SUBSTANTIAL VARIABILITY EXISTS IN UTILITIES' NUCLEAR DECOMMISSIONING FUNDING ADEQUACY: BASELINE TRENDS (1997-2001) AND SCENARIO & SENSITIVITY ANALYSES (YEAR 2001)

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

ABSTRACT

This paper explores the *trends* over 1997-2001 in my *baseline* analysis of the sufficiency of electric utilities' funds to eventually decommission the nation's nuclear power plants. Further, for 2001, I describe the utilities' funding adequacy results obtained using *scenario* and *sensitivity* analyses, respectively. In this paper, I focus more on the wide *variability* observed in these adequacy measures among utilities than on the results for the "average" utility in the nuclear industry. Only *individual* utilities, not *average* utilities -- often used by the nuclear industry to represent its funding adequacy -- will decommission their nuclear plants. *Industry-wide* results tend to *mask* the varied results for *individual* utilities.

This paper shows that over 1997-2001, the variability of my *baseline* decommissioning funding adequacy measures (in percentages) for *both* utility fund *balances* and current *contributions* has remained *very large*, reflected in the sizable ranges and frequency distributions of these percentages. The relevance of this variability for nuclear decommissioning funding adequacy is, of course, focused more on those utilities that show *below* ideal balances *and* contribution levels. *Looking backward*, 42 of 67 utility fund (available) *balances*, in 2001, were *above* (and 25 *below*) their ideal *baseline* levels; in 1997, 42 of 76 were *above* (and 34 *below*) ideal levels. Of these, many utility balances were far above, and many far below, such ideal levels. The problem of certain utilities continuing to show balances much below ideal persists even with increases in the adequacy of "average" utility balances.

Looking forward, 46 of 67 utility fund (available) current *contributions*, in 2001, were *above* (and 21 *below*) their ideal *baseline* levels; in 1997, 59 of 76 were *above* (and 17 *below*). The ranges and frequency distributions of these *contribution* adequacy percentages reveal an *extremely-wide* spread among utilities. My *baseline* assumption results show that in 2001, 13 utilities were "over-funded" and that, *given these assumptions*, require *no* future contributions. Yet, 15 of these 67 utilities in 2001 had *both* balances and current contributions *below* ideal.

Both my scenario and sensitivity analyses for 2001 show that there is generally substantial *sensitivity* of utility adequacy results to *changes* in key assumptions (from the *baseline*). In my scenario analyses for 2001, *each* of (for 7 of the 8) key assumptions, respectively, was "improved" (optimistic), or "worsened" (pessimistic), by a small amount -- *5 percent* -- from the *baseline*. Although each assumption change is *individually* small, *together* their scenario effect is quite substantial on my funding adequacy measures. In the *pessimistic* scenario, 44 of 67 utility balances, and 37 utility contributions are below ideal. However, in the *optimistic* scenario, only 8, and 7 utilities, respectively, are below. 21 utilities are "over-funded," yet 4 utilities still have *less-than-ideal* balances *and* current contributions!

In my sensitivity analyses for 2001, each of 8 key *baseline* assumptions, respectively, was "improved," or "worsened" -- one-at-a-time -- by 5%, 10%, and 20%. Changes in the values for all but 2 of these 8 key assumptions – "current-year contributions" and "decommissioning start date" – substantially affect fund *balance* adequacy. Only "decommissioning start date" changes fail to substantially affect fund *contribution* adequacy. An example: a sizable market decline (e.g., 20%) in the fund balance (i.e., a decline in asset values). My results show that this decrease from the *baseline* reduces the balance, and contribution adequacies, for the "average" utility, from 10 percent above ideal to 12 percent below, and from 62 percent above to 21 percent above, respectively.

INTRODUCTION

At the WM'02 Symposium, I presented a paper[a] assessing the recent *baseline* trends over 1997-00 in the sufficiency of electric utilities' funds to eventually decommission the nation's nuclear power plants. A shortened version of this paper was published as a recent *Nuclear Plant Journal* article.[b] This work built upon my prior research at the U.S. General Accounting Office (GAO) assessing utility funding adequacy, as of December 31, 1997, for pessimistic, baseline and optimistic scenarios -- research undertaken for The U.S. Congress and published in a GAO report in May 1999 (GAO/RCED-99-75). The present paper extends these *baseline* trend results through 2001, focusing here more on the wide variability of my results for our adequacy measures among utilities rather than on the trends in the results for the "average" utility in the nuclear industry. Further, for 2001, I describe the funding adequacy results obtained using scenario and sensitivity analyses, respectively. I undertook these latter analyses to see whether there are any sizable effects on these funding adequacy measures of *changes* in key assumptions from the *baseline*. This paper will present a less detailed description of my data sources, model methodology, and rationale for the baseline values assumed for my eight key assumptions. A more full description can be found in my earlier WM'02 paper.

METHODOLOGY

The simulation models used in my decommissioning funding adequacy analyses are essentially large "what if" financial models whose results for each utility depend upon the values chosen for the key assumptions. The *definition* of each utility's "ideal" fund balance and "ideal" current-year contribution can be explained by using a simplified example: If, by December 31, 2001, a utility with 100% ownership of a single reactor has "used up" 40 percent (e.g., 16 years) of the lifespan of that reactor, its actual balance should equal its "ideal" balance of 40 percent of the *present value* of the future decommissioning costs for that reactor. If, say, this utility has accumulated only 30 percent, then its actual balance would be 25 percent *below* its ideal balance. However, this utility could be currently contributing to its fund at a much higher rate than in the past and, thus, be showing that it likely will "make up" that shortage over its future funding years (e.g., 24 years). If its current-year contribution were *above* the annual-average present-value of its future required contributions (i.e., the *present value* of 70% of the future costs, divided by 24 years), then it would be currently contributing *above* its ideal amount. Note, however, that *this assessment of contribution adequacy* ***assumes*** *that a utility will increase yearly its most recent (two-year-average-cost-adjusted) contribution, over the remaining lives of its reactors, by the after-tax rate-of-return on its decommissioning funds*.

KEY ASSUMPTIONS

Table I lists the eight key assumptions used in my utility decommissioning funding adequacy analyses. These are: (1) annual-average decommissioning cost-escalation rate (%), (2) after-tax annual-average rate-of-return on decommissioning fund assets -- "discount rate"(%), (3) operating license extension (# years), (4) fund balance & contribution "available" for meeting "NRC-defined" costs (%), (5) "instantaneous" decommissioning start after license expiration (# years), (6) "initial" decommissioning costs increase (%), (7) decommissioning fund market value increase (%), and (8) current-year contributions increase (%). The table lists the *baseline*

scenario values of these key assumptions assumed for my *trend* analysis of utility funding adequacy over 1997-2001, as well as, for 2001, the "5% worse" and "5% improved" values, from the baseline, for the *pessimistic* and *optimistic* scenarios, respectively. The size chosen for each of these changes is, of course, very small, and somewhat arbitrary, but should *combined* represent, alternatively, a very pessimistic and very optimistic scenario of the future. (Note that for the *scenario* analyses, the "current-year contribution" is *not* changed because this key assumption may be better viewed as a "policy instrument" than as a "state-of-nature" facing each utility.)

Table I. Eight Key Assumptions –
Pessimistic, Baseline, and Optimistic Scenarios

Key Assumptions	**SCENARIO**		
	Pessimistic	**Baseline**	Optimistic
	5% "worse"		5% "improved"
Cost Escalation Rate (Annual-Average %)	5.25%	**5.0%**	4.75%
After-Tax Rate-of-Return (Ann-Average %)	5.9375%*	**6.25%****	6.5625%***
Operating License *Extension* (# Years)	-1	**0**	+1
Fund Balance/Contribution "available" (%)	81.61%	**85.9%**	90.195%
Decom Start After License Exp (# Years)	2.375	**2.5**	2.625
Initial Decom Costs *Increase* (%)	5.0%	**0.0%**	-5.0%
Fund Market Value *Increase* (%)	-5.0%	**0.0%**	5.0%
Current-Year Contributions *Increase* (%)	-0.0%	**0.0%**	0.0%

* Real rate: 0.6875% ; ** Real rate: 1.25%; and *** Real rate: 1.8125%, each relative to scenario cost escalation rate.

MODEL RESULTS

Baseline Trend Results. Table II shows, for 1997-2001, trends in the frequency distribution and utility-wide averages for my *looking-backward* analyses -- the *baseline* adequacy percentages for utility fund *balances*. From 1997 through 2001, the range of these percentages has remained very wide – from 75% *below* ideal balance to 300% *above*. Taking into account the reduction (9) in the number of utilities from 1997 to 2001, the number showing below ideal balance levels has remained quite substantial – from 34 below ideal in 1997 to 25 below in 2001. And, many utilities are *far below*, and many *far above* ideal. For example, in 2001, a few utilities (7 of 67) had balances more than 25 percent *below* their ideal levels, while many utilities (17) were far *above* -- 76 percent or more. The "average" utility, an average that excludes 3 (or 4) utilities[c] over 1997-01, had balances *above* ideal levels. Namely, in 1997, a utility-wide weighted balance near ideal (4 percent above), rising to 22 percent above in 1999, and falling to 10 percent above in 2001. The un-weighted (i.e., equal weighted) averages are higher reflecting the lower adequacy percentages for the balances of the larger utilities – larger in terms of greater fund balances and higher decommissioning costs. The related un-weighted standard deviations remain between 60 and 67 percent, indicating a wide spread in utility adequacy for balances.

Table II. Trends in Utilities' Decommissioning Fund Balance Adequacy – 1997-2001: Frequency Distributions, and Weighted and Un-weighted Utility-wide Averages

(Adequacy, by Percentages, Above or Below the Zero "Ideal" Level)

All Utilities	December 31 of the CURRENT YEAR				
BASELINE	2001	2000	1999	1998	1997
Number of Utilities	**67**	**77**	**80**	**76**	**76**
Utility-wide:					
Weighted Average*	**10%**	**20%**	**22%**	**14%**	**4%**
Un-weighted Average**	**38%**	**45%**	**46%**	**35%**	**27%**
Un-weighted Stan. Deviation**	**67%**	**65%**	**66%**	**64%**	**60%**
Number of Utilities with:					
Percentages *Above* Zero					
301% & Over	0	0	0	0	0
201-300%	2	2	2	2	0
151-200%	2	5	5	3	5
101-150%	7	9	9	7	3
76-100%	6	5	8	6	10
51-75%	4	8	7	7	4
26-50%	6	9	8	7	7
11-25%	8	9	7	7	10
0-10%	7	6	9	8	3
Number Above Zero	**42**	**53**	**55**	**47**	**42**
Percentages *Below* Zero					
1-10%	8	5	9	6	6
11-25%	10	6	4	10	13
26-50%	4	12	9	10	11
51-75%	3	1	3	3	4
76-100%	0	0	0	0	0
Number Below Zero	**25**	**24**	**25**	**29**	**34**

* Across *all* utilities (i.e., except for Connecticut Yankee, Maine Yankee, and Yankee Atomic – 1997-2001; GPU Nuclear – 2000). As a percentage: *sum of* "available" balances (one for each utility) divided by *sum of* ideal balances (one for each utility).
** Across *all* utilities (i.e., except for Connecticut Yankee, Maine Yankee, and Yankee Atomic – 1997-2001; GPU Nuclear – 2000).

Table III shows, for 1997-2001, trends in the frequency distributions and utility-wide (weighted) averages for my *looking-forward* analyses -- *baseline* adequacy percentages for utility current-year fund *contributions*. From 1997 through 2001, the range of these percentages has remained *extremely wide* – from 100% *below* ideal contribution to *infinitely above*. Taking into account the reduction (9) in the number of utilities from 1997 to 2001, the number showing below ideal contribution levels has significantly increased – from 17 below ideal in 1997 to 21 below in 2001 – partially reflecting a slowdown in current-year contributions. While in the baseline many utilities are *far below*, many are *far above* ideal contributions. For example, in 2001, 15 of 67

Table III. Trends in Utilities' Decommissioning Fund Current-Year Contribution Adequacy* – 1997-2001: Frequency Distributions and Weighted Utility-wide Averages

(Adequacy, by Percentages, Above or Below the Zero "Ideal" Level)

All Utilities	December 31 of the CURRENT YEAR				
BASELINE	2001	2000	1999	1998	1997
Number of Utilities	**67**	**77**	**80**	**76**	**76**
Utility-wide:					
Weighted Average**	**62%**	**107%**	**140%**	**153%**	**144%**
Number of Utilities with:					
Percentages *Above* Zero					
+Infinity %	13	13	13	11	6
1,001% & Over (**not** incl. *+Inf.*)	2	1	0	1	4
501-1,000%	0	3	3	2	3
301-500%	3	6	5	8	6
201-300%	4	7	7	5	5
151-200%	4	3	10	3	6
101-150%	4	10	8	10	9
76-100%	2	1	4	5	4
51-75%	3	1	1	6	6
26-50%	5	8	4	5	6
11-25%	5	2	5	2	3
0-10%	1	1	3	2	1
Number Above Zero	**46**	**56**	**63**	**60**	**59**
Percentages *Below* Zero					
1-10%	2	4	1	1	4
11-25%	4	2	2	6	1
26-50%	5	6	7	6	5
51-75%	2	2	2	0	4
76-99%	3	3	2	2	3
100%	5	4	3	1	0
Number Below Zero	**21**	**21**	**17**	**16**	**17**

*Contribution adequacy with respect to annual-average present-value of ideal future contributions (for each utility).

** Across *all* utilities (i.e., except for Connecticut Yankee, Maine Yankee, and Yankee Atomic – 1997-2001; GPU Nuclear – 2000). As a percentage: *sum of* "available" current contributions (one for each utility) divided by *sum of* annual-average present-value of ideal future contributions (one for each utility).

utilities had contributions more than 25 percent *below* their ideal levels, while almost half of the utilities (32) were far *above* -- 76 percent or more. At the upper extreme, with baseline assumptions, in 1997, 6 utilities, and in 2001, 13 utilities were *over-funded*, requiring no future funding. In 2001, 15 of 67 utilities showed, in the baseline, *negative* percentages for *both* balances and current-year contributions. The "average" utility (see footnote "c"), over 1997-

2001, had current contributions *far above* ideal levels. Namely, in 1997, a utility-wide weighted contribution 144 percent above ideal, rising to 153 percent above in 1998, and falling to 62 percent above in 2001 – again partially reflecting declining contributions.

Scenario Analyses Results. Tables IV and V show the results for my scenario analyses for 2001 -- for the pessimistic, baseline (results repeated in Tables IV and V for reference), and optimistic scenarios. The values for the eight key assumptions for each scenario are listed in Table I. Table IV gives the results for the *looking-backward* fund balance analysis, and Table V the results for the *looking-forward* fund current-year contribution analysis.

Table IV shows, for 2001, the frequency distributions and utility-wide averages for my looking-backward analyses; that is, for the three scenarios, results for my adequacy percentages for utility fund *balances*. Over the three scenarios, the respective ranges of these percentages are very wide in all three – from 75% *below* ideal balances (in all three), to 200% above in the pessimistic scenario, to over 301% *above* in the optimistic scenario. The number of these 67 utilities showing below ideal balances is sizable (44) for the pessimistic scenario and, surprisingly, 8 of these utilities remain below under the optimistic scenario.

This above result could be worrisome in that these above 8 utilities in Table IV continue to show below ideal balances even when the "scenario dice" are "optimistically" loaded in their favor. These 8 utilities are: Connecticut Yankee, Corn Belt Power Coop, Energy Northwest (WPP), Exelon, KEPCO(KCPC), Maine Yankee, Tennessee Valley Authority, and Yankee Atomic. However, for Connecticut Yankee, Maine Yankee, and Yankee Atomic, these results are "understandable" in that each of these 3 utilities own single reactors, each in decommissioning, and each closed "prematurely" before sufficient decommissioning funds had been collected. **(But, such occurrences should represent a "warning" to utilities to perhaps fund reactors at somewhat *above* an ideal *baseline* pace to plan prudently for such a risk!)** In contrast, my results show that Corn Belt Power, Exelon, and KEPCO all appear to be "making up" their balance shortages with significantly above ideal current-year contributions, at least under the *optimistic* scenario.

In Table IV the average utility (see footnote "c") in 2001 had balances far *above* ideal for the optimistic scenario but somewhat *below* for the pessimistic scenario. Namely, a utility-wide weighted balance of 46 percent above ideal and 16 percent below for these two scenarios, respectively. The un-weighted (i.e., equal weighted) averages are again higher. The related un-weighted standard deviations are 48 percent for the pessimistic and 94 percent for the optimistic scenarios, indicating that the range of adequacy percentages becomes larger as the key assumptions become progressively more optimistic.

Table V shows, for 2001, the frequency distributions and utility-wide averages for my looking-forward analyses; that is, for the three scenarios, results for my adequacy percentages for utility fund current-year *contributions*. Over the three scenarios, the respective ranges of these percentages are extremely wide in all three – from 100% *below* ideal contributions (i.e., *no* current-year contributions when future contributions *are* necessary), to *infinitely above* (i.e., when *no* future contributions are necessary because these utilities are "*over-funded*" given the values for the key assumptions). At this upper extreme, 21 utilities are over-funded in the

Table IV. Scenario Analysis of Utilities' Decommissioning Fund Balance Adequacy – 2001: Frequency Distributions, and Weighted and Un-weighted Utility-wide Averages

(Adequacy, by Percentages, Above or Below the Zero "Ideal" Level)

All Utilities	SCENARIO		
Year 2001	*Pessimistic*	***Baseline***	*Optimistic*
Number of Utilities	**67**	**67**	**67**
Utility-wide:			
Weighted Average*	**-16%**	**10%**	**46%**
Un-weighted Average**	**2%**	**38%**	**90%**
Un-weighted Stan. Deviation**	**48%**	**67%**	**94%**
Number of Utilities with:			
Percentages *Above* Zero			
301% & Over	0	0	3
201-300%	0	2	4
151-200%	1	2	9
101-150%	3	7	5
76-100%	2	6	7
51-75%	2	4	5
26-50%	9	6	16
11-25%	3	8	7
0-10%	3	7	3
Number Above Zero	**23**	**42**	**59**
Percentages *Below* Zero			
1-10%	5	8	3
11-25%	16	10	2
26-50%	18	4	2
51-75%	5	3	1
76-100%	0	0	0
Number Below Zero	**44**	**25**	**8**

* Across *all* utilities (i.e., except for Connecticut Yankee, Maine Yankee, and Yankee Atomic). As a percentage: *sum of* "available" balances (one for each utility) divided by *sum of* ideal balances (one for each utility).

** Across *all* utilities (i.e., except for Connecticut Yankee, Maine Yankee, and Yankee Atomic).

Table V. Scenario Analysis of Utilities' Decommissioning Fund
Current-Year Contribution Adequacy* – Year 2001:
Frequency Distributions and Weighted Utility-wide Averages

(Adequacy, by Percentages, Above or Below the Zero "Ideal" Level)

All Utilities	**SCENARIO**		
Year 2001	*Pessimistic*	***Baseline***	*Optimistic*
Number of Utilities	**67**	**67**	**67**
Utility-wide:			
Weighted Average**	**-11%**	**62%**	**255%**
Number of Utilities with:			
Percentages *Above* Zero			
+Infinity %	5	13	21
1,001% & Over (**not** incl. *+Inf.*)	4	2	4
501-1,000%	0	0	9
301-500%	1	3	3
201-300%	1	4	5
151-200%	0	4	1
101-150%	3	4	5
76-100%	2	2	2
51-75%	3	3	3
26-50%	5	5	6
11-25%	2	5	0
0-10%	4	1	1
Number Above Zero	**30**	**46**	**60**
Percentages *Below* Zero			
1-10%	3	2	0
11-25%	4	4	0
26-50%	13	5	1
51-75%	6	2	1
76-99%	5	3	2
100%	6	5	3
Number Below Zero	**37**	**21**	**7**

* Contribution adequacy with respect to annual-average present-value of ideal future contributions (for each utility).
** Across *all* utilities (i.e., except Connecticut Yankee, Maine Yankee, and Yankee Atomic). As a percentage: *sum of* "available" current contributions (one for each utility) divided by *sum of* annual-average present-value of ideal future contributions (one for each utility).

optimistic scenario and 5 of these remain over-funded even under the pessimistic scenario. These 5 are: Anaheim Electric Division, Massachusetts Municipal Power, San Diego Gas & Electric, Southern California Edison, and Wisconsin Public Service. Note that 3 of these 5 are utilities based in California.

The number of these 67 utilities in Table V showing below ideal contributions is sizable (37) for the pessimistic scenario; 7 of these utilities remain below under the optimistic scenario. These 7 utilities are: AmerGen, Energy Northwest (WPP), Maine Yankee, North Carolina Electric Co, Oglethorpe Power, Tennessee Valley Authority, and Yankee Atomic. However, at least under my optimistic scenario, these below ideal, "looking-forward" contribution results for AmerGen, N.C. Electric, and Oglethorpe Power may be economically rational in the short run in that all three utilities show *above* ideal fund balances under this scenario. In Table V the average utility (see footnote "c") in 2001 had balances *extremely above* ideal for the optimistic scenario but somewhat *below* for the pessimistic scenario. Namely, a utility-wide weighted current-year contribution of 255 percent above ideal and 11 percent below for these two scenarios, respectively. My looking-forward adequacy measures for contributions are, therefore, more *sensitive* to changes in key assumptions than are the looking-backward measures for end-of-year balances.

Sensitivity Analyses Results. Tables VI and VII list the values used for my eight key assumptions in my sensitivity analyses of the effects on utility funding adequacy of *one-by-one* changes in these assumptions *from those values in the baseline scenario*. Table VI lists the values for those changes that "improve" utility balance & contribution adequacy and Table VII lists the corresponding values that "worsen" this adequacy. In each table, these values are increased, or decreased from the baseline depending upon which such change improves, or worsens the measured adequacy. Changes from baseline values are by 5%, 10%, and 20%, respectively.

Table VI. Sensitivity Analyses: Eight Key Assumptions – "*Improved* Results"

Key Assumptions: **Year 2001**	**SIMULATION**			
Baseline, and Changes from Baseline that "*Improve*" Adequacy Results	**Baseline**	+, or -5 %	+, or -10%	+, or -20%
	i.e.,"+" or "–" Changes that *Improve* Results			
Cost Escalation Rate (Annual-Average %)	**5.0%**	4.75%	4.5%	4.0%
After-Tax Rate-of-Return (Annual-Average %)	**6.25%**	6.5625%	6.875%	7.5%*
Operating License *Extension* (# Years)	**0**	+1	+2	+4
Fund Balance/Contribution "available" (%)	**85.9%**	90.195%	94.49%	100.0%**
Decom Start After License Expiration (# Years)	**2.5**	2.625	2.75	3.0
Initial Decom Costs *Decrease* (%)	**0.0%**	-5.0%	-10.0%	-20.0%
Fund Market Value *Increase* (%)	**0.0%**	5.0%	10.0%	20.0%
Current-Year Contributions *Increase**** (%)	**0.0%**	5.0%	10.0%	20.0%

* Real rate: 2.5% relative to baseline cost escalation rate.
** 16.4% simulation increase (i.e., max = 100.0% of balance & contribution "available").
*** In other words, the *actual* level of current-year contributions is assumed to be increased by 0%, 5%, 10%, and 20%, respectively; then, from this higher base, each future-year contribution is assumed, as before, to increase at the after-tax rate of return assumed for the fund.

Table VII. Sensitivity Analyses: Eight Key Assumptions – "*Worsened* Results"

Key Assumptions: **Year 2001**	**SIMULATION**			
Baseline, and Changes from Baseline that "*Worsen*" Adequacy Results	**Baseline**	+, or -5 %	+, or –10%	+, or -20%
	i.e., "+" or "–" Changes that *Worsen* Results			
Cost Escalation Rate (Annual-Average %)	**5.0%**	5.25%	5.5%	6.0%
After-Tax Rate-of-Return (Annual-Average %)	**6.25%**	5.9375%	5.625%	5.0%*
Operating License *Reduction* (# Years)	**0**	-1	-2	-4
Fund Balance/Contribution "available" (%)	**85.9%**	81.61%	77.31%	68.72%
Decom Start After License Expiration (# Years)	**2.5**	2.375	2.25	2.0
Initial Decom Costs *Increase* (%)	**0.0%**	5.0%	10.0%	20.0%
Fund Market Value *Decrease* (%)	**0.0%**	-5.0%	-10.0%	-20.0%
Current-Year Contributions *Decrease*** (%)	**0.0%**	-5.0%	-10.0%	-20.0%

* Real rate: 0.0% relative to baseline cost escalation rate.

** In other words, the *actual* level of current-year contributions is assumed to be decreased by 0%, 5%, 10%, and 20%, respectively; then, from this lower base, each future-year contribution is assumed, as before, to increase at the after-tax rate of return assumed for the fund.

Tables VIII and IX show the results for the "*looking-backward*" adequacy of utility balances for my sensitivity analyses for 2001; that is, for the baseline scenario (results repeated in Tables VIII and IX for reference), and for the 5%, 10%, and 20% changes in values from the baseline. Table VIII gives the results for those *one-by-one* simulations that *improve* the adequacy of balances from that of the baseline and Table IX gives the results for those *one-by-one* simulations that *worsen* that adequacy. To conserve space, only the results for the utility-wide weighted *averages* (see footnote "c") will be listed in these two tables, rather than the results for *all* 67 utilities, for *each* of the 24 changes (8 key assumptions times 3 changes) that improves balance adequacy, and for *each* of the 24 changes (8 key assumptions times 3 changes) that worsens balance adequacy.

Table VIII. Sensitivity Analyses: *Improved* Results
Utilities' Decommissioning Fund Balance Adequacy -- Year 2001:
Weighted Utility-wide Averages*

(Adequacy, by Percent, Above or Below the Zero "Ideal" Level)

Key Assumption Changes: **"Improved"** Results	**SIMULATION**			
Year 2001	**Baseline**	+, or –5%	+, or -10%	+, or -20%
All 64 Utilities: *utility-wide weighted average*	w/ "+" or "–" Changes that *Improve* Results			
Cost Escalation Rate (Annual-Average %)	**10.4%**	16.0%	21.8%	34.3%
After-Tax Rate-of-Return (Annual-Average %)	**10.4%**	15.5%	20.8%	31.9%
Operating License *Extension* (# Years)	**10.4%**	13.8%	17.3%	24.2%
Fund Balance/Contribution "available" (%)	**10.4%**	15.9%	21.4%	28.5%**
Decom Start After License Expiration (# Years)	**10.4%**	10.5%	10.7%	11.0%
Initial Decommissioning Costs *Decrease* (%)	**10.4%**	16.2%	22.6%	37.9%
Fund Market Value *Increase* (%)	**10.4%**	15.9%	21.4%	32.4%
Current-Year Contributions *Increase* (%)	**10.4%**	10.4%	10.4%	10.4%

* Across *all* 64 utilities (i.e., except for Connecticut Yankee, Maine Yankee, and Yankee Atomic). As a percentage: *sum of* "available" balances (one for each utility) divided by *sum of* ideal balances (one for each utility).
** 16.4% simulation increase (i.e., max = 100.0% of balance & contribution "available").

Table IX. Sensitivity Analyses: *Worsened* Results
Utilities' Decommissioning Fund Balance Adequacy -- Year 2001:
Weighted Utility-wide Averages*

(Adequacy, by Percent, Above or Below the Zero "Ideal" Level)

Key Assumption Changes: **"Worsened"** Results	**SIMULATION**			
Year 2001	**Baseline**	+, or –5%	+, or -10%	+, or -20%
All 64 Utilities: *utility-wide weighted average*	w/ "+" or "–" Changes that *Worsen* Results			
Cost Escalation Rate (Annual-Average %)	**10.4%**	5.0%	-0.2%	-9.8%
After-Tax Rate-of-Return (Annual-Average %)	**10.4%**	5.4%	0.5%	-8.7%
Operating License *Reduction* (# Years)	**10.4%**	6.9%	3.6%	-3.1%
Fund Balance/Contribution "available" (%)	**10.4%**	4.8%	-0.7%	-11.7%
Decom Start After License Expiration (# Years)	**10.4%**	10.2%	10.0%	9.7%
Initial Decommissioning Costs *Increase* (%)	**10.4%**	5.1%	0.3%	-8.0%
Fund Market Value *Decrease* (%)	**10.4%**	4.8%	-0.7%	-11.7%
Current-Year Contributions *Decrease* (%)	**10.4%**	10.4%	10.4%	10.4%

* Across *all* 64 utilities (i.e., except for Connecticut Yankee, Maine Yankee, and Yankee Atomic). As a percentage: *sum of* "available" balances (one for each utility) divided by *sum of* ideal balances (one for each utility).

Tables VIII and IX show that changes (from the baseline assumptions) in the values for all but 2 of the 8 key assumptions substantially affect the measured adequacy of utility balances. (Note that, *mathematically*, changes in "current-year *contributions*" cannot affect fund *balance* adequacy; hence, its related utility-wide percentage remains *constant*.) In other words, given our 5%, 10%, and 20% changes, the utility-wide weighted average adequacy for balances increases (Table VIII), and decreases (Table IX) substantially from its baseline average of 10.4 percent above ideal balance for all assumptions except the "number of years for the "instantaneous" start of decommissioning after license expiration" and the "current-year contributions" (as noted above). In Table VIII, decreases in the "initial decommissioning costs estimation" increase the utility-wide weighted average for balances the most -- to 37.9 percent above ideal, for a 20% decrease. In Table IX, decreases in the "fund balance/contribution "available"," and decreases in the "market value of the decommissioning fund" decrease the utility-wide average the most -- to 11.7 percent below ideal for, separately, a 20% decrease in each assumption. (Note that changes in these two assumptions – up or down – have, *mathematically*, an identical effect on the measured adequacy of *balances* but not of *contributions*.)

Tables X and XI show the results for the "*looking-forward*" adequacy of utility current-year contributions for my sensitivity analyses for 2001; that is, for the baseline scenario (results repeated in Tables X and XI for reference), and for the 5%, 10%, and 20% changes in values from the baseline. Table X gives the results for those *one-by-one* simulations that *improve* the adequacy of contributions from that of the baseline and Table XI gives the results for those *one-by-one* simulations that *worsen* the measured adequacy. Again, to conserve space, only the results for the utility-wide weighted *averages* (see footnote "c") will be listed in these two tables.

Table X. Sensitivity Analyses: *Improved* Results
Utilities' Decommissioning Fund Current-Year Contribution
Adequacy* -- Year 2001: Weighted Utility-wide Averages**
(Adequacy, by Percent, Above or Below the Zero "Ideal" Level)

Key Assumption Changes: **"Improved"** Results	**SIMULATION**			
Year 2001	**Baseline**	+, or –5%	+, or -10%	+, or -20%
All 64 Utilities: *utility-wide weighted average*	w/ "+" or "–" Changes that *Improve* Results			
Cost Escalation Rate (Annual-Average %)	**61.6%**	85.6%	114.9%	200.8%
After-Tax Rate-of-Return (Annual-Average %)	**61.6%**	84.3%	114.4%	186.8%
Operating License *Extension* (# Years)	**61.6%**	73.0%	84.8%	109.9%
Fund Balance/Contribution "available" (%)	**61.6%**	82.1%	105.1%	139.7%***
Decom Start After License Expiration (# Years)	**61.6%**	62.2%	62.8%	63.9%
Initial Decommissioning Costs *Decrease* (%)	**61.6%**	83.3%	110.6%	197.9%
Fund Market Value *Increase* (%)	**61.6%**	73.5%	86.4%	118.5%
Current-Year Contributions *Increase***** (%)	**61.6%**	69.7%	77.8%	94.0%

* Contribution adequacy with respect to annual-average present-value of ideal future contributions (for each utility).
** Across *all* 64 utilities (i.e., except for Connecticut Yankee, Maine Yankee, and Yankee Atomic). As a percentage: *sum of* "available" current contributions (one for each utility) divided by *sum of* annual-average present-value of ideal future contributions (one for each utility).
*** 16.4% simulation increase (i.e., max = 100.0% of balance & contribution "available").
**** See footnote "***" Table VI.

Table XI. Sensitivity Analyses: *Worsened* Results
Utilities' Decommissioning Fund Current-Year Contribution
Adequacy* -- Year 2001: Weighted Utility-wide Averages**

(Adequacy, by Percent, Above or Below the Zero "Ideal" Level)

Key Assumption Changes: **"Worsened"** Results	**SIMULATION**			
Year 2001	**Baseline**	+, or –5%	+, or -10%	+, or -20%
All 64 Utilities: *utility-wide weighted average*	w/ "+" or "–" Changes that *Worsen* Results			
Cost Escalation Rate (Annual-Average %)	**61.6%**	41.4%	24.5%	-1.8%
After-Tax Rate-of-Return (Annual-Average %)	**61.6%**	42.2%	25.7%	-0.3%
Operating License *Reduction* (# Years)	**61.6%**	50.5%	39.5%	17.9%
Fund Balance/Contribution "available" (%)	**61.6%**	42.3%	25.2%	-2.9%
Decom Start After License Expiration (# Years)	**61.6%**	61.1%	60.5%	59.4%
Initial Decommissioning Costs *Increase* (%)	**61.6%**	43.1%	28.2%	5.8%
Fund Market Value *Decrease* (%)	**61.6%**	49.7%	39.1%	21.4%
Current-Year Contributions *Decrease**** (%)	**61.6%**	53.5%	45.5%	29.3%

* Contribution adequacy with respect to annual-average present-value of ideal future contributions (for each utility).
** Across *all* 64 utilities (i.e., except for Connecticut Yankee, Maine Yankee, and Yankee Atomic). As a percentage: *sum of* "available" current contributions (one for each utility) divided by *sum of* annual-average present-value of ideal future contributions (one for each utility).
*** See footnote "**" Table VII.

Tables X and XI show that changes (from the baseline assumptions) in the values for all but one of the 8 key assumptions substantially affect the measured adequacy of utility current-year contributions. Again, the exception is the assumption for the "number of years for the "instantaneous" start of decommissioning after license expiration." (For reference, recall that, in the baseline, utility-wide current-year contributions are, weighted, 61.6 percent above ideal levels.) In Table X, decreases in the "annual-average decommissioning costs escalation rate" assumption increase the utility-wide weighted average for contributions the most -- to 200.8 percent above ideal, for a 20% decrease in this assumption. Note too that, except for the "number of years …" assumption, of the remaining 7 key assumptions, increases in the "current-year contribution" assumption increase contribution adequacy *the least* – to 94.0 percent above ideal, for a 20% increase in this assumption. But, this assumption is perhaps the one assumption that a utility can *directly* effect *the most* – and, perplexingly, it has relatively the *least effect* on contribution adequacy! In other words, this assumption is most similar to a utility funding *policy* variable, or "lever," rather than to an assumption for a "state of nature" facing a utility, about which the utility can directly do little, or nothing, to change. In Table XI, decreases in the "fund balance/contribution 'available'" assumption decrease the utility-wide average the most -- to 2.9 percent below ideal, for a 20% decrease in this assumption.

Over *All* Scenario Results: Four Utilities With *Less Than* Ideal Balances *and* Current-Year Contributions. Table XII lists the four utilities that have *negative* balance *and* contribution percentages under *all* three scenarios, even optimistic. Maine Yankee and Yankee Atomic are on this list because each of these utilities has a single reactor, each of which has closed prematurely,

each is in decommissioning but, under all my scenarios, each is without sufficient decommissioning funds *at plant closure*. The other two utilities in Table XII are: Energy Northwest (WPP) and Tennessee Valley Authority, both federally operated and owned. Perhaps, because of "deeper financial pockets," the federal government does not perceive, as much as does the private sector, the need for a current contribution stream to the decommissioning fund that closely matches the associated stream of "accrued" future decommissioning costs. The four utilities in Table XII represent 7.1 percent of (the present value of) the total future decommissioning costs for the industry under the *baseline* scenario – a total industry present-value cost of about $37.7 billion at the end of 2001.

Table XII. *Four* Utilities With Balances *and* Contributions
Below Expected Fund Balances *and* Contributions,
for *All Three* Scenarios, as of December 31, 2001

(Adequacy, by Percentages, Above or Below the Zero "Ideal" Level)

Four Utilities	Present Value Decom Costs	Number Reactors; Number Closed / FutureYr Last Rct Closed	Act Bal Above Expect Balance	Actual Contrib Above Expect Contrib	Act Bal Above Expect Balance	Actual Contrib Above Expect Contrib	Act Bal Above Expect Balance	Actual Contrib Above Expect Contrib
Year 2001				(aapv)		(aapv)		(aapv)
Scenario	***Baseline***		**Pessimistic**		***Baseline***		**Optimistic**	
	$ Mill	Number	%	%	%	%	%	%
Energy Northwest (WPP)	306	1; 0	-68.3	-78.0	-56.2	-68.7	-38.8	-53.6
		2023						
Maine Yankee	298	1; 1	-61.7	-87.3	-54.8	-84.0	-46.7	-79.0
		N/a						
Tennessee Valley Authority	1,827	6; 0	-56.5	-100.0	-41.9	-100.0	-21.7	-100.0
		2035						
Yankee Atomic	239	1; 1	-65.2	-89.9	-59.0	-87.5	-51.7	-84.0
		N/a						
All 4 Utilities	**2,670**							
All (67) Utilities	**37,680**							
4 Utilities % of 67 Utilities	**7.1**							

"aapv" = annual-average present-value future *ideal* contributions.

CONCLUSION

Over 1997-2001, the variability of utilities' funding adequacy to finance their future nuclear decommissioning costs has remained very wide. Although weighted utility-wide averages for balances and, especially, for current-year contributions have remained well above my baseline "ideal" levels over the period, this sanguine result is a misleading one for the nuclear industry. In 2001, 15 of 67 utilities in my baseline scenario showed *negative* adequacy percentages (i.e., below "ideal") for *both* their fund balances *and* current-year contributions. This *under-ideal* funding by such utilities will not be "offset" by the *over-ideal* funding of certain other utilities. But, such offsets are implicit when using *utility-wide averages* – as are often used by the nuclear industry – to characterize the adequacy of decommissioning funding for the industry.

Moreover, a strong case can be made that to be financially prudent (with respect to *risk*) in their decommissioning funding utilities might want to contribute to their funds at levels *somewhat above* these baseline "ideal" levels. (*How much above* is uncertain, but a more precise answer may depend upon the use of *stochastic* – e.g., Monte Carlo – simulation analyses on these measured adequacies, analyses to be undertaken in the future by this author.) My "current-contribution" *key assumption* is an example of a "looking-forward" policy instrument that can be used by utilities to improve their measured contribution (and, ultimately, balance) adequacy. (Note that utilities' fund *balance* adequacy is "backward-looking," and relates only to contribution levels and fund asset growth from *previous* years.) In particular, my sensitivity results show that a 20% increase in the "base" level of "current-year contributions" increases the utility-weighted contribution adequacy by about *one third* – from 62 percent above ideal to 94 percent above.

Both my scenario (pessimistic, baseline, and optimistic assumptions) and sensitivity (*one-at-a-time* assumption changes) analyses for 2001, each of which varies my 8 key assumptions, show that my utility balance and, especially, my utility contribution adequacy measures are fairly *sensitive* to *changes* in these assumptions from their baseline values. Therefore, utilities might want to increase their funding to counteract the negative effects from one or more adverse changes in these key assumptions from the baseline. Also, some utilities have been forced to shut and decommission their plants early, *before* sufficient funds have been collected. More such utilities may be similarly affected in the future. Perhaps such occurrences should represent a "warning" to utilities to consider the "unexpected" when making their future funding plans to finance the decommissioning of their reactors!

FOOTNOTES

a Williams, Daniel G., "Recent Trends In The Adequacy Of Nuclear Plant Decommissioning Funding" (Reference/Abstract # 7), WM'02 Proceedings, Tucson, AZ, Feb. 24-28, 2002.

b Williams, Daniel G., "Adequacy of Funds for Nuclear Plant Decommissioning," Nuclear Plant Journal, Volume 20, No. 4, July-August 2002, pp. 29-31.

c Over 1997-01, 3 utilities – Connecticut Yankee, Maine Yankee and Yankee Atomic -- represent utilities with single, closed reactors; in 2000, GPU Nuclear also owned 2 closed reactors. Because these utilities had already shut their reactors without sufficient funds (i.e., *new* contributions were required by these utilities *after* closure), their balance adequacy percentages and, especially, their current-year contribution adequacy percentages are *far below* ideal. Including them in my *utility-wide* averages would slightly bias these averages downward for balances, and greatly downward for contributions. Thus, I excluded them from both the weighted and un-weighted averages.