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Financing Strategies for Nuclear Power Plant Decommissioning

New England Conference of Public Utilities Commissioners, Inc.

Temple, Barker & Sloane, Inc.

Prepared for
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Commission

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Financing Strategies for Nuclear Power Plant Decommissioning

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ABSTRACT

The report analyzes several alternatives for financing the decommissioning of nuclear power plants from the point of view of assurance, cost, equity, and other criteria. Sensitivity analyses are performed on several important variables and possible impacts on representative companies' rates are discussed and illustrated.

EXECUTIVE SUMMARY

The choice of a strategy for financing the decommissioning of a nuclear power plant involves a balance between cost and risk. No financing alternative clearly emerges as the optimal choice.

Delaying the financing until decommissioning is the strategy with the lowest cost to consumers and investors. It also poses the highest risk that funding will not be available when required. This risk arises from the possibility of utility insolvency caused by a serious nuclear accident and from the difficulty of predicting the financial condition of the utility over a long time period.

These risks can be avoided by obtaining and securing the required funds at the beginning of the plant's life. Under most reasonable assumptions, funding at commissioning is considerably more expensive, however, than funding at decommissioning--perhaps three times more costly to consumers.

A sinking fund is a compromise alternative. It is approximately twice as expensive as the least expensive alternative but provides assurance that at least part of the funding will be available.

Although there is significant variation in cost among financing alternatives, the impact of decommissioning on consumer bills is small, typically less than 1 percent.

Ratemaking and tax treatment issues affect the cost of the alternatives but not significantly enough to change the above conclusions. Furthermore, consideration of equity implications, institutional barriers, and jurisdictional differences should not preclude any alternatives. Finally, interest and inflation rates can have significant impacts on both the absolute and relative costs of the alternative financing strategies.

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I. INTRODUCTION

This study by Temple, Barker & Sloane, Inc. (TBS) for the New England Conference of Public Utilities Commissioners (NEC/PUC) addresses the financial aspects of nuclear power plant decommissioning. The study's objective is to evaluate alternative financing and ratemaking strategies in light of the multiple, and sometimes conflicting, criteria of financial assurance, cost, equity, and legal and institutional feasibility.

Nuclear decommissioning is the process by which a nuclear power plant is taken out of service at the end of the plant's useful life and its radioactive material disposed of. Although all types of power plants are decommissioned, nuclear plants present a more technically difficult and expensive problem because of the residual radioactivity in the plant's structures and components. Proper decommissioning of nuclear plants is necessary to protect public health and prevent environmental damage.

The electric utility industry's experience with nuclear decommissioning is limited due to the small number of reactors which have been decommissioned. To date, barely a dozen facilities have been decommissioned, and these have been primarily small-scale experimental facilities. None of the large-scale, commercial reactors which are now common in the industry has yet been decommissioned.

One result of this lack of experience is considerable uncertainty regarding the technology of decommissioning. Several alternatives are being considered and studied, including dismantlement of the facility, placing the facility in safe storage followed at some later time by dismantlement, and entombment of the facility. Dismantlement would return the site to its original state. All materials would be transported to final disposal areas. Placing the facility in safe storage is usually viewed as a temporary measure until most radioactivity contained in the structures and components decays sufficiently to permit dismantlement. Placing the facility in safe storage involves removing fuel rods and radioactive liquids and keeping the facility intact and under guard. Entombment involves making the plant more physically secure, perhaps by encasing buildings in concrete.

Technical uncertainty is accompanied by cost uncertainty, although the costs are known to be large. Estimates range from $38 to $97 million for a commercial 1,000 mw reactor in 1978

dollars.[1] These costs are uncertain both because of unresolved technical issues and the timing of the decommissioning. Under one plausible scenario, a plant would be placed in safe storage for 100 years and then finally dismantled. It is extremely difficult to make either technical or economic projections over such a long period.

Numerous studies have been performed in both technical and economic areas to resolve some of the uncertainties. Several of the economic and financial studies were reviewed by TBS in another report, A Review of Methodologies for Analyzing Nuclear Decommissioning Financing, which was done under the same contract as this report.

This study goes beyond the scope of earlier ones by focusing on two important characteristics of nuclear decommissioning financing: cost and risk. Cost differences among financing strategies result primarily from differences between the utilities' cost of capital and the rate of return which they can earn on external investments. The timing of financing, the choice of amortization schedule, ratemaking treatment, and tax policies also affect cost. The risk of concern to regulators is whether funds will be available for decommissioning considering the difficulty of predicting the financial position of the utility over an extended period of time. In addition, there exists the attendant possibility of premature decommissioning caused by a serious nuclear accident or other unforeseen financial stresses.

These two characteristics, cost and risk, are in conflict. No single financing alternative emerges as dominant on both the risk and cost criteria. The policy maker must choose a financing strategy based on his tradeoffs between cost and risk.

The motivation for this study is to assist the current investigation by the Nuclear Regulatory Commission (NRC) of all aspects of decommissioning. Regulations will likely be promulgated to cover both the technology and the financing of decommissioning.

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[1] McLeod, N. Barrie and R. John Stouky; Factors Affecting Nuclear Power Generating Station Decommissioning Options and Decommissioning Cost Recovery; NUS Corporation, September 1979.

The study presents case studies of two New England utilities, although the conclusions are applicable to national policy. New England was selected because of the unique diversity of the institutional arrangements surrounding its nuclear plants. These institutional factors must be included in a complete financial and economic examination of alternative financing strategies.

The report is organized into five chapters, the first being introductory. The second discusses TBS's approach to decommissioning analysis and identifies the numerous alternatives for nuclear decommissioning financing and ratemaking. The following chapter describes the methodology used for the New England case studies. The fourth chapter presents the findings, and the final chapter summarizes the major conclusions of the study. Two appendices provide further background on the utility financial model used in the analysis and on the major assumptions embodied in the cases.

II. ALTERNATIVES FOR NUCLEAR DECOMMISSIONING FINANCING AND RATEMAKING

TBS's approach separates the analysis of nuclear decommissioning into technical, financial, and rate portions. This chapter describes the study approach and identifies the financing alternatives and the related rate issues which affect the financial analysis.

SEPARATION OF TECHNICAL, FINANCIAL, AND RATEMAKING ANALYSES

A plan for decommissioning a nuclear power plant involves several separate but related actions. These include:

- Selection of a technical plan for decommissioning the plant;
- Financing the decommissioning costs; and
- Incorporating these costs into electricity rates.

The timing of these actions is somewhat flexible. Timing is, in fact, one of the primary concerns of this report because it affects cost, risk, and equity.

The choice of a technical decommissioning plan can be made prior to plant construction, but the plan can be revised at any time prior to the end of the plant's life. The choice of options can actually be delayed indefinitely if the option of placing the facility in safe storage is chosen.

The financing of decommissioning can be done at any time prior to the physical decommissioning and after the costs have been estimated from the technical plan. The financing problem is to make sufficient funds available to cover costs by the time the costs are incurred. While the choice of a technical alternative will determine the amount of financing required, it does not affect the choice of financing strategy. The financing strategy should be decided upon before the start-up of the plant, regardless of the final choice.

In order to separate fully the technical and financial decisions, the financing is assumed to be complete by the end of the plant's useful life. At that time a liquid fund (e.g., a

bank account or stock portfolio) is established which is sufficient to cover all decommissioning costs. If decommissioning is not completed immediately after the plant closes, the amount of the fund must take into account the future interest earned on the fund and the inflation in decommissioning costs. (If forecasts of interest and inflation are not perfect, some residual adjustments may be required after plant closing, but this amount should be small relative to the total required financing.) This separation of technical and financial decisions allows the choice of financing strategy to be independent of the technical assessment because the technical choice affects only the size of the final fund and has no effect on the relative merits of financing strategies.

Financing can also be separated from the incorporation of the costs into rates. For example, in one possible scenario, all of the funds for decommissioning are raised at the beginning of the plant's life, but the costs are included in rates over the entire operating period of the unit. This financing strategy is intended to minimize risk by keeping funds available for decommissioning throughout the plant's life, and the rate treatment is consistent with the regulatory principle of matching electricity rates with the period in which the plant is used and useful. Allowance for funds during construction is an example of financing during one period, the construction phase, and rate impacts in another, the plant's operating life.

Financing and ratemaking are separable in time, but they affect each other in quantity. On the one hand, the amount and timing of financing affect the amount of the rate increase. On the other hand, alternative rate treatments affect the level of rate increases and thus the desirability of alternative financing strategies.

FINANCING ALTERNATIVES

As discussed above, the financing of the decommissioning cost can occur at any time before decommissioning. Furthermore, this report assumes that the financing is complete by the end of the plant's life in order to divorce the financing from the timing of the physical decommissioning.

Three financing alternatives are examined in this report: funding at commissioning, sinking fund, and funding at decommissioning using amortization of a negative salvage value. They are characterized by differences in timing, and they yield different costs and risks.

In the first strategy, funding at commissioning, the utility raises funds by selling a combination of stocks and bonds at the beginning of the plant's life. These funds are segregated from other utility accounts into a trust fund and invested in low-risk liquid assets, e.g., government bonds, where they remain and accrue interest until needed for decommissioning.

A second approach, a sinking fund, involves the gradual accumulation of funds in a similar trust fund. Each year the utility collects additional revenues, issues additional securities, and contributes the proceeds to the trust fund. The trust therefore increases by the accrued interest as well as the annual utility contributions.

The third approach, funding at decommissioning, allows the utility to wait until the end of the plant's life to finance decommissioning. Although the utility collects decommissioning amortization each year based on the plant's negative salvage value, revenues received from customers for decommissioning during the plant's life are not isolated. The funds are treated as a source of internal funds and can be used by the utility for other, unrelated projects.

It is important to realize that each of these options is designed to raise the same amount of money by the last year of plant operation. This amount equals the total funding required to pay for all of the costs of placing the facility in safe storage, entombing, and/or dismantling the plant at some time after plant closure.

While the nominal future value of the three funding options will be the same, the net present value will not be the same because of the different cash flow streams. Funding at commissioning will have the highest net present value, largely due to the difference between the rate of return the utility can earn on an investment and the rate it must pay for borrowed funds. The return that the utility must pay is higher for two reasons. First, the decommissioning fund should be invested in low-risk, lower-return assets such as government or high quality corporate bonds. Second, part (typically half) of the utility's cost of capital is in common and preferred stock whose dividend payments are not tax deductible. The utility will therefore have to raise more money initially because the value of the fund will decrease in real terms over time. This alternative has the lowest risk, however, because the full amount of decommissioning is always available in a liquid fund.

Funding at decommissioning, on the other hand, has the lowest net present value. The utility will raise money from customers over the life of the plant (consistent with the

matching principle mentioned earlier) and will use these funds to reduce its external financing requirements. With funding at decommissioning, consumers, in effect, lend the utility money and pay lower electricity rates than with funding at commissioning due to the utility's reduced financing costs. When the time for decommissioning arrives, the utility must raise the full amount through traditional means. The financial security of this option is based on the financing ability of the utility at some distant future time. Funding at decommissioning is riskier because of the uncertain financial status or even the uncertain existence of the utility 30 years in the future. In the case of a serious financial or technical problem leading to premature decommissioning, financing will probably be more difficult or, at best, more expensive if a trust fund does not exist.

There are a number of critical parameters which affect the desirability of these financing alternatives. These include economic parameters such as interest and inflation rates. The discount rate used to evaluate the results is also important. Finally, the manner in which financing costs are incorporated into rates affects costs.

RATEMAKING ALTERNATIVES

Ratemaking policies will affect the costs to consumers of the financing alternatives. These policies are therefore important in the financing decision.

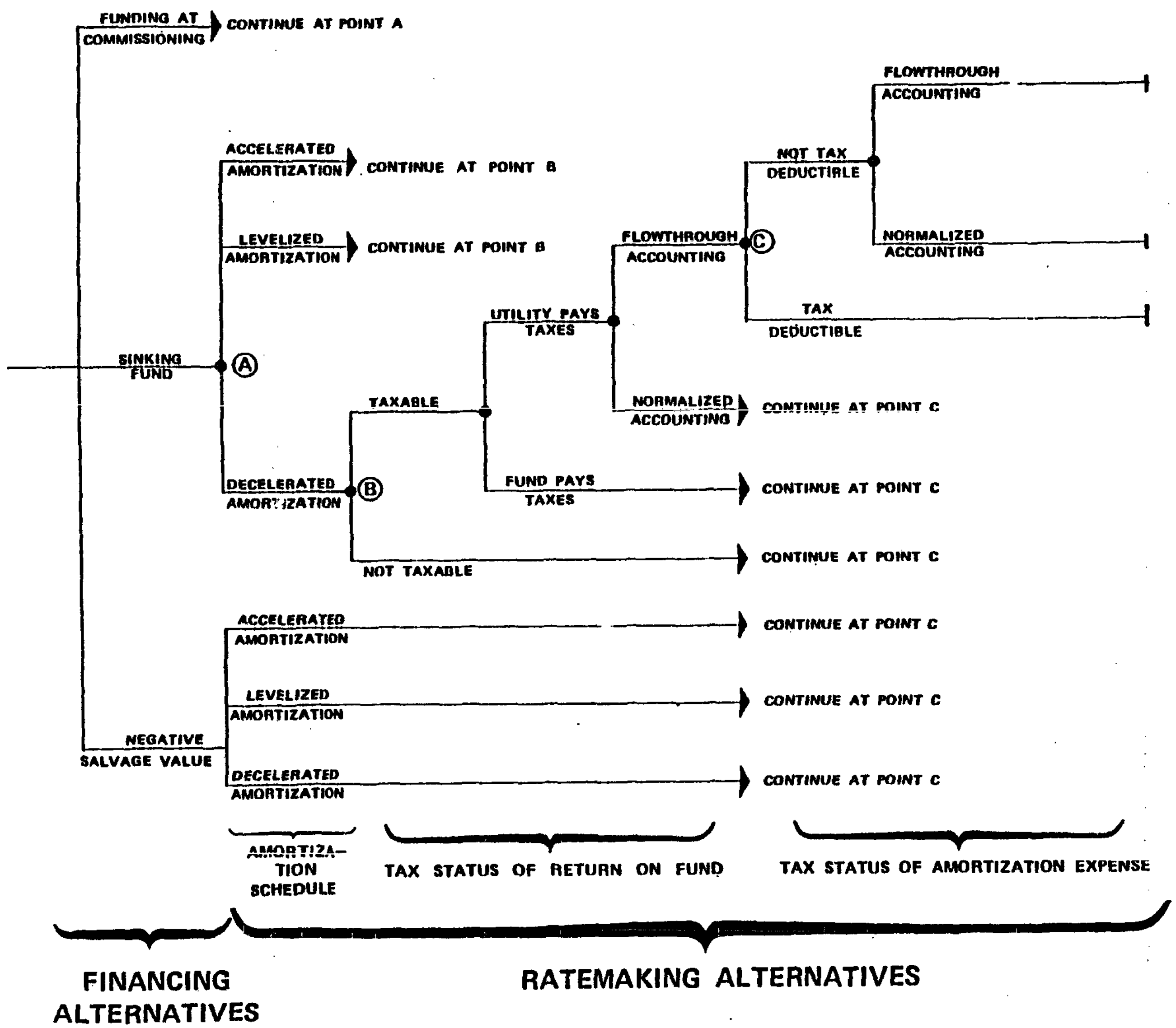
Rate treatment also is the major determinant of the fairness or equity of each alternative. There are two principles of equity involved. First, accepted regulatory accounting principles attempt to match rates with benefits. This implies that only those customers who receive the benefits of the nuclear plant should pay for the costs. Second, the beneficiaries should pay in proportion to the benefits received. This second tenet, much less widely accepted, implies that the incremental cost of a kilowatt-hour should be constant over time in constant dollars.

The relevant ratemaking issues fall into three categories:

- The decommissioning amortization schedule;
- The tax status of the return on the fund; and
- The tax status of the amortization expense.

Figure II-1

DECOMMISSIONING FINANCING ALTERNATIVES



Each of these issues alone can lead to several alternative policies. In combination with the three financing strategies, almost 100 combination financing/rate strategies become possible. (Figure II-1 illustrates these combinations.) The three rate issues are discussed below.

Decommissioning Amortization Schedules

Amortization is the amount of money collected from consumers each year for decommissioning. Similar to the depreciation of physical assets, amortization allows the utility to recover a large cost over time.

Just as there is more than one accepted method of computing depreciation, numerous amortization schedules are possible. The three general patterns are accelerated, straightline, and decelerated schedules. Accelerated schedules have larger payments in earlier years than in later years, and decelerated schedules are the reverse. A straightline schedule refers to a constant amortization amount each year.

Straightline amortization was selected for the case studies as the most likely alternative because it conforms with the convention of straightline depreciation of physical assets for rate purposes. As will be seen later, however, straightline amortization may not be the most desirable approach, so other options are also examined.

This report also assumes that the appropriate period over which to amortize decommissioning costs is the operating life of the plant or, for existing plants, the remaining life. Amortization over the entire plant life provides the greatest likelihood that all beneficiaries of the plant will share in the costs of decommissioning. In the cases where a plant has been operating for some time, the question of whether the uncollected amount accruing from the earlier period can be collected from present and future customers is one to be ultimately decided by regulatory commissions.

Tax Status of Return on the Fund

In two of the three selected financing strategies, funding at commissioning and sinking fund, a liquid reserve is accumulated and presumably is invested in a return-bearing asset. In this study, it is assumed that the investment is in financial assets which have low risk, such as government or high-quality

corporate bonds, because a major purpose of the fund is to minimize risk. Sensitivity analysis is performed to determine the effects of investments in riskier assets.

An important issue regarding the form of the investment is the tax status of the return on the fund. If the fund is invested in certain types of government bonds, interest on the fund is tax-free. If invested in most securities, the return will be taxed under current tax law. In this case, taxes may be paid by the fund itself or by the utility, and, if by the utility, the taxes can be either flowed through or normalized.[2]

There are two alternatives for eliminating or significantly reducing taxes and thus decreasing the cost of decommissioning. The first is the establishment of a state controlled fund which would not be liable for federal taxation under current regulations. This type of fund would have to be established by state legislatures in accordance with IRS guidelines. The second alternative is investment of the fund in dividend bearing securities such as preferred stock. Current tax law provides that only 15 percent of the dividend income is taxable. While financially attractive, this strategy is riskier because of the stock price uncertainty.

The analysis in this report is based on the assumption that funds are invested in tax-free government bonds. This is roughly equivalent to the case where the return is not tax-free, but the taxes are paid by the fund, because yields from high-quality government bonds are almost equivalent to the after-tax yield from corporate bonds when the marginal tax rate is 46 percent. Investment in government bonds was selected over other strategies because of its simplicity and low financial risk. A tax-free, state controlled fund was not selected because it requires legislative action.

Tax Status of the Amortization Expense

The final issue to be considered is the tax status of the amortization expense. Under current tax law, the cost of decommissioning must be deducted as a current expense in the year or years incurred. It cannot be amortized for tax purposes over the life of the plant as it can for rate purposes.

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[2] Flowthrough and normalization refer to alternative timing strategies for incorporating costs into rates. With flowthrough, consumers pay for the utility's actual tax liability in each year. Actual taxes will increase steadily over time as the fund and its income grow, so normalization could be used to make the rate impact level.

The current tax law leads to an inequitable situation unless tax normalization is used. The inequity occurs because non-beneficiaries of the plant receive a large tax deduction when the plant is actually decommissioned--perhaps decades after the plant closes. Normalization would remedy this by charging the beneficiaries for taxes as if the amortization were deductible, and non-beneficiaries would not receive the benefit of the large deduction when decommissioning actually occurs.

Normalization may not entirely correct the inequity if the utility is unable to use the tax deduction in the actual year of decommissioning. As will be seen in a later case study, the single-plant Yankee companies in New England will have no electricity revenues against which to offset the deduction.

While the amortization of decommissioning costs is not tax deductible under current tax law, it may be possible under certain circumstances to claim as deductible payments to an external decommissioning fund. The Internal Revenue Service has indicated to NRC that case-specific revenue rulings would be required.[3] This study therefore examines the effects of tax deductible amortization for the two external fund cases: funding at commissioning and sinking fund.

[3] Wood, Robert S., Assuring the Availability of Funds for Nuclear Facilities, unpublished paper, July 1979, p. 14.

III. METHODOLOGY

This analysis uses a case study approach. Complete financial projections were prepared for two New England utilities for a number of scenarios. The projections were made with TBS's utility financial model.

This chapter describes the methodology and two cases used in the study. Appendix A contains a more detailed description of the financial model, and Appendix B lists the major assumptions involved in the projections.

GENERAL APPROACH

The methodological approach can be characterized as incremental analysis of total-company projections. A computer model is used to prepare for each scenario a complete set of pro forma financial projections: balance sheets, income statements, and sources and uses of funds statements. Comparison of these alternative projections identifies the effects of alternative policies or events.

The preparation of total-company projections is important for two reasons. First, it allows a more accurate assessment of a particular policy in light of all other factors affecting the company. This is central to the concept of a case study. Second, it allows computation not only of the absolute impact of a given policy but also of the impact relative to a base case.

The relevant base case represents the state of the world in which nuclear decommissioning cost is not considered. This case, projected in this study for 40 years, must include forecasts of interest and inflation rates, electricity growth rates, and capital costs and construction plans. These data are, of course, difficult to forecast for 40 years, but any reasonable assumption can provide a suitable baseline against which to measure alternative decommissioning strategies. Appendix B discusses the major assumptions of the projections.

CASE DESCRIPTIONS

Two New England utilities were chosen as cases: Northeast Utilities and Maine Yankee. These two represent diverse forms of plant ownership: joint ownership by members of a holding company, sole ownership by one operating company, and joint ownership by several utilities through a stock company. They also represent both regulation in a single jurisdiction as well as multiple jurisdictions. Finally, they allow analysis of companies both with a single plant and with multiple units.

Northeast Utilities

Northeast Utilities (NU) is a holding company which services portions of Connecticut and Massachusetts through four operating subsidiaries:

- Connecticut Light and Power Company (CL&P);
- Hartford Electric Light Company (HELCO);
- Western Massachusetts Electric Company (WMECO); and
- Holyoke Water Power Company (HWP).

Two of these subsidiaries, CL&P and HELCO, operate entirely in Connecticut, and the other two, WMECO and HWP, operate solely in Massachusetts. Approximately 80 percent of NU's operations are in Connecticut and 20 percent in Massachusetts.

With almost three million customers and 5,855 megawatts of generating capacity, NU is one of the largest utilities in the industry. By the end of 1978, NU's electric operating revenues were $834 million and its gross plant value was $3.1 billion. External financing requirements have averaged over $100 million in the last five years.[4]

Northeast Utilities currently owns and operates one of its own nuclear stations: the Millstone Station. Two units are in operation at Millstone, and a third is under construction. This station represents 28 percent of NU's generating capacity,

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[4]All data were obtained from the Uniform Statistical Report, an annual report by Northeast Utilities to the Edison Electric Institute.

and this figure will rise to 34 percent when Millstone 3 is completed. Table III-1 provides further background on the three units.

Table III-1

MILLSTONE STATION STATISTICS

Unit	Commis-sioning Date	Capacity (mw)	Percent Ownership CL&P	HELCO	WMECO	HWP
1	1971	660	53	28	19	0
2	1976	812	53	28	19	0
3	1986*	1,150	35	18	12	0

*Estimated completion date.

Source: Uniform Statistical Report, 1978, and communication from Northeast Utilities.

NU also owns portions of several nuclear generating companies in New England through ownership in the Yankee operating companies. These companies are one-plant entities which are totally owned by other New England operating companies. NU's ownership in the Yankees, shown in Table III-2, represents 519 mw of capacity. In 1978, the Yankee companies supplied 17 percent of NU's total generation.

Table III-2

YANKEE STATISTICS

Unit	Commis-sioning Date	Capacity (mw)	Percent Ownership CL&P	HELCO	WMECO	HWP	NU
Connecticut Yankee	1968	600	25.0	9.5	9.5	0	44.0
Maine Yankee	1972	829	8.0	4.0	3.0	0	15.0
Massachusetts Yankee	1960	185	15.0	9.5	7.0	0	31.5
Vermont Yankee	1972	563	6.0	3.5	2.5	0	12.0

Source: Exhibit 43, "Stockholder Companies and Percent Ownership of Nuclear Generating Companies in New England," FERC Docket No. ER78-360; The Statistics of Privately Owned Electric Utilities in the United States; and Maine Yankee's USR.

For the purposes of this case study, only decommissioning costs for the three Millstone units were examined; Yankee decommissioning costs are ignored. This approach recognizes that NU will probably provide for the Yankees' decommissioning costs by paying increased rates for electricity purchased from the Yankee companies.

The siting of all three Millstone units at one site may affect the technical decommissioning plan because the company will attempt to avoid large-scale construction or demolition activities at one unit while other units are still running. As discussed earlier, however, the financial analysis can be performed separately from the technical assessment. All units are assumed to have the same decommissioning costs in constant dollars, and the decommissioning fund for each unit is established by the end of its operating life.

Maine Yankee

The Maine Yankee Atomic Power Company owns and operates an 829 mw nuclear plant in Wiscasset, Maine. The company was incorporated in 1966 by 11 investor-owned utilities in New England. The sponsoring companies and their ownership are displayed in Table III-3.

Table III-3

OWNERSHIP IN MAINE YANKEE

Utility	Percent Ownership*
Central Maine Power Company	38
New England Power Company	20
Connecticut Light & Power Company	8
Bangor Hydro-Electric Company	7
Maine Public Service Company	5
Public Service Company of New Hampshire	5
Cambridge Electric Light Company	4
Montaup Electric Company	4
Hartford Electric Light Company	4
Western Massachusetts Electric Company	3
Central Vermont Public Service Corporation	2
	100

*Based on common stock ownership.

Source: 1978 Uniform Statistical Report.

In 1978, Maine Yankee's operating revenues were $70.4 million. The company's rates are solely under the jurisdiction of the Federal Energy Regulatory Commission because all of its power sales are at wholesale and in interstate commerce.

The financial arrangements of the company are largely determined by two agreements signed by the sponsoring utilities. The Power Contract requires each utility to purchase a portion of the plant's output and cover the plant's costs in proportion to its ownership share. Costs include fuel, operating costs, interest charges, and a return on common equity. The operating costs include a depreciation charge based on a 30-year plant life. The other agreement, the Capital Funds Agreement, requires the sponsors to provide the company's capital requirements not obtainable from other sources. This Agreement presumably covers capital expenditures associated with plant operations. Whether decommissioning falls within the purview of the Agreement is a legal question beyond the scope of this report.

Maine Yankee was selected as a case because of its unusual ownership arrangement. Any financing requirements determined by NRC should pertain to the Yankee companies as well as to ongoing investor-owned utilities.

IV. FINDINGS

This chapter presents the quantitative and qualitative findings of the study. Although cost and financial assurance (risk) are the primary evaluation criteria, equity and flexibility are also important. The chapter is organized around these four evaluation criteria.

The primary focus is on the three financing strategies discussed in Chapter II: funding at commissioning, sinking fund, and funding at decommissioning. For each financing strategy, at least one scenario is examined which includes straightline amortization, investment of the fund in tax-free bonds, and straight line normalization of the decommissioning tax deduction. This ratemaking treatment provides a reasonable and consistent basis for comparing the three financing strategies. Where most appropriate, other scenarios are also analyzed.

Results are presented for both case studies: Northeast Utilities and Maine Yankee. Most of the results are presented for the Connecticut-only portion of Northeast Utilities, designated NU/Connecticut in this report. This consolidation of CL&P and HELCO represents a company with operations totally within a single state. Unless otherwise stated, all NU results pertain to NU/Connecticut.

COST

In this study the cost of a decommissioning financing alternative is defined as the incremental revenue requirements imposed on utility customers. Incremental revenue requirements are determined by changes in ratebase, financing costs, and operating costs.

On the basis of the net present value of revenue requirements, a good measure of cost to consumers, funding at commissioning is the most expensive option, and funding at decommissioning is the least expensive. Results are presented in Table IV-1 for a discount rate of 9.4 percent--the decommissioning inflation rate plus 2 percent.[5] Funding at commissioning is approximately three times and sinking fund twice as expensive as funding at decommissioning under the assumption used.

[5] A real discount rate of 2 percent was chosen as the approximate, historical real interest rate. See Wood, Robert S., op. cit., p. 24.

Table IV-1

NET PRESENT VALUE
OF REVENUE REQUIREMENTS

	Millions of Dollars	Percent Increase Over Baseline
Baseline	$39,528	-
Incremental Impacts of:		
Funding at Commissioning	283	0.72%
Sinking Fund	186	0.47
Funding at Decommissioning	91	0.23

Incremental revenue requirements can be interpreted as the average rate increase to electricity customers. While this measure disregards all issues related to rate design, the percentage increase in revenue requirements approximates the increase in a customer's total bill.

It can be seen in Table IV-1 that the increase in consumers' bills due to nuclear decommissioning is not large under any strategy, ranging between 0.2 and 0.7 percent for the utility studied. (This range is naturally sensitive to the assumed $50 million decommissioning cost and the utility's fuel mix.) As will be discussed later regarding equity, however, the magnitude of the rate impact varies over time.

While the ranking of the three alternatives is not affected by the choice of discount rate, the magnitude of the cost difference decreases at high discount rates. Figure IV-1 illustrates the change in cost for different discount rates. The lowest reasonable discount rate is 7.4 percent, the assumed rate of inflation for decommissioning costs. This rate is effectively a zero real discount rate.

Sensitivity to Interest and Inflation Rates

Given the 40-year horizon of this study, it is certainly proper to question the sensitivity of the results to changes in interest and inflation rates. There are three areas in this analysis where these rates are important: the return on the decommissioning fund, the inflation rate of decommissioning costs, and the utility's cost of capital.

Figure IV-1

SENSITIVITY ANALYSIS ON DISCOUNT RATES

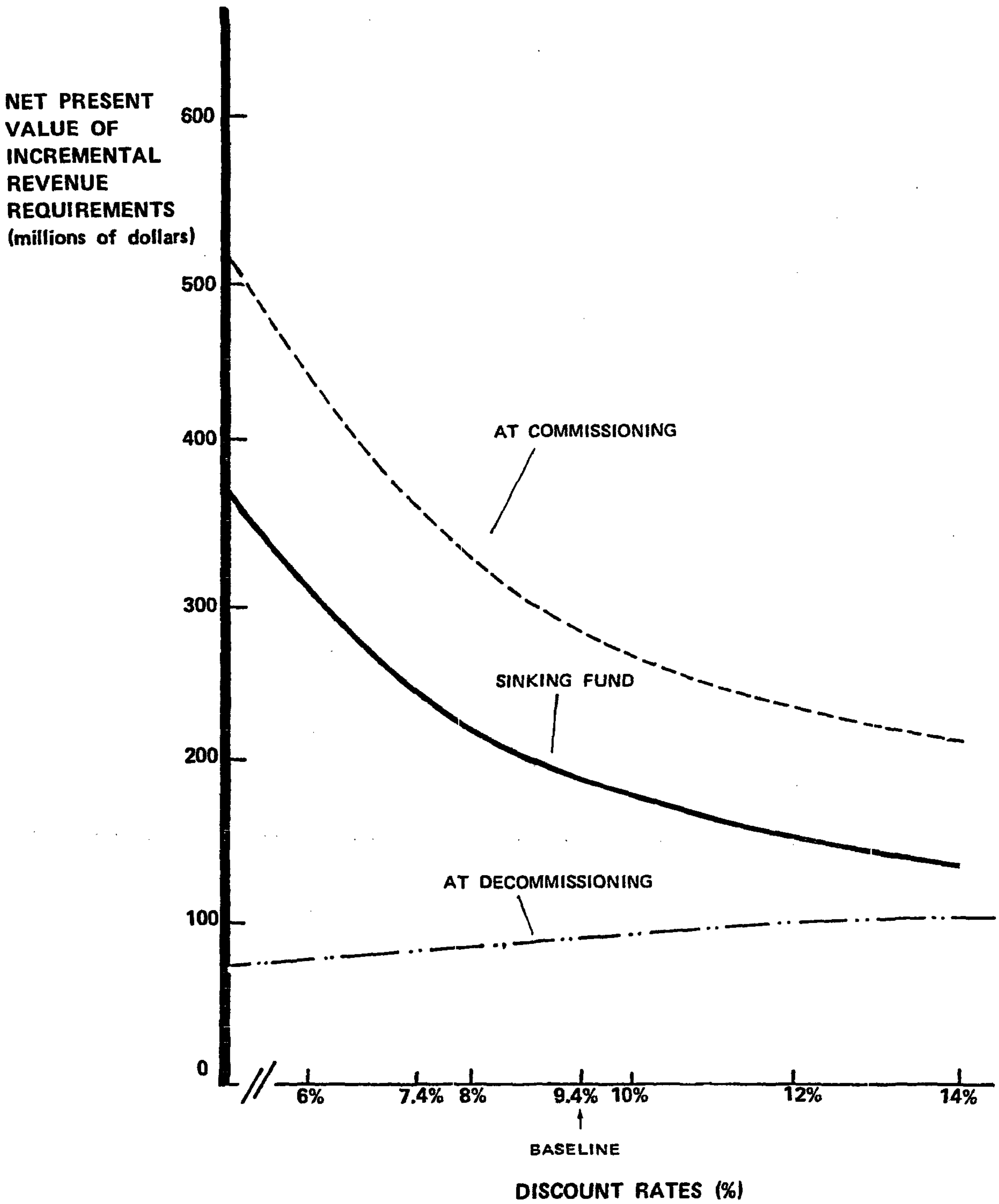

Figure IV-2 shows the effects of changing the rate of return (after taxes) on the decommissioning fund, all other parameters held constant.[6] At reasonable, risk-averse rates, there is no change in the ranking of the alternatives, although the relative impacts narrow at high rates of return. This is due to the fact that the funding at decommissioning option is unchanged because there is no liquid fund, but the two funded options decrease in cost if the fund is invested in higher return assets. At a sufficiently high rate, the three options actually reverse rank. This seems unlikely because such a high return asset would also normally reflect high risk. The after-tax return which reverses the ranking of the decommissioning alternatives is higher than the rate of inflation, and these returns are historically associated with risky investments. As discussed earlier, the most likely means of achieving such high returns would be investment in dividend-bearing stocks or the establishment of a tax-exempt state controlled fund.

Sensitivity analysis was also performed on the rate of inflation for decommissioning costs. The study assumed 7.4 percent for the entire 40-year study horizon, approximately 1.4 percent higher than the projected GNP deflator. Figure IV-3 illustrates the effects of changing the inflation rate for decommissioning costs. The cost of all strategies increases with the inflation rate because a larger sum must be raised in all years.

Finally, the costs of decommissioning are affected by the company's own costs for new capital, although the ranking remains unchanged. With funding at commissioning, increased costs of capital further aggravate the situation where the company borrows at a high rate and invests at a low rate. As can be seen in Table IV-2, increasing the cost of capital increases the cost of this option from $283 million to $388 million. If the discount factor is appropriately increased, however, the discounted revenue requirements increase only 4 percent to $294 million. Funding at decommissioning presents the opposite results because this option involves collection of funds from consumers before the decommissioning fund is established. Since the utility has the unrestricted use of the money collected for amortization, external financing requirements decline, and the value of the avoided financing increases with capital costs. With a 12 percent discount factor, the net present value of this option declines 16 percent to $76 million.

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[6] All of our sensitivity analysis is carried out in this manner.

Figure IV–2

SENSITIVITY ANALYSIS ON RATES OF RETURN ON THE DECOMMISSIONING FUND

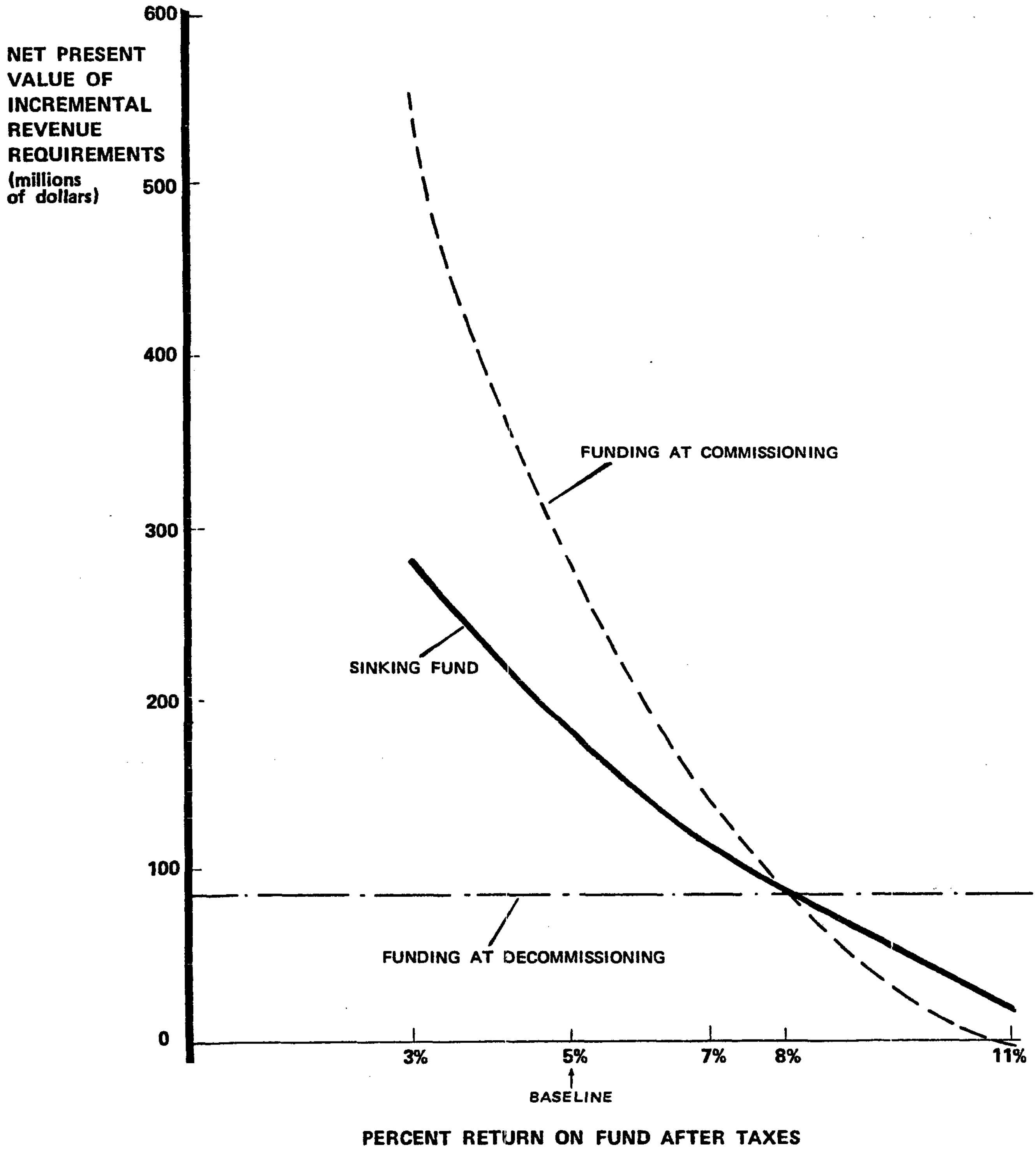

Figure IV—3

SENSITIVITY ANALYSIS ON INFLATION RATES

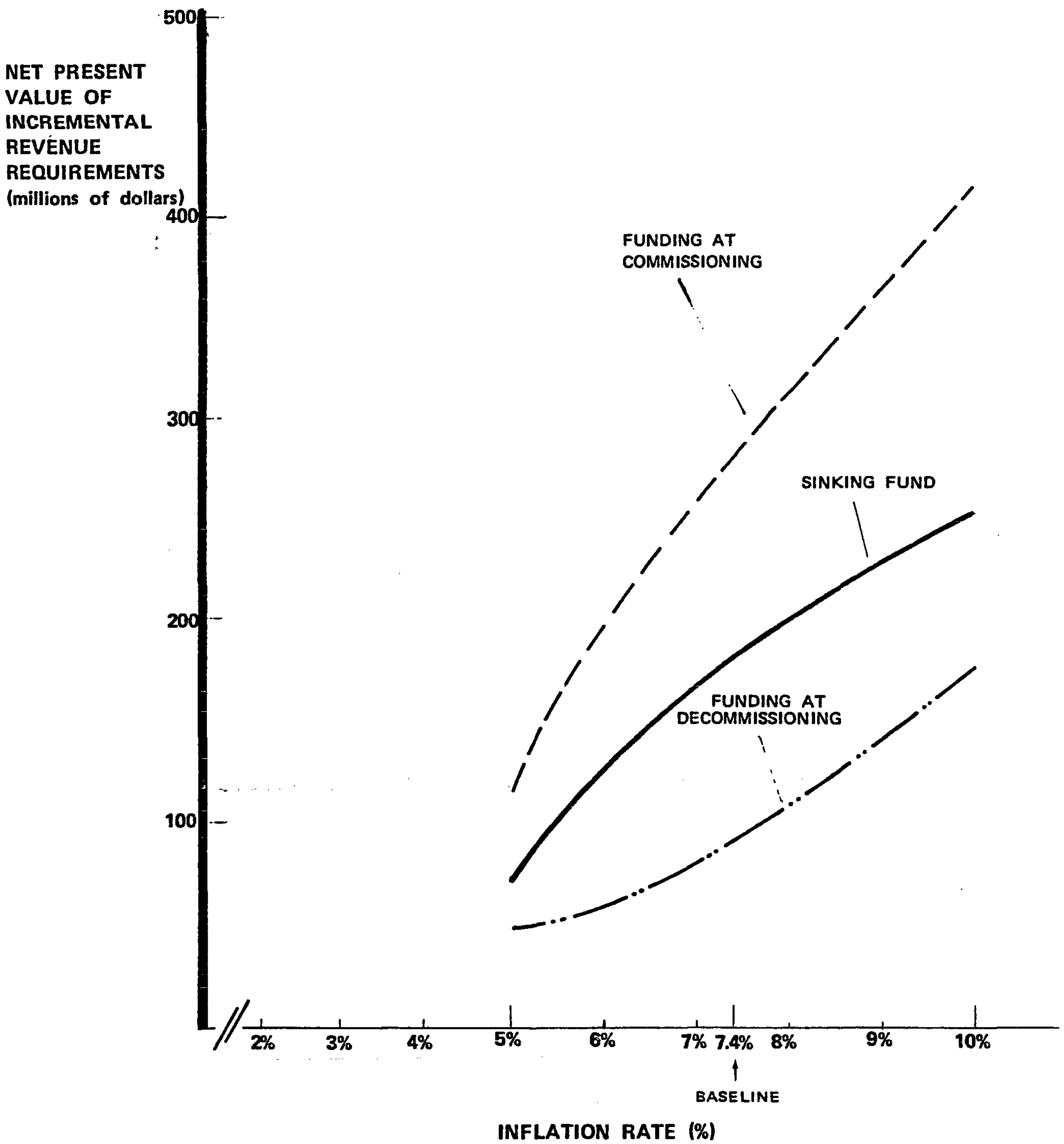

Table IV-2

SENSITIVITY ANALYSIS ON THE COST OF CAPITAL TO THE UTILITY

	Net Present Value of Incremental Revenue Streams (millions of dollars)		
	Baseline	High Interest* (discounted at 9.4%)	High Interest* (discounted at 12%)
Funding at Commissioning	283	388	294
Sinking Fund	186	240	165
Funding at Decommissioning	91	68	76

*This scenario assumes a 2 percent rise in the cost of all forms of capital.

To summarize the sensitivity analyses:

- As the rate of return that a utility can earn on external investments increases, the costs of two options, funding at commissioning and sinking fund, decrease. The ranking of the three financing strategies does not change for all reasonable rates of return.

- The costs for all alternatives increase if the inflation rate for decommissioning costs also increases. The ranking of the alternatives does not change, however.

- As the utility's cost of capital increases, the cost increases for funding at commissioning, and the cost decreases for funding at decommissioning. If the discount rate is adjusted, the differences are small.

The preceding sensitivity analyses investigated the effects of an incorrect assumption about a study parameter taken in isolation. In fact, most of these interest and inflation rates move in relative harmony. A much more likely scenario where all interest and inflation rates increase is presented below.

Table IV-3 illustrates the effect of combining all three changes: a high return on the decommissioning fund, increased decommissioning cost inflation, and higher utility cost of capital. The results demonstrate that these changes do indeed

compensate for each other. The ranking remains unchanged, although funding at decommissioning loses some cost advantage.

Table IV-3

SENSITIVITY ANALYSIS ON
ALL INTEREST AND INFLATION RATES

	Net Present Value of Incremental Revenue Requirements (millions of dollars)	
	Baseline	High Interest and Inflation*
Funding at Commissioning	283	295
Sinking Fund	186	202
Funding at Decommissioning	91	154

*This scenario assumes a 7 percent return on the decommissioning fund, 10 percent inflation, and a 2 percent increase in the cost of common, preferred, and debt financing. A discount rate of 12 percent was used.

Sensitivity to Decommissioning Tax Policy

Current tax laws view decommissioning expenses as a negative salvage value. The value of the plant at the end of its useful life is negative because a cost must be incurred to close the plant. This cost is recognized as a tax deduction in the year(s) incurred. Thus, the utility will actually pay greatly reduced taxes in the year(s) of decommissioning, which may not be completed until many years after the plant is shut down.

The tax normalization strategy assumed thus far is intended to reflect more equitably the decommissioning tax deduction in electricity rates over time. While actual taxes paid by the utility will still decrease significantly when the decommissioning occurs, taxes reported for rate purposes reflect the benefit of the large tax deduction spread evenly over the life of the plant. This is referred to as straightline (i.e., equal each year) normalization of the decommissioning tax deduction.

A reasonable alternative to the current tax policy would be to claim as tax deductible each year the contribution made to the decommissioning reserve. In this case, actual taxes

paid decrease each year during the life of the plant, and consumers get the advantage of the actual deduction rather than the normalized deduction.

NRC has investigated the possibility of annual decommissioning deductions with the Internal Revenue Service. While IRS will not make a generic ruling on the issue, utilities may be able to obtain a ruling from IRS on petition. In certain limited situations, the IRS has indicated that it will allow annual deductions for decommissioning expenses. Investor-owned utilities may be eligible for annual deductions if they meet four criteria. (Note that publicly owned utilities are generally exempt from federal income tax.)

> First, all funds collected from customers (or any other source) for decommissioning expense must be immediately segregated from the utility's assets. A utility may collect from its customers by its normal monthly billing procedures and deposit such funds in a blind trust immediately upon collection. In other words, the utility cannot have even short-term use of these funds. In fact, IRS suggested that perhaps a separate decommissioning account be established on a customer's bill. Second, the blind trust itself cannot be reinvested in a utility's assets. If it is desired that earnings from the trust fund themselves are tax-exempt, the fund should be invested in state or municipal tax-exempt securities. Third, the fund must be administered by parties not normally involved with the operations of the utility. A fourth restriction indicated by IRS pertains to when a utility overestimates decommissioning costs. If a state establishes a trust fund that meets the conditions described above, but provides that any excess funds after decommissioning expenses have been paid will be returned to the utility, the IRS has indicated that this provision would probably jeopardize the tax-exempt status of the fund.[7]

The funding at commissioning and sinking fund alternatives may be able to meet the criteria identified above. Table IV-4 presents the impacts of making tax deductible contributions to the decommissioning reserve each year for these two financing strategies. The ranking of the alternatives does not change.

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[7] Wood, Robert S., op. cit., p. 15.

Table IV-4

SENSITIVITY ANALYSIS ON TAX STATUS OF DECOMMISSIONING FUND

	Net Present Value of Incremental Revenue Stream (millions of dollars)	
	Baseline	Alternate Tax Treatment*
Funding at Commissioning	283	296
Sinking Fund	186	135

*A discount rate of 9.4 percent was used.

These results are not very different because the non-deductible cases reflect the normalization of the decommissioning deduction. Thus the ratemaking policies in both tax scenarios in Table IV-4 reflect attempts to spread the tax deduction over the life of the plant. The relative costs of tax normalization and current year tax deduction are largely determined by other factors such as decommissioning amortization schedules and interest and inflation rates.

The ability to deduct currently the decommissioning reserve accumulations does have an important advantage, however. The decommissioning expense may actually be so large that the utility will be unable to take advantage of the full deduction. Shifting the deduction forward in time and spreading it over the life of the plant ensures that the company and its customers receive the full benefit of the deduction.

Table IV-5 compares the large deduction for decommissioning to the taxable income in the year of decommissioning. NU/Connecticut should have little problem using the tax deduction. Since the process of decommissioning a plant will most likely occur over several years, the deduction would also be spread over several years and thus the possibility of unused deductions decreases even further. If Millstone 1 and 2 are placed in safe storage until Millstone 3 is taken out of service, then the major decommissioning deductions for all three units may occur in the same time period. Nevertheless, TBS feels that there is a relatively low probability that decommissioning expenses would be unused for an ongoing utility with a mix of generating facilities.

Table IV-5

COMPARISON OF TAXABLE INCOME TO DECOMMISSIONING TAX DEDUCTION (millions of dollars)*

	Millstone 1	Millstone 2	Millstone 3
Taxable Income	501	373	519
Tax Deduction	195	278	568

*Values for NU/Connecticut only.

Maine Yankee, however, presents a unique situation because it will not have any operating revenues against which to offset the decommissioning deduction. It is unclear whether the utilities which own Maine Yankee can take advantage of the deduction because a company's tax deductions cannot usually be claimed by its stockholders. If the deduction cannot be used, Yankee's owners will need to raise a significant amount of funds for decommissioning at that time because the tax normalization scheme used in this report assumes that normalized tax savings will provide much of the cash flow necessary for decommissioning.

The major conclusion from the cost analysis of the three primary funding mechanisms is that funding at commissioning is more costly than a sinking fund which in turn is more costly than funding at decommissioning. Furthermore, this ranking is insensitive to most reasonable assumptions about interest and inflation rates and changes in tax policy. These results are most easily explained by the difference between the after-tax cost of capital to the utility (at the time of this writing approximately 13 percent) and the after-tax return that a utility can earn on its investments (currently approximately 8 percent). The more money the utility borrows at a high cost and invests at a lower return, the more expensive the financing option becomes to the company and its customers.

EQUITY

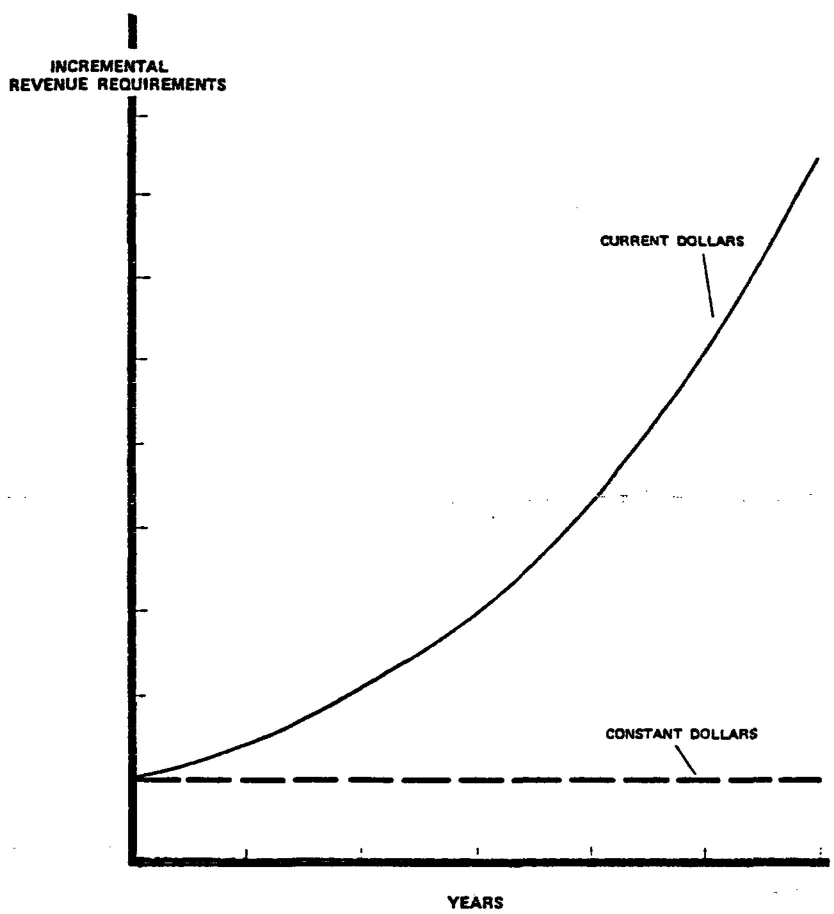
One of the goals of utility ratemaking is the fair apportioning of the cost of service among consumers. A reasonable standard of equity is to apportion costs to consumers in relation to the benefits received.

This goal of equity has been translated in this study into two operational objectives. First, the entire cost of decommissioning a nuclear power plant should be borne by the beneficiaries of the plant. Second, the incremental revenues required for decommissioning should increase each year at the rate of inflation, or, in other words, the rate impact in constant (deflated) dollars should be equal each year.

Figure IV-4 illustrates a hypothetically desirable pattern for decommissioning revenue requirements for a single nuclear plant. The decommissioning charge begins in the first year of the plant's operation and ends in the last. In current dollars, the charge increases at the rate of inflation. In constant dollars, the charge remains flat. Stated another way, the charge for decommissioning should increase proportionately to the cost of electricity.

Figure IV-4

DESIRABLE INCREMENTAL REVENUE STREAM OVER THE LIFE OF ONE PLANT



In practice, it will be difficult to achieve these objectives of equity because of uncertainties in forecasting costs and interest rates. For example, if a technical decommissioning strategy is adopted which requires a plant to be placed in safe storage for 100 years and then dismantled, the financial goal should be to establish a fund by the time the plant retires which with accumulated interest will be sufficient to pay all future decommissioning costs. A long-range cost forecast is thus required to compute the amount of the target fund. If costs are higher than anticipated, future ratepayers will shoulder the additional burden. If costs are lower, future ratepayers receive a windfall. In spite of this uncertainty, the goal of equity requires a current strategy based on an estimate of future costs.

Figure IV-5 presents the incremental revenue requirements for NU/Connecticut in both current and constant dollars. The effects of the units entering or leaving service can be seen by the sharp turns in the curve. (Unusual levels may occur in the first and last year of a plant's operation because commissioning and retirement are presumed to occur at mid-year.)

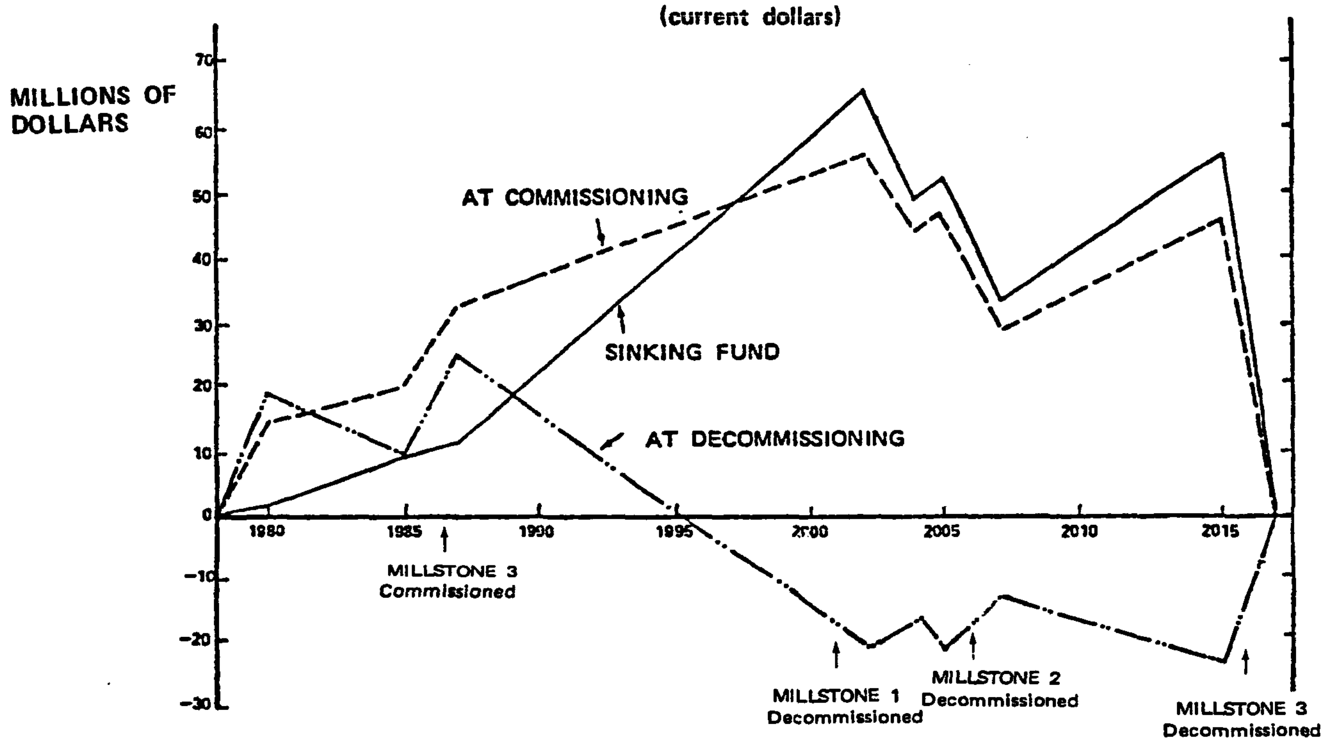
Figure IV-6 better illustrates the relative equity of the three strategies. In this graph, incremental revenue requirements have been divided by nuclear generation to adjust for the different timing of the three units.

Of the three strategies, funding at commissioning option is the most equitable. A sinking fund places a relatively larger burden on later ratepayers. Funding at decommissioning is the most inequitable; its negative revenue requirements in later years constitute a subsidy of later ratepayers by near-term customers.

To determine why the three strategies have such different equity impacts, it is necessary to understand the components of the incremental revenue requirements. Figure IV-7 illustrates the current dollar incremental revenue requirements (for a one-unit decommissioning case) with the individual components identified. (All lines have been estimated with straight lines for illustration purposes.)

In each case, both decommissioning amortization and deferred income taxes are flat in current dollars. This was done to conform with the straight line depreciation of the plant's initial cost and the straight line normalization (in states which allow normalization) of income tax differences arising from book and tax depreciation. While this practice is viewed by TBS as the most likely to occur, it is certainly not optimal

Figure IV-5
INCREMENTAL REVENUE REQUIREMENTS
(current dollars)



INCREMENTAL REVENUE REQUIREMENTS
(constant dollars)