost increase rates could necessitate future fee adjustments.

Table 5. Percentage Increase in Real Life-Cycle Cost Estimates that can be Recovered by the 1.0 Mill per Kwh Disposal Fee

Alternate Program Assumptions	Program Cost Category	Annual Real Interest Rate (Percent) 2	3	4
Reference Mid Case	Low	45	48	51
	High	19	23	27
No New Orders Case	Low	20	24	29
	High	0	4	9

The values in Table 5 may also be interpreted as the maximum amount of uncertainty that can be accommodated in the current cost estimates. Although the uncertainty level of the cost estimates has not been statistically characterized, it has been estimated at 30-40 percent. The uncertainty in both the cost and revenue projections supports the recommendation to leave the fee unchanged until the program costs can be more accurately estimated as the program matures beyond the conceptual design stage.

The final program balances are also extremely sensitive to the effects of compounded annual inflation. With no inflation, or if the fee is indexed to inflation, the final program balance is positive for all but one of the cases discussed in this report, as shown in Table 3 above. However, as the assumed rate of inflation rises, the estimated final program balance declines if the disposal fee is not increased accordingly, even if the current real cost estimates are accurate. The program could end with a final deficit of $34 billion, expressed in 1984 dollars, with the reference Mid Case, high cost repository media, and continuous 3 percent inflation. That deficit could grow to $62 billion with 5 percent inflation. With the No New Orders assumption, the cumulative program deficit could reach $52 billion with 5 percent inflation. Table 6 illustrates this phenomenon for an assumed real interest rate of 3 percent.

Table 6. Final Nuclear Waste Program Balances with Continuous Inflation, Constant 1.0 Mill per Kwh Fee and 3 Percent Real Interest (Billions of 1984 dollars)

Alternate Program Assumptions	Program Cost Category	Annual Rate of Inflation (In Percent) 0	2	3	4	5
Reference Mid Case	Low	74	18	-2	-18	-31
	High	42	-14	-34	-49	-62
No New Orders Case	Low	35	-2	-15	-26	-35
	High	7	-29	-43	-54	-63

With continuing inflation, the fee will need to be increased to avoid the deficits discussed above. Indexing, or automatic fee adjustment, represents a method of fee increases that would levelize the fee over time in real terms. The margin of revenues over estimated program costs in the constant dollar analysis described above provides a buffer so indexing does not need to start immediately. The date that indexing will be needed to avoid program deficits varies with the inflation rate, the system configuration, and the nuclear growth rate. Table 7 identifies, for several example rates of inflation, the year in which the fee indexing should begin to maintain full cost recovery. If indexing is not initiated at the prescribed times, full cost recovery could still be accomplished by larger fee adjustments at a later time.

Table 7. Year to Begin Indexing the Waste Disposal Fee to Insure Full Cost Recovery For Various Assumed Inflation Rates

Alternate Program Assumptions	Program Cost Category	Annual Rate of Inflation (In Percent) 2	3	4	5
Reference Mid Case	Low	--	2013	2001	1996
	High	2000	1994	1991	1990
No New Orders	Low	2009	1996	1992	1991
	High	1987	1986	1986	1986

References

1/ U.S. Department of Energy, Report on Financing the Disposal of Commercial Spent Fuel and Processed High-Level Radioactive Waste (DOE/S-0020/1), July 1983.

2/ U.S. Department of Energy, Nuclear Waste Fund Fee Adequacy: an Assessment, July 1984.

3/ U.S. Department of Energy, Mission Plan for the Civilian Radioactive Waste Management Program (Draft) (DOE/RW-0005), April 1984.

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5/ U.S. Department of Energy's Energy Information Administration, Commercial Nuclear Power 1984: Prospects for the United States and the World, November 1984.

*U.S. GOVERNMENT PRINTING OFFICE: 1985-461-208:11240