RECENT TRENDS IN THE ADEQUACY OF NUCLEAR PLANT DECOMMISSIONING FUNDING

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ABSTRACT

Concerned about the potential cost and sufficiency of funds to decommission the nation's nuclear power plants, the Congress asked the U.S. General Accounting Office (GAO) to assess the adequacy, as of December 31, 1997, of electric utilities' funds to eventually decommission their plants. GAO's report (GAO/RCED-99-75) on this issue addressed three alternative assumption scenarios -- baseline (most likely), optimistic, and pessimistic – and was issued in May 1999. This paper *updates* GAO's *baseline* assessment of fund adequacy in 1997, and *extends* the analysis through 2000.* In 2000, we estimate that the present value cost to decommission the nation's nuclear plants is about $35 billion; utility fund balances are about $29 billion. Both our two measures of funding adequacy for utilities are *on average* not only much above ideal levels, but also overall have greatly improved since 1997. However, certain utilities still show less than ideal fund balances and annual contributions. We suggest that the *range* of these results among the *individual* utilities is a more important policy measure to assess the adequacy of decommissioning funding than is the funding adequacy for the industry *as a whole*.

Looking backward, in 1997, utility fund (available) *balances* were, *on average,* only slightly above their ideal level. In 1998-00, fund balances, *on average,* rose sharply above their ideal levels to about 19 percent above in 2000. In 1998 and 1999, these large increases were mostly due to the rise in the market value of the funds' financial assets after deducting current year contributions. In 2000 the measure fell very slightly as the rise in asset values other than from current year contributions slowed substantially. The results are less sanguine, however, for certain individual utilities. In 1997, 34 of 76 utilities had fund balances *below* ideal. In spite of the rapid growth of the adequacy of *average* fund balances, by 2000, 24 of 77 utilities still had fund balances *below* ideal levels.

Looking forward, in 1997, utilities' latest two-year-average real (available) *contributions* to their decommissioning funds were *on average* about 38 percent *above* their ideal future annual-average present-value contributions. In 1998-00 this percentage first rose sharply and then fell, but remained about 36 percent above in 2000 as the growth in asset values slowed. The rapid rise over 1997-99 is mainly due to the increased valuation of fund assets, reducing the need for future funding. In fact, current year contributions fell slightly over 1997-00 to about $1.3 billion. As with the analysis of fund balances, these superb results for the adequacy of *average* utility contributions tend to mask the varied results for *individual* utilities. In 1997, 17 utilities were contributing less than their ideal amounts. By 2000, 20 utilities were contributing below ideal amounts.

INTRODUCTION

The potential cost and sufficiency of funds for electric utilities to eventually decommission the nation's nuclear power plants is an important national issue. GAO reported in May 1999 on these issues as of December 31, 1997. This report showed both a "looking backward" and a "looking forward" analysis for

* The views and opinions expressed in this paper are those of the author and do not necessarily reflect those of the U. S. General Accounting Office.

three scenarios: baseline (most likely), optimistic, and pessimistic. Under *baseline* assumptions, utilities *on average* had already accumulated funds at a rate only slightly below "ideal" levels but were currently contributing at rates much above (46 percent) the annual-average present-value (*aapv*) of the "ideal" contribution rates needed in the future. However, 36 of the 76 utilities had not accumulated sufficient funds through 1997 and 17 utilities were not *currently* (in 1997) contributing sufficient funds.

To say whether decommissioning funding for a utility is adequate or "on track" as of a particular date, and to compare adequacy results among utilities, a funding *standard* must be defined. Such a standard must be both reasonable and identical for all utilities. GAO defined the "ideal" funding stream for each year's "ideal" balance as annual contributions to the decommissioning funds of one-fortieth (assuming a 40-year operating license) of each year's present value of a plant's future decommissioning cost. Mathematically, there are, of course, an infinite number of possible funding streams for a utility that can accumulate funds sufficient for decommissioning. No utility can be expected to follow *precisely* its ideal funding stream; rather our stream may represent more of an ideal annual average to be achieved over a period of years. Nonetheless, we feel that our stream of steadily-growing, ideal current-dollar contributions is reasonable in that as each year's electricity customers are charged through their rates for their *accrued* decommissioning costs, each successive year's current-dollar charges are larger. This increase reflects the decreasing time until *actual* funds are expended for decommissioning. In other words, the *present-value* dollar burden (relative to the first year) of each year's ideal contributions is *constant*.

Using the same Duff & Phelps (D&P) data source for utilities' fund balances and current contributions as was used in our May 1999 GAO report, this paper updates that *baseline* assessment of fund adequacy at the end of 1997. Then, to explore trends, it extends the baseline analysis through 1998, 1999, and 2000. Our year 2000 database includes 77 licensees (or parent companies of licensees) owning all or parts of 118 operating and retired plants, representing most of the nation's nuclear decommissioning fund assets and costs. In 2000, the value of these decommissioning fund assets is nearly $29 billion. Our corresponding estimate in 2000 of the present-value dollar cost to dismantle all of these nuclear power plants is about $35 billion dollars. Our cost represents a *Nuclear Regulatory Commission (or "NRC-defined*") cost rather than a *total* decommissioning cost. The NRC cost definition includes within its scope only the costs to dismantle structures and restore sites that are contaminated with radioactivity. It does *not* include the costs to either: (1) dismantle nonradioactive structures and restore the sites or (2) store/dispose of spent (used) fuel. This process of dismantling, called decommissioning, is necessary because, following the retirement of a nuclear power plant and the removal of the plant's spent fuel, a significant radiation hazard remains.

METHODOLOGY

The (Excel) spreadsheet simulation/sensitivity models used in our analysis are essentially large "what if" financial models whose results for the adequacy of decommissioning funding for each utility depend upon the assumptions chosen.[a] We maintained the comparability of the *baseline* results between the years (1997-2000). This contributes to the ease of analysis and allows us to focus only on the effects of changes in fund asset values and contribution rates. We retained the values for most of our GAO report's baseline assumptions for 1997: utilities' initial decommissioning cost estimates, a cost escalation rate, an after-tax rate of return on fund assets, plant shutdown dates, and the fraction of funds "available" for "NRC-defined" decommissioning costs.[b]

Because D&P lists fund balances and current contributions[c] only by licensee/utility, not by reactor, the adequacy results generated by our models are organized *only by utility*. Therefore, our analysis implicitly treats the *individual* reactor fund balances and contributions as being *fungible* among these reactors for each utility. Analysis by utility (by reactor), using a different data source – from NRC -- is currently underway at GAO for the Congress and will be presented in a future GAO report for the year 2000.[d] Since fund balances and contributions are typically organized by reactor by each utility, fund adequacy analysis organized in this same way should be useful. However, a case can be made that such adequacy analysis *should* be performed *by utility only*. The utility/licensee (or parent company) is the legal entity responsible for the decommissioning funding for *all* of its reactors. For example, suppose that one of its reactors, assumed to shut down far into the future, is now prematurely shut down and decommissioned quite early. Funds for that reactor would likely be insufficient for immediate decommissioning. This utility likely would want to transfer funds from the funds of its other reactors to that of this prematurely-shut reactor. Even if such transfers cannot be accomplished because of legal constraints, the utility's Public Utilities Commission (PUC) might allow it to greatly accelerate its contributions to the fund of the prematurely-shut reactor and correspondingly slow its contributions to the funds of its open reactors. That is, fund dollars may be in effect somewhat *fungible*.

The models used in this paper are, with a few exceptions, the same as our (Quattro Pro) spreadsheet models used in our previous GAO report. The exceptions are minor data corrections, a few changes in assumptions, and some enhancements in model simulation capability.[e] These changes alter our original results for 1997 only slightly. Several important enhancements and changes in baseline assumptions are: (1) five plants (Millstone 2, Dresden 2 & 3, Oyster Creek, and River Bend) previously assumed to shut early (baseline) are assumed to operate over their full respective license operating periods; (2) decommissioning, previously assumed to occur "instantaneously" upon plant shutdown (in all three scenarios), is now modeled as occurring evenly over *five* years *following* shutdown;[f] and (3) a method to estimate the "remaining" decommissioning costs of plants *already* being decommissioned is included.[g] The first change is because the financial viability of electric power generation has recently improved and, therefore, we assume that no currently operating plant will shut early; the second change reflects a more accurate simulation in that decommissioning would occur over a period of years *after* shutdown; and the third change reflects our use of D&P's more complete data in 1998-00 for plants already being decommissioned.

For each utility, our two basic model algorithms can be expressed briefly as follows for any current year. *Looking-backward*, the model first computes the surplus (or shortage) of the fund balance over the expected (or ideal) balance. Then it divides this surplus by the ideal balance to yield the percentage excess (or shortage) of the fund balance relative to its ideal balance. A positive percentage represents over-funding, a negative percentage represents under-funding, and a zero percentage represents funding that is exactly "on track." *Looking-forward*, the model computes the utility's *unfunded* balance on *each* of its reactors. (Note that the earliest-shutting reactor is "allocated" existing funds first, the next-earliest, second, and so on, from the decommissioning fund). For each reactor requiring additional funds beyond these existing funds, such funds will be met by the model's ideal, future yearly contributions over the respective remaining life of each of these reactors.

For example, consider a single-reactor utility with an unfunded balance of $10 million (expressed here as a *future-dollar* cost) and 10 more years until shutdown. For this reactor, each of the utility's yearly future contributions should ideally equal 1/10th of each successive year's present value of $10 million. The model computes the surplus (or shortage) of the utility's current contribution over the expected (or ideal) future contribution.[h] Then it divides this surplus by the ideal future contribution to yield the percentage excess (or shortage). A positive percentage represents over-contribution, a negative percentage represents under-contribution, and a zero percentage represents contributions that are exactly "on track." *This assessment of contribution adequacy* ***assumes*** *that this utility will increase its most recent contribution*[i] *yearly, over the remaining life of its reactor, by the assumed after-tax rate-of-return on the fund.*

KEY ASSUMPTIONS

Both our looking-backward and looking-forward analyses of fund adequacy use key assumptions, whose assigned values can affect the results. This paper assumes the *same baseline values* over 1997-00 for the five factors that were used in our 1999 GAO report (for 1997). These five factors are: (1) the estimated "initial" cost to decommission a nuclear power plant, (2) the cost-escalation rate, (3) the after-tax rate of return on the fund's assets (discount rate), (4) the expected operating life of each plant, and (5) the portion of a licensee's decommissioning fund that is "available" to pay decommissioning costs as defined in NRC's regulations.

Initial Decommissioning Cost Estimates. Where available, we obtained licensees' most recent site-specific estimates (*as of 1997 or earlier*) of the costs to decommission each of their nuclear power plants. We used the site-specific estimates for 91 of the 118 plants that were prepared for the licensees by TLG Services, Inc. (TLG). Because we wished to limit our analysis to *NRC-defined* decommissioning costs only, we asked TLG to separate out, where possible, these costs from their *total* estimated decommissioning costs. On average, these NRC-defined costs were about 82 percent of TLG's total cost estimates. (Non-radiation-related costs were about 13 percent and spent-fuel management costs were about 5 percent.) For each of the remaining 27 plants, we calculated, using NRC's generic cost-escalation formula, an estimated decommissioning cost (in 1997). This cost determines the minimum level of funds that NRC requires the plant's licensee to have accumulated by the time the plant's license expires. Because NRC's formula in 1997 overstated low-level waste disposal costs, we used its 1998 year waste burial "correction" to reduce these 1997 cost estimates. Thus, for both the site-specific and generic-formula procedures, we obtained the "initial" estimates of what it would cost to decommission a plant *in the year that the estimate was prepared*.

Annual-Average Cost-Escalation Rate. Our analysis requires that we estimate the costs to decommission nuclear power plants at the end of their license expiration year, *evenly* over the five years following shutdown. (For modeling simplicity we assume that in the baseline decommissioning occurs "instantaneously" 2.5 years after shutdown). Using the above "initial" decommissioning cost estimates, the model escalates these costs from the values of the year in which they were prepared to forecast what the current-dollar costs might be at the end of each plant's life span (*plus 2.5 years*). For all plants that are already retired but not yet decommissioned, the "future" decommissioning costs are for the *current* year (1997 to 2000) *plus 2.5 years*. Our (1997) estimate of an annual-average cost-escalation rate reflects two conditions: expected price inflation and changes in the scope and/or technology of decommissioning. The effect of price inflation on increasing future current-dollar costs is self-evident. Changes in the scope and/or technology of decommissioning could either increase or decrease future costs. For example, future costs will decrease if more economically efficient technologies are used in the decommissioning process but will increase if experience shows that *more* activities must be performed.

TLG (in 1997) provided us with site-specific "initial" decommissioning cost estimates for 91 nuclear plants. Of these, the company had prepared *more than one* site-specific cost estimate for 43 plants (over roughly the 1990-97 period). For each of these 43 plants, we calculated the annual-average cost-escalation rate from the year of the earliest cost estimate to the year of the most recent cost estimate. (We used only TLG's estimates of *NRC-defined* costs.) We then computed the simple average of these 43 rates: an annual-average cost (*estimation*) increase of 6.6 percent. Over the same period, inflation was on average about 2.5 percent per year.[j] Thus, TLG's cost *estimates* escalated, on average, at a rate about 4 percentage points *above* the *overall* rate of inflation.

We estimated that the GDP price deflator would grow over the 1997-2018 period (the approximate *average* future life expectancy of a nuclear plant) at an annual-average rate of 2.5 percent.[k] Then, for our *baseline* cost escalation forecast, we assumed a lower-than-historical increase of 2.5 percentage points *above* this forecast rate for overall inflation. This results in an annual-average cost-escalation forecast increase of 5.0 percent. We assumed that this cost-escalation rate would decline from the 6.6 percent historical-cost *estimation* increase because we believed that the cost estimation process had "matured" somewhat. That is, the understanding of the decommissioning process had likely followed a steep "learning curve" and was now leveling off as the substantial complexity of the process was increasingly being revealed.

After-Tax Rate-of-Return on Fund Assets (Discount Rate). In 1997, we reviewed the after-tax rate of earnings from investments of decommissioning funds for eight licensees' recent financial statements. These earnings rates varied from 5.5 to 7.3 percent. For the *baseline*, we assumed the more typical rate of return of 6.25 percent. Because our sample was small, our earnings rate estimate has perhaps a greater degree of imprecision than that of our other estimates. However, we expect that as time progresses, improved rate-of-return *forecasts* will become available.[l]

Nuclear Plant's Operating Life (Shutdown Dates). Several years ago, various experts believed that some nuclear power plants would not operate for the full length of their operating licenses because of, for example, the expected introduction of competition into the retail electricity markets. (Wholesale electricity markets had been deregulated since 1996.) On the other hand, recent events in these markets may suggest the opposite – that some (or perhaps a substantial number of) reactors will have their operating lives extended beyond their license expiration dates. For example, as of 2001, Constellation Energy's Calvert Cliffs 1 & 2 plants already have such license extensions. In our previous GAO report, we assumed in our *baseline* that *six* plants would shut early. (One of these plants, Millstone 1, was retired early in 1998.) Therefore, for purposes of comparison among plants/utilities and as a compromise among competing viewpoints, we assume in our *baseline* for this paper that there will be *no* plant license reductions or extensions[m] and that all plants will operate over their *full* operating license periods.

Portion of Funds and Contributions *Available* for NRC-Defined Costs. In our *baseline,* we assumed that only a percentage of licensees' fund balances and current-year contributions will be *"available"* for meeting *NRC-defined* decommissioning costs. As explained earlier, only these specific "NRC-defined" costs are the focus of the analyses in both our prior GAO report and this paper. *Total* decommissioning costs can be categorized in three portions as (1) plant/site costs related to radiological processes (NRC-defined costs), (2) plant/site costs related to nonradiological processes, and (3) maintenance & storage costs related to spent fuel. Using data (1990-97) from TLG, we estimated that, respectively, 82 percent of such costs are NRC-defined radiological costs, 13 percent are nonradiological costs, and 5 percent are spent-fuel storage related costs. In our baseline we assumed that *all* spent-fuel maintenance & storage costs would be paid *eventually*, not by the licensee, but by a third party – perhaps the federal government. We assumed that the utility would pay for the *other two* decommissioning costs. These other two costs combined are about 95 percent of the *total* estimated decommissioning costs. Therefore, *NRC-related* costs represent about 86 percent (82 percent divided by 95 percent) of this 95 percent cost share. By analogy, we assumed that the licensee's *funds* and current *contributions* will also pay for *only* this 95 percent cost share (i.e., for only the NRC-defined costs and nonradiological costs). Consequently, in the *baseline*, the model assumes that only about 86 percent of the *funds and contributions* will be *"available"* to meet *NRC-defined* decommissioning costs and that the remaining 14 percent (13 percent divided by 95 percent) will be used to meet non-radiation-related costs.

MODEL RESULTS

Because of the inherent uncertainty in this analysis as reflected in our various baseline assumptions, and the possibility of data errors, our model results should be used only as a ***general, or approximate*** *guide to the relative (and absolute) positions of the licensees in accumulating decommissioning fund balances* *and contributing new funds by December 31 of each (current) year (1997-2000)*. In particular, special circumstances such as licensees with reactors already closed (but not yet being decommissioned), and not yet fully funded by *past* contributions, may account for some of the utilities showing fund balances and/or current contributions far below ideal levels. Because of space restrictions, only *summary* results for *all utilities combined* are presented in Tables I, V, and VIII for 1997-00. However, results for selected groups of utilities are presented in Tables II, III, IV, VI, VII, and IX for 2000.

Looking-Backward Results. Table I shows the summary *baseline* results for all licensees for our adequacy analysis of fund *balances* over the 1997-00 period. Some utilities merged and/or acquired nuclear reactors from other utilities over this span. Therefore, the adequacy of utilities' fund *balances* is reported in the table for 76 licensees in 1997 and 1998, 80 in 1999, and 77 in 2000. Specifically, Table I shows the percentage that licensees are above or below their expected (ideal) fund balances for the current year (1997-00).

Table I. Utilities With More Than or Less Than Expected Fund Balances
as of December 31 of the Current Year
(By Percentage, Above or Below Zero)

All utilities	Current year			
	2000	1999	1998	1997
Number of utilities	77	80	76	76
All utilities: weighted average	19	23	12	1
Number of utilities: %s above; below 0.0	53; 24	55; 25	48; 28	42; 34

In 1997 utilities *on average*[n] had accumulated (*available*) decommissioning funds about 1 percent above their expected amounts. Thus, on average, the nuclear industry was almost exactly "on track" in its funding for eventual decommissioning of its nuclear plants. This measure of funding adequacy rose sharply in 1998 and 1999 to 12 percent and 23 percent above, respectively, and fell slightly to 19 percent above in 2000. This increase in 1998-99 was mainly due to the sharp rise in the market value of existing fund assets rather than to increasing current-year contributions; its slight decline in 2000 was due to a slowing rise in such asset values. Our estimate of the *present-value* cost in 2000 to decommission all 118 nuclear power plants is about $35 billion dollars. D&P's year 2000 value of the industry decommissioning fund assets is nearly $29 billion (of which we estimate that 86 percent, or about $25 billion, will be "available" for NRC-defined costs). Thus, when viewed as a whole, the nuclear industry is in *excellent* condition with respect to our "looking-backward" performance measure even if, as may be likely, there will be some decline in fund asset values in 2001.

However, Table I shows that in 1997, 34 of 76 utilities had *not* accumulated funds at a rate that is sufficient for eventual decommissioning. In 1998, 28 of 76 utilities and in 1999, 25 of 80 utilities had not. Even by 2000, 24 of 77 utilities *still* had not accumulated sufficient funds in spite of the rapid rise in our *industry-wide* adequacy measure. Therefore, these superb *average* results for the industry mask the wide variability of results among *individual* utilities, some of which still show results substantially *below* ideal. We suggest that the *range* of funding adequacy among the different utilities should be examined at least as strongly as is the result usually reported – the funding adequacy for the industry *as a whole*. For example, utility A with a *surplus* in its available fund far above its ideal balance does not offset a corresponding *shortage* in utility B.

Although not shown in Table I, 2 of 77 utilities (in 2000) achieved a fund balance over 200 percent *above* their ideal balance. (An ideal balance represents *zero* percent above.) 14 utilities achieved a balance 101-200 percent above; 13 utilities, 51-100 percent above; 9 utilities, 26-50 percent above; and 15 utilities, 0-25 percent above. By contrast, 0 of 77 utilities achieved a fund balance 51-100 percent *below* its ideal balance; 11 utilities achieved a balance 26-50 percent below; and 13 utilities, 1-25 percent below. (Note that mathematically these percentages can be no more than 100 percent *below* ideal but can be more than 100 percent *above* ideal.) Thus, the distribution of these 77 fund balance percentages in 2000 shows that many utilities (38) have balances *far above* ideal (i.e., more than 25 percent above). However, the results for 11 utilities may be worrisome in that these utilities have balances *far below* ideal (i.e., more than 25 percent below).

Tables II, III, and IV show the fund *balance* results for certain small groups of utilities in 2000. (Note that the number of utilities that we have included in these small groups is essentially arbitrary.) Table II lists these balance results for the 12 utilities with percentages *most above* ideal. These 12 utilities on average have fund balances about 180 percent above ideal and represent about 9 percent of the (present value of) the industry's future decommissioning costs. Observe that 7 of these 12 utilities are *California* licensees suggesting that their PUC has been very aggressive in pushing the decommissioning funding of its utilities. By contrast, Table III lists these balance results for the 12 utilities with percentages *most below* ideal. These 12 utilities on average have fund balances about 27 percent below ideal and represent about 28 percent of the industry's future decommissioning costs. Table IV shows that the 12 *largest* utilities[o] in 2000 have fund balances about 13 percent above ideal, slightly lower than the 19 percent above for *all* 77 utilities. These 12 largest utilities are important in that their costs represent about 55 percent of the industry's total decommissioning costs.

Table II. Utilities With Balances Most Above Expected Fund Balances
as of December 31, 2000
(By Percentage, Above or Below Zero)

12 utilities	PV decom. cost	Number of reactors	Act. balance above expct. bal.	Act. contrib. above expct. contr. (aapv)	Act. contrib. above expct. contr. (fstyrPV)
Year 2000:	$ Mill		%	%	%
National Grid	65	2	217	Inf	Inf
L.A. Dept. of Water & Power	63	3	201	Inf	Inf
Southern California Edison	1144	6	200	Inf	Inf
Southern California Public Power	63	3	193	Inf	Inf
Anaheim Electric Division	30	2	191	Inf	Inf
San Diego Gas & Electric	256	3	183	Inf	Inf
Pacific Gas & Electric	806	3	167	Inf	Inf
Great Bay Power	33	1	164	422	423
Madison Gas & Electric	56	1	135	Inf	Inf
Texas Utilities	477	2	129	111	111
Reliant Energy	205	2	127	441	441
Riverside Public Utilities	20	2	122	Inf	Inf
All 12 utilities	3220	Wtg. ave.	180	924	924
All (77) utilities	35240	Wtg. ave.	19	36	25

"Inf" = infinity; "aapv" = annual-average present-value; "fstyrPV" = present-value first-year contribution.

Table III. Utilities With Balances Most Below Expected Fund Balances
as of December 31, 2000
(By Percentage, Above or Below Zero)

12 utilities	PV decom. cost	Number of reactors	Act. balance above expct. bal.	Act. contrib. above expct. contr. (aapv)	Act. contrib. above expct. contr. (fstyrPV)
Year 2000:	$ Mill		%	%	%
Corn Belt Power Cooperative	31	1	-50	-42	-42
Washington Public Power	288	1	-46	-64	-64
Central Iowa Power Coop	63	1	-39	13	13
KEPCO	19	1	-39	-25	-25
Connecticut Yankee	278	1	-38	-82	-82
GPU Nuclear Corp.	482	2	-33	-81	-81
Maine Yankee	233	1	-31	-59	-59
NC Eastn Muni Powr Agn	220	4	-29	-30	-37
Tennessee Valley Authority	1720	6	-28	-100	-100
Consolidated Edison	534	2	-26	29	29
Conectiv	216	5	-26	-33	-54
Exelon	5616	20	-25	-2	-26
All 12 utilities	9699	Wtg. ave.	-27	-58	-62
All (77) utilities	35240	Wtg. ave.	19	36	25

“aapv” = annual-average present-value; “fstyrPV” = present-value first-year contribution.

Table IV. Largest Utilities: Balances Above/Below Expected Fund Balances
as of December 31, 2000
(By Percentage, Above or Below Zero)

12 utilities	PV decom. cost	Number of reactors	Act. balance above expct. bal.	Act. contrib. above expct. contr. (aapv)	Act. contrib. above expct. contr. (fstyrPV)
Year 2000:	$ Mill		%	%	%
Exelon	5616	20	-25	-2	-26
Entergy	1782	6	25	42	38
Tennessee Valley Authority	1720	6	-28	-100	-100
AmerGen	1281	3	12	-71	-72
Duke Energy	1250	7	17	236	195
Progress Energy	1239	5	17	167	111
First Energy	1201	4	-8	2	-5
Southern California Edison	1144	6	200	Inf	Inf
Northeast Utilities	1120	4	-18	122	72
Southern Company	1119	6	3	146	106
FPL Group	1065	4	99	Inf	Inf
PS Enterprise Group	956	5	29	101	101
All 12 utilities	19492	Wtg. ave.	13	68	33
All (77) utilities	35240	Wtg. ave.	19	36	25

“Inf” = infinity; “aapv” = annual-average present-value; “fstyrPV” = present-value first-year contribution.

Looking-Forward Results: Annual-Average Present-Value. Table V shows the summary *baseline* results for all licensees for our *first* adequacy measure of the utilities' current-year *contributions* over the 1997-00 period. Specifically, the table shows the percentage that all licensees' cost-adjusted two-year-average contributions are above (or below) their expected (ideal) future contribution streams. That is, this is the percentage above or below the annual-average present-value (*aapv*) of the average utility's *entire* future contributions. (An ideal contribution represents *zero* percent above. Note that mathematically this percentage can be *infinitely* above ideal for those utilities that, *given our assumptions*, require *no* future funding.)

Table V. Utilities That Contributed More or Less Funds in Last Two Years (Annual-Average) than the Annual-Average Present-Value of the Expected Future Contributions
(By Percentage, Above or Below Zero)

All utilities	Current year			
	2000	1999	1998	1997
Number of utilities	77	80	76	76
All utilities: weighted average	36	83	90	38
Number of utilities: %s above; below 0.0	57; 20	64; 16	60; 16	59; 17

This additional adequacy measure (i.e., for *contributions*) is necessary because while a licensee might have collected an (*available*) fund *balance* less than its expected balance by the end of the current year, it may currently be making up that shortage with larger recent fund contributions. (NRC did not have specific contribution rules in place until July 27, 1990.) This additional measure implicitly "smoothes" all ideal contributions over the utility's entire future contribution stream. (However, this smoothing effect applies only for utilities that require ideal future contributions for more than one reactor.)

Table V shows that in 1997 utilities' (*available*) current contributions to their decommissioning funds were *on average*[p] about 38 percent above their expected contributions. Thus, on average, the nuclear industry was contributing *much more* than was needed to eventually decommission its nuclear plants. Moreover, this contribution percentage rose sharply in 1998 and 1999 to 90 percent and 83 percent above, respectively, and fell back to 36 percent above in 2000. As with fund balances, this increase in 1998 and 1999 was mainly due to the sharp rise in the market value of existing fund assets rather than to increasing current-year contributions. In fact, total 1997 contributions of about $1.5 billion fell slightly to below $1.3 billion by 2000. (A rapid rise in decommissioning fund asset values reduces the need for future funding). The decline in the percentage in 2000 was mainly due to a slowing rise in fund asset values. As with our analysis of fund balances, these superb adequacy results for *average* utility contributions tend to *mask* the varied results for *individual* utilities. Again, a surplus in available contributions in utility A cannot offset a shortage in utility B. In 1997, 17 utilities were contributing less than their ideal amounts. In both 1998 and 1999, 16 utilities, and in 2000, 20 utilities were contributing below ideal amounts.

Although not shown in Table V, 30 of 77 utilities (in 2000) contributed over 200 percent *above* their ideal future contributions. 15 utilities contributed 101-200 percent above; 1 utility, 51-100 percent above; 8 utilities, 26-50 percent above; and 3 utilities, 0-25 percent above. By contrast, 9 of 77 utilities contributed 51-100 percent *below* their ideal future contributions; 5 utilities contributed 26-50 percent below; and 6 utilities, 1-25 percent below. Thus, the distribution of these 77 fund contribution percentages in 2000 shows that most of these utilities (54) have contributions *far above* ideal (i.e., more than 25 percent above). However, the results for 14 utilities may be worrisome in that these utilities have contributions *far below* ideal (i.e., more than 25 percent below).

In Tables VI and VII (and in Table IV) we list current *contribution* results for certain small groups of utilities in 2000. (Again, note that the number of utilities that we have included in these small groups is essentially arbitrary.) Table VI lists these contribution results for the 13 utilities with percentages *most above* ideal; that is, for those utilities with current contributions *infinitely above* their ideal future contribution of *zero*. These 13 utilities represent about 14 percent of the (present value of) the industry's future decommissioning costs. Again, observe that 7 of these 13 utilities are *California* licensees suggesting that their PUC has been very aggressive in pushing the decommissioning funding of its utilities.

Table VI. Utilities With Contributions Most Above Expected Contributions as of December 31, 2000 (By Percentage, Above or Below Zero)

13 utilities	PV decom. cost	Number of reactors	Act. contrib. above expct. contr. (aapv)	Act. contrib. above expct. contr. (fstyrPV)	Act. balance above expct. bal.
Year 2000:	$ Mill		%	%	%
Southern California Edison	1144	6	Inf	Inf	200
FPL Group	1065	4	Inf	Inf	99
Pacific Gas & Electric	806	3	Inf	Inf	167
American Electric Power	695	4	Inf	Inf	103
Wisconsin Energy	471	2	Inf	Inf	57
San Diego Gas & Electric	256	3	Inf	Inf	183
Wisconsin Public Service	127	1	Inf	Inf	107
National Grid	65	2	Inf	Inf	217
L.A. Dept. of Water & Power	63	3	Inf	Inf	201
Southern California Public Power	63	3	Inf	Inf	193
Madison Gas & Electric	56	1	Inf	Inf	135
Anaheim Electric Division	30	2	Inf	Inf	191
Riverside Public Utilities	20	2	Inf	Inf	122
All 13 utilities	4863	Wtg. ave.	Inf	Inf	139
All (77) utilities	35240	Wtg. ave.	36	25	19

"Inf" = infinity; "aapv" = annual-average present-value; "fstyrPV" = present-value first-year contribution.

By contrast, Table VII lists the 14 utilities that contributed more than 25 percent *below* ideal. These 14 utilities on average have contributions about 76 percent below ideal and represent about 17 percent of the industry's future decommissioning costs. Table IV shows that the 12 *largest* utilities in 2000 contributed about 68 percent above ideal levels, substantially higher than the 36 percent above for *all* utilities.

Table VII. Utilities With Contributions Most Below Expected Contributions
as of December 31, 2000
(By Percentage, Above or Below Zero)

14 utilities	PV decom. cost	Number of reactors	Act. contrib. above expct. contr. (aapv)	Act. contrib. above expct. contr. (fstyrPV)	Act. balance above expct. bal.
Year 2000:	$ Mill		%	%	%
NY Power Authority	589	2	-100	-100	53
Oglethorpe Power	365	4	-100	-100	-11
Saluda River Power	46	2	-100	-100	115
Tennessee Valley Authority	1720	6	-100	-100	-28
Connecticut Yankee	278	1	-82	-82	-38
GPU Nuclear Corp.	482	2	-81	-81	-33
AmerGen	1281	3	-71	-72	12
Washington Public Power	288	1	-64	-64	-46
Maine Yankee	233	1	-59	-59	-31
Corn Belt Power Coop.	31	1	-42	-42	-50
Conectiv	216	5	-33	-54	-26
Kansas City Power & Light	147	1	-32	-32	-11
NC Eastn Muni Powr Agn	220	4	-30	-37	-29
Scana Corporation	145	1	-30	-30	-5
All 14 utilities	6040	Wtg. ave.	-76	-78	-12
All (77) utilities	35240	Wtg. ave.	36	25	19

"aapv" = annual-average present-value; "fstyrPV" = present-value first-year contribution.

Looking-Forward Results: Present-Value First-Year. Table VIII shows the summary *baseline* results for all licensees for our *second* adequacy measure of the utilities' current-year contributions over the 1997-00 period. The only difference in these contribution results from the results listed in Table V is that the percentage surplus (or shortage) of all utilities' current contributions is measured with respect to their ideal *first year only* contributions. That is, the percentage surplus of the actual over ideal contribution is with respect to the present value of the average utility's *first year* contribution rather than to the *aapv* of the average utility's future contribution *stream*.

Table VIII. Utilities That Contributed More or Less Funds in Last Two Years (Annual-Average) than the Present-Value of the Expected First-Year Future Contribution
(By Percentage, Above or Below Zero)

All utilities	Current year			
	2000	1999	1998	1997
Number of utilities	77	80	76	76
All utilities: weighted average	25	68	72	25
Number of utilities: %s above; below 0.0	56; 21	64; 16	60; 16	59; 17

In short, our second measure of contribution adequacy (Table VIII) does *not* implicitly "smooth" the ideal contributions over all future funding years as does our first contribution measure (Table V). Mathematically, the percentages in Table VIII cannot be larger than, but can be smaller than the corresponding percentages in Table V. Therefore, our contribution adequacy measure in Table VIII is relatively a more stringent one on utilities.

However, the contribution results in both Tables V and VIII are, in fact, fairly similar for average utilities (and, although not shown, for individual utilities). Table VIII shows that in 1997 utilities' (available) current contributions *on average* were about 25 percent above their expected first-year contributions to their decommissioning funds. This measure of funding adequacy rose sharply in 1998 and 1999 to 72 percent and 68 percent above, respectively, and fell to 25 percent above in 2000. For *individual* utilities, 17 utilities were contributing less than their ideal amounts in 1997. In both 1998 and 1999, 16 utilities, and in 2000, 21 utilities were contributing below ideal amounts.

Results: 14 Utilities With Less Than Ideal Balances and Current Contributions. Table IX lists the 14 utilities that have *negative* balance *and* contribution percentages. These 14 utilities are perhaps the utilities that should be monitored somewhat more closely with respect to their decommissioning funding. *However, these results do **not** mean that such utilities cannot, or will not adequately finance their future decommissioning costs. These results merely mean that these utilities will have to increase their future yearly contributions at a **faster rate** than the annual rate assumed in the **ideal** future contribution stream for our baseline – the 6.25 percent after-tax rate-of-return on the decommissioning fund assets.*

Table IX. Utilities With Both Balances and Contributions Below Expected Fund Balances and Contributions as of December 31, 2000
(By Percentage, Above or Below Zero)

14 utilities	PV decom. cost	Number of reactors	Act. balance above expct. bal.	Act. contrib. above expct. contr. (aapv)	Act. contrib. above expct. contr. (fstyrPV)
Year 2000:	$ Mill		%	%	%
Conectiv	216	5	-26	-33	-54
Connecticut Yankee	278	1	-38	-82	-82
Constellation Energy	501	2	-15	-6	-6
Corn Belt Power Coop	31	1	-50	-42	-42
Exelon	5616	20	-25	-2	-26
GPU Nuclear Corp.	482	2	-33	-81	-81
Kansas City Power & Light	147	1	-11	-32	-32
KEPCO	19	1	-39	-25	-25
Maine Yankee	233	1	-31	-59	-59
NC Eastn Muni Powr Agn	220	4	-29	-30	-37
Oglethorpe Power	365	4	-11	-100	-100
Scana Corporation	145	1	-5	-30	-30
Tennessee Valley Authority	1720	6	-28	-100	-100
Washington Public Power	288	1	-46	-64	-64
All 14 utilities	10258	Wtg. ave.	-26	-60	-64
All (77) utilities	35240	Wtg. ave.	19	36	25

"aapv" = annual-average present-value; "fstyrPV" = present-value first-year contribution.

Some utilities with *less than* ideal fund *balances* (i.e., *negative* balance percentages) are currently "making up" their fund balance shortages. These utilities are perhaps of somewhat less concern because they are making current contributions *above* their ideal future contributions. (Although not shown, 10 of the 24 utilities in 2000 with fund balance shortages have *positive* contribution percentages.) However, the remaining 14 of these utilities (Table IX) are contributing *below* their ideal future contributions. These 14 utilities *on average* have fund balances about 26 percent below ideal and have current contributions about 60 percent below ideal (with respect to the *aapv* of their ideal future contribution streams), and represent about 29 percent of the industry's future decommissioning costs.

For 3 of these 14 utilities in 2000, their *negative* balance and contribution results are perhaps understandable. Both Connecticut Yankee and Maine Yankee own single reactors that are currently closed and in decommissioning. Similarly, for GPU Nuclear, both of its 2 reactors are closed, but neither is currently in decommissioning. For *closed* reactors with *insufficient* decommissioning funds, our models permit contributions for only *one year* beyond the current year so that, as much as is possible, we maintain *comparability* in our ideal funding among utilities. (Note that for all other utilities/reactors the models permit *no* funding for reactors beyond December 31 of their assumed closing year.) As an economic *efficiency/fairness* principle, we believe that, if possible, decommissioning funding (i.e., decommissioning costs) for a reactor should be borne only by ratepayers who actually use the electricity from that reactor. Such will not be possible, however, for an under-funded closed reactor.

CONCLUSION

In 2000, for all 77 utilities combined, our decommissioning funding adequacy measures for both fund balances and current contributions are not only above ideal amounts but also have been rising substantially over the 1997-00 span, with a slight retrenchment in 2000. Nonetheless, these *average* results for utilities mask the wide variability of results among *individual* utilities, some of which still show results substantially *below* ideal. We suggest that the *range* of results among different utilities is a more important policy measure to assess the adequacy of decommissioning funding than is the result often reported – the funding adequacy for the industry as a whole. There are no *average* utilities only *individual* utilities—one utility's fund balance and/or contribution rate in excess of its ideal balance and/or rate does not offset another utility's shortage. Finally, fund contributions have fallen in 1999 and 2000, and fund asset values will likely not continue to rise at the high rates of 1997-00. This suggests that our generally very positive results on the nuclear industry's decommissioning funding adequacy should be viewed with some caution.

FOOTNOTES

[a] Our simulation models are deterministic, given the assumptions chosen, rather than stochastic. We chose deterministic rather than stochastic (e.g., Monte Carlo simulation) analysis for several reasons. First, the modeling is much simpler, especially when it must be repeated for each of 76-80 utilities, for each year/scenario chosen, and for both the "looking forward" and "looking backward" fund adequacy analysis. Second, we feel that a "what if" analysis may be of more practical use for a utility. The utility can see the effects on its funding adequacy of different assumptions and future contribution streams and, thereby, initiate funding changes to improve that measured adequacy. Third, for our many assumptions, what statistical distributions (e.g., univariate normal, multivariate normal, etc.) should be used for these variables? The parameters for these distributions would also be difficult to estimate and therefore these parameter estimates too would be somewhat arbitrary.

[b] In an analysis covering just one year, the values of such assumptions would likely change slightly each year based on the best current information available.

[c] The D&P decommissioning fund balance and current contribution data over 1997-00 include "internal reserves" for some utilities. D&P likely reasons that such funds *could* be used for decommissioning. However, in total, these amounts are relatively small compared to D&P's total balance and contribution amounts for the nuclear industry.

[d] D&P's data were obtained from the *company-wide* financial balance sheets of utilities. The NRC data (as we currently understand) for 1998 and 2000 are both more, and less comprehensive than are those of D&P. NRC lists decommissioning fund *balances* by reactor (by utility), but includes no yearly fund

contributions by reactor or by utility. Thus, using NRC data, our “looking backward” fund balance analysis can be performed by utility (by reactor), but not our “looking forward” fund contribution analysis. An additional data source(s) must be obtained before we can undertake the looking-forward analysis.

[e] To reduce the length of this paper, and to focus only on *baseline* trends, most of the results of such simulations and scenario analyses will be examined in another *future* paper. Besides parametrically varying the values for the five assumptions listed above, in our enhanced models we can also vary the assumptions for the (1) start date and length of decommissioning, (2) initial decommissioning cost estimates, and (3) decommissioning fund asset values.

[f] However, for simplicity of modeling, the full decommissioning is now assumed in our baseline to occur “instantaneously” 2.5 years after shutdown. This first-five-year decommissioning-period assumption is, of course, somewhat arbitrary, but, for comparison purposes, we had to select a *single* standard. NRC requires only that the amount of funds actually accumulated by the end of a plant’s operating life equals the projected cost to decommission the plant. These required funds will be *less* (with respect to present value costs) the *longer* that decommissioning is delayed after shutdown (as long as the future cost escalation rate is less than the future after-tax rate-of-return on decommissioning fund assets).

[g] For the licensees of plants already being decommissioned, some of their decommissioning funds have already been expended and are therefore not included in their respective fund balances. For these plants, we use D&P’s estimates of the “percentage (share) of costs spent” as of the end of the current year. This share is used to provide an estimate of *remaining* decommissioning costs. For example, in 2000, D&P included such *share* data for these plants/licensees already being decommissioned: Big Rock Point/CMS Energy; Haddam Neck/Connecticut Yankee; Maine Yankee/Maine Yankee Atomic; Millstone 1/Northeast Utilities; and Yankee-Rowe/Yankee Atomic.

[h] This expected (or ideal) contribution is defined, respectively, for our two looking-forward adequacy measures as: (1) the annual-average present-value of the *utility’s* ideal future contribution *stream* and (2) the present-value of the *utility’s* ideal *first-year* future contribution.

[i] That is, the utility’s most recent two-year-average *real* contribution.

[j] From the February 1998 Economic Report of the President, we calculated that over 1990-97 a broad-based measure of inflation – the Gross Domestic Product (GDP) Implicit Price Deflator -- had increased at an annual-average rate of about 2.5 percent.

[k] This inflation forecast was computed by averaging forecast data from Standard & Poor’s/DRI and WEFA Group for the 1997 through 2018 period.

[l] There is always innate imprecision in estimating the value of any key factor. Similarly, models themselves are, by definition, simplifications – a model cannot contain the full complexity of “reality” and, therefore, a model’s results are too subject to error. This, in short, is an important reason for using simulation/scenario analyses to obtain reasonable ranges for a model’s results.

[m] The effects of such license reductions/extensions (e.g., Calvert Cliffs 1 & 2 license extensions) on our looking-backward and looking-forward funding adequacy measures will be examined in a later paper using simulation analyses.

[n] Implicitly, this is a *weighted* average, weighted by both the sizes of the utilities’ decommissioning funds and the utilities’ estimated decommissioning costs.

[o] That is, these utilities are largest with respect to the *present value* of each respective utility's future decommissioning costs.

[p] Implicitly, this is a *weighted* average, weighted by both the sizes of the utilities' current-year contributions and the utilities' *aapv* of their ideal future contribution *streams*.