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Committee on Science and Technology
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Madam Chairman, I am pleased to appear before your Subcommittee to discuss pricing and investment strategies for U.S. uranium enrichment. As the Congress reviews this program, it faces the difficult task of balancing competing goals. One goal, reducing the federal deficit, would suggest an enrichment program that covered its full production costs and repaid its outstanding debt to the Treasury. However, budgetary savings, especially in the short-term, could work against another federal purpose -- providing price-competitive enrichment services in order to retain the U.S. share of the world market. The task of policy is to strike the appropriate balance between short-term budgetary considerations and long-run competitiveness.

In my testimony today, I will discuss:

- Price competition in world enrichment markets;
- The effects of alternative pricing and investment policies on the international competitiveness of U.S. enrichment; and
- The budgetary implications of these pricing and investment options.

PRICE COMPETITION AND THE WORLD MARKET

The dominant characteristic of world enrichment markets is oversupply, both in terms of capacity to produce separative work units (SWU) and stockpiles of enriched uranium. The four major suppliers -- the United States, Eurodif, Urenco, and the Soviet Union -- have a combined annual capacity of 42 million SWU. By contrast, demand in 1983 was less than 18 million SWU. In addition, almost 29 million SWU of excess inventory are now available at prices well below current production costs. Using mid-range projections for nuclear powerplant deployment, we estimate annual demand in the range of 33 million SWU by 1995, suggesting continued long-run overcapacity.

Implications of Overcapacity

Many nations invested in uranium enrichment facilities to gain greater control over their energy supplies and to promote domestic industries. These investments were planned under optimistic projections of nuclear power growth and pessimistic assessments of uranium supplies. Neither view proved correct, and with global overcapacity now a reality, the large fixed costs of the enrichment plants provide a strong incentive for producers to retain or even expand their share of the market. Thus, price competition for market share is likely to be severe, and many segments of the market, already committed to foreign suppliers, appear unlikely customers for U.S. enrichment at any price.

Nevertheless, about 20 percent of projected demand -- some 5 to 7 million SWU per year between 1990 and 2000 -- is likely to be influenced by price. This includes the currently uncommitted demand of countries such as Japan, Korea, Sweden, Switzerland, and Yugoslavia. In addition, some domestic utilities have recently contracted for foreign enrichment, suggesting that this market of 10 to 12 million SWU per year is price sensitive also.

The benefits to the United States of maintaining or even expanding its share of the world market include greater diversity in nuclear fuel supply and foreign policy leverage in nuclear nonproliferation matters. While analysis cannot assign a value to these benefits, it can address the instruments that influence competitiveness: pricing policy and investment policy.

PRICING POLICIES, INVESTMENT OPTIONS, AND COMPETITION

Understanding the competitive position of the U.S. enrichment program requires estimating the price structure of the major competitors. As shown in Figure 1, at the end of this testimony, recovery of production costs (operating and some capital) enables Eurodif to charge about $115 per SWU at present, while Urenco, with its more efficient centrifuge technology, charges about $90. (The current U.S. price is $135.) According to the Department of Energy (DOE), both could fall to $60 per SWU (in 1986 dollars) by the year 2000 if Eurodif introduces laser enrichment and if Urenco deploys advanced centrifuges. Taken together, these prices can be thought of as establishing a range within which the U.S. enterprise must compete if it is to retain or expand its share of the price-sensitive market.

The analysis that follows relates pricing and investment options to this competitive range and to the financial performance of the enrichment enterprise. This range, however, must be viewed with one important uncertainty in mind: a market characterized by high fixed costs and strong price competition leads producers to cut their prices to levels approaching operating cost rather than lose market share. This could push actual prices to the bottom of the range shown in Figure 1, perhaps even to a level that would make full cost recovery impossible for any supplier.

Current Pricing, Investment Options, and Competition

Current policy would continue a price structure based on long-run average cost. This is calculated each year by summing the next ten years' operating costs, depreciation charges, and interest charges on unrecovered government investment. This sum is then divided by the amount of SWUs to be sold over that period. Thus, operating costs would be recovered in 10 years and capital investment over 25 to 37 years, depending upon the depreciation schedules for individual facilities.

The effects of current policy on the price per SWU vary with the investment strategy. As shown in Figure 2, a decision to make no new investment but to rely on the current gaseous diffusion plants (GDP) would allow the constant-dollar SWU price to drop from the current $135 to about $100 by the early 1990s. Further improvements, however, would not occur; and by the mid-1990s, an enrichment program that included deployment of laser isotope separation (AVLIS) would offer the most competitive prices -- about $80 per SWU by the year 2000. A program based on the advanced gas centrifuge (AGC) would yield the highest prices until 1998 due to its large capital investment and consequent interest charges. Beyond that time, the AGC price would drop below that of GDP. (All data presented here reflect the cost estimates and deployment schedules used by the Process Evaluation Board in reaching its decision to select the AVLIS technology over the AGC. CBO has not analyzed an optimal deployment schedule.)

The price paths for each investment option are superimposed over the competitive range in Figure 2. These results suggest that the current pricing formula would not yield a competitive position for the U.S. whatever the choice of process technology.

Revised Pricing Policy, Investment Options, and Competitiveness

Alternately, the DOE could revise its pricing policy within the provisions of current law, primarily by reducing the interest rate charged on the unrecovered federal investment. The current DOE charges imply a real interest rate of 10.5 percent, considerably above the historical cost of long-term government borrowing. In recent years, that rate has been unusually high and volatile; but assuming more normal circumstances in the future, a real rate in the range of 4 percent would be closer to long-term borrowing costs.

Under such a policy, the early price advantage of relying on GDP alone would be significantly reduced, as shown in Figure 3. The AGC investment would yield the lowest prices by the late 1980s and the AVLIS investment would become superior by the mid-1990s. Both advanced technologies would be priced at approximately $70 per SWU by the year 2000 -- a marked improvement over the $90 per SWU possible with GDP alone and no other investment. This would move the advanced technologies toward the lower end of the competitive range, though still leaving them at a possible price disadvantage relative to foreign competitors.

Marginal Cost Pricing, Investment Options, and Competitiveness

Pricing policy could also be based on marginal cost: the concept that costs previously incurred ought not to influence decisions about future resource use. Marginal cost pricing, therefore, includes variable costs only, unlike average cost pricing, which includes recovery of past expenditures.

Economic analysis suggests that competitive markets yield prices approximating marginal cost, and that such prices lead to the most efficient use of resources. When price exceeds marginal cost, society forgoes benefits because consumers are willing to pay more for the additional unit of service than the value of the resources committed to producing it. This suggests that the prices set for government enterprises should be based on marginal cost to the extent that efficiency considerations apply.

Under a marginal cost approach, the Treasury would forgo repayment of the $3 billion in undepreciated investment for gaseous diffusion and centrifuge technology. This action would require amending the current pricing statute that calls for full cost recovery. It could, however, leave open the possibility of eventual repayment -- perhaps beyond the year 2000, and possibly even with interest -- if the program's financial position made that possible.

Marginal cost pricing, with a 4 percent real interest charge, would yield the lowest price of any option, as shown in Figure 4. Both GDP and the advanced technologies would be well below the competitive range in the short term, reaching a constant dollar SWU price of $75 by 1990. The competitive position of the GDP, however, would begin to deteriorate, especially beyond 1995. At $80 per SWU in the late 1990s, a program relying on the current technology is not likely to be attractive to price-sensitive purchasers. By contrast, the advanced technologies appear to be price competitive throughout the period of analysis.

IMPLICATIONS FOR THE FEDERAL BUDGET

The enrichment program could contribute a small amount to deficit reduction by charging a price that covers annual expenses with annual revenues and provides a surplus to repay the Treasury debt of roughly $4 billion to $5 billion, a figure that includes interest charges on the unrecovered investment. Annual cash flow -- the difference between revenues and outlays before any debt repayment -- is one measure of the program's ability to do this. A continued positive balance would allow repayment, while a negative balance would require net appropriations.

For each technology option, the current pricing policy would provide the strongest short-term cash flow. Assuming no loss of sales, a policy of reliance on GDP without further investment would provide an annual cash flow on the order of $400 million (in 1986 dollars) through the year 2000. This is shown in Figure 5. Commitment to AVLIS would yield a similar cash flow until the early 1990s, when construction expenditures would begin to consume the surplus. By the mid-1990s, both the AVLIS and AGC technologies could provide markedly superior financial performance.

This pattern of cash flow would hold for the other pricing options as well. For example, Figure 6 illustrates cash flow under marginal cost pricing, assuming no increase in sales due to lower prices. As under current pricing, reliance on GDP alone would provide the strongest cash flow in the early years. But by the mid-1990s, the advanced technology options would begin to show stronger positive cash flows.

This pattern, however, can only be considered illustrative for two reasons. First, the analysis ends at the year 2000, well before the end of economic life for the advanced technologies. Extending the period of analysis to include the payback period for the advanced technologies would provide a more accurate view of the merits of each alternative. The DOE cost data, however, do not allow this to be done.

Second, this pattern of cash flow is based on a static view of the market. It assumes that buyers do not respond to changing prices for enrichment services, and that the sales estimates contained in the current DOE demand projections are realized. While contract provisions would surely limit the short-term response of enrichment purchasers, the long-run demand for U.S. separative work is likely to rise or fall with price. The data are not adequate to calculate a market response, but reasonable scenarios can be constructed. 1/

Under a moderate scenario for market loss -- one most applicable to the current pricing policy -- the positive cash flows for each technology option would be cut almost in half by the late 1990s. Further, the SWU price under current policy (calculated by dividing total cost by projected sales) would have to rise because of the lower sales base available to cover costs. This would lead to an even further decline in SWU sales. Conversely, a scenario for long-run market gain -- most applicable to the advanced technologies under marginal cost pricing -- would lead to even lower prices as costs were divided by a larger sales base.

The eventual outcome of these market effects is highly speculative. Nevertheless, they point to several conclusions. First, the time lags required for market response suggest that cash flow would be greatest in the early years under the current pricing policy and reliance on GDP with no other investment. Under these conditions, we estimate the discounted

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1. A moderate scenario for market loss would include: no market response through 1989; current customers taking from DOE the required minimum of 70 percent of their annual SWU requirements between 1990 and 1994; and DOE retaining only 75 percent of the domestic market and 25 percent of its current foreign demand beyond 1995. A moderate scenario for market gain would include: slightly higher DOE sales from 1988 through the early 1990s; and DOE servicing 55 percent to 60 percent of the world market by the late 1990s, compared with 47 percent today.

present value of net cash receipts by 1995 to be $1.6 billion. (By contrast, an AVLIS investment under current policy would yield a present value of $0.1 billion, and the AGC investment a $1.0 billion deficit.) Market response, however, might prevent any pricing policy or investment option from recovering sufficient cash to repay the full Treasury debt before the year 2000. Beyond that date, the stronger financial position resulting from an investment in advanced technology could provide the means for eventual repayment.

Nevertheless, there is a cost to postponing positive cash flows while investments are made and market positions sought. In present value terms, an investment in AVLIS technology under marginal cost pricing would leave a net cash deficit of $2.3 billion by the year 2000, even assuming an expanded market share. This present value deficit would be $2.6 billion under an AGC investment. (These deficits are not surprising, however, since the analysis does not extend far enough to include the full payback period.)

SUMMARY

In summary, Madam Chairman, pricing and investment options can serve either of two goals: short-term budgetary savings or long-term competitiveness. In general, the current pricing policy, with no funds diverted for investment, appears to offer the strongest financial position in the near term. Over the long term, marginal cost pricing with an investment in advanced enrichment technology appears to offer the strongest competitive position.

Figure 1: COMPETITIVE PRICE RANGE

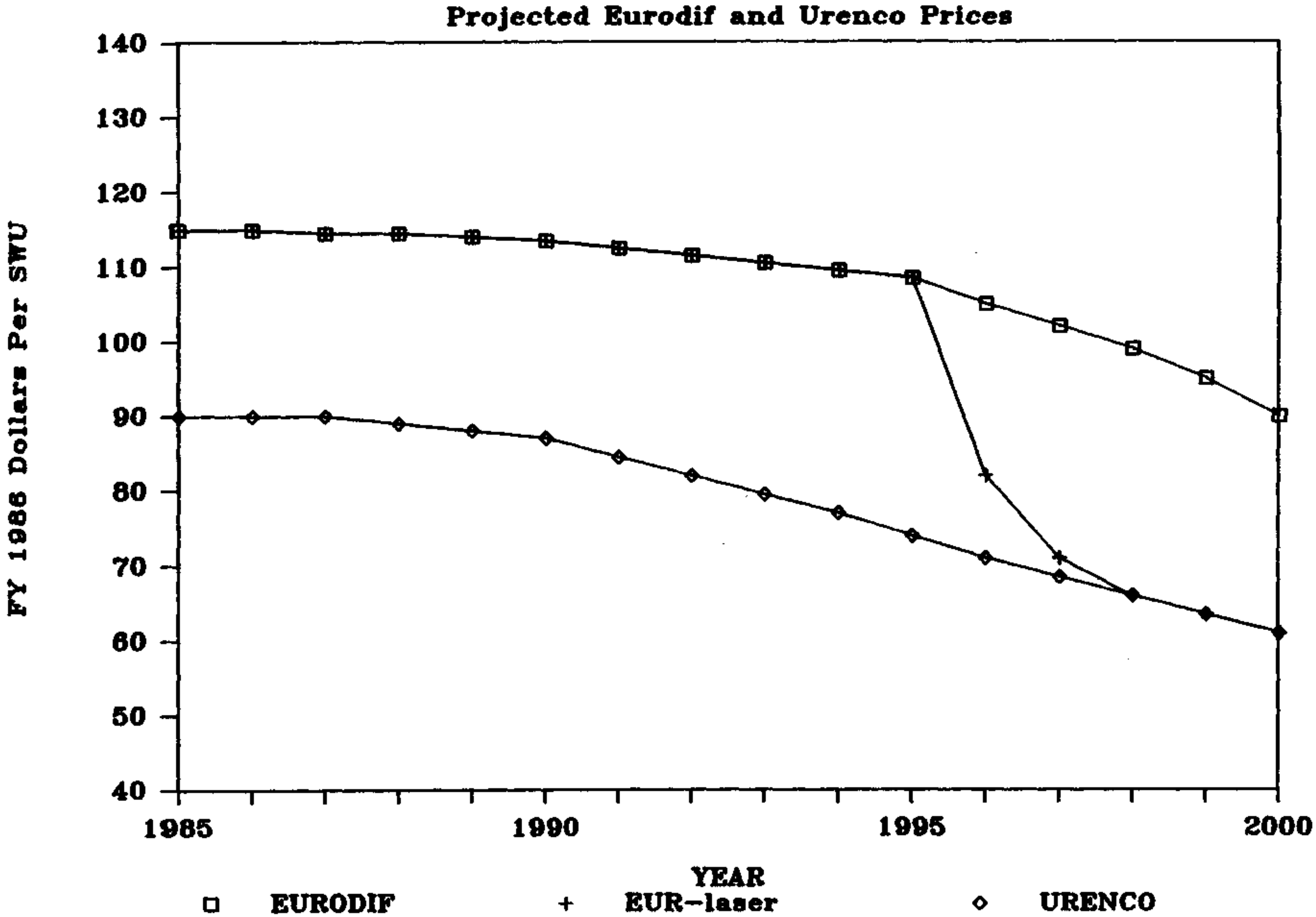
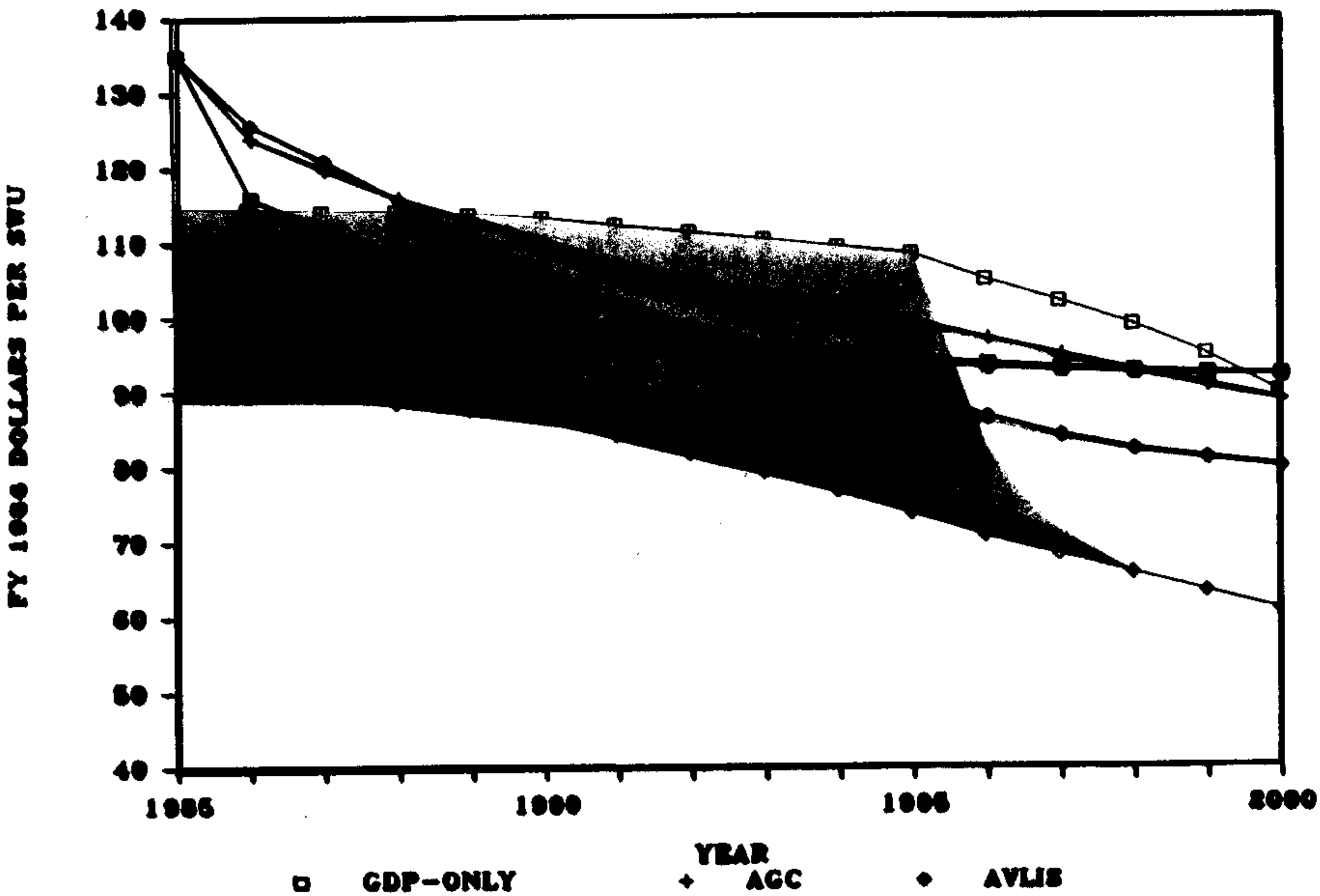
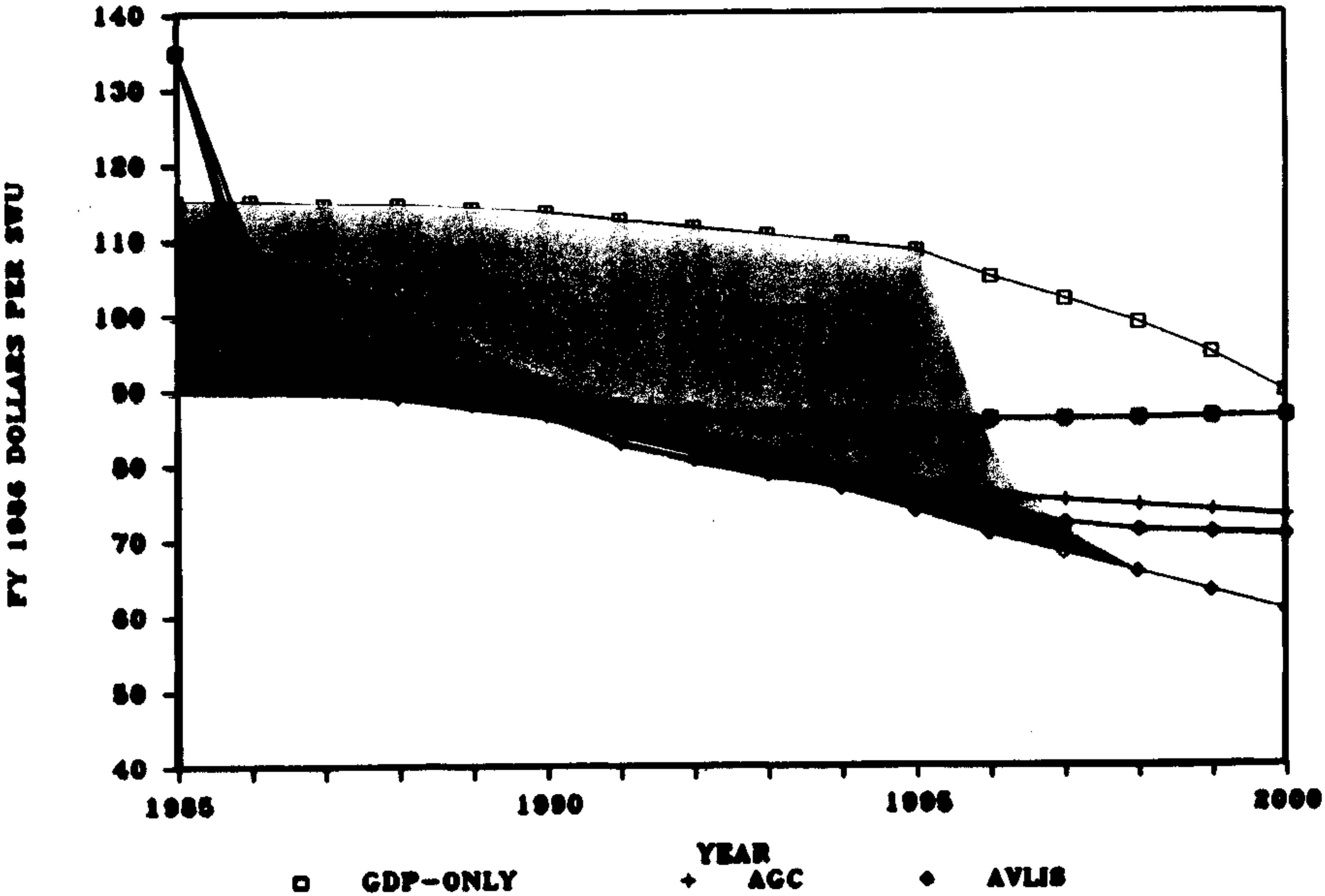


Figure 2. PRICES: CURRENT POLICY



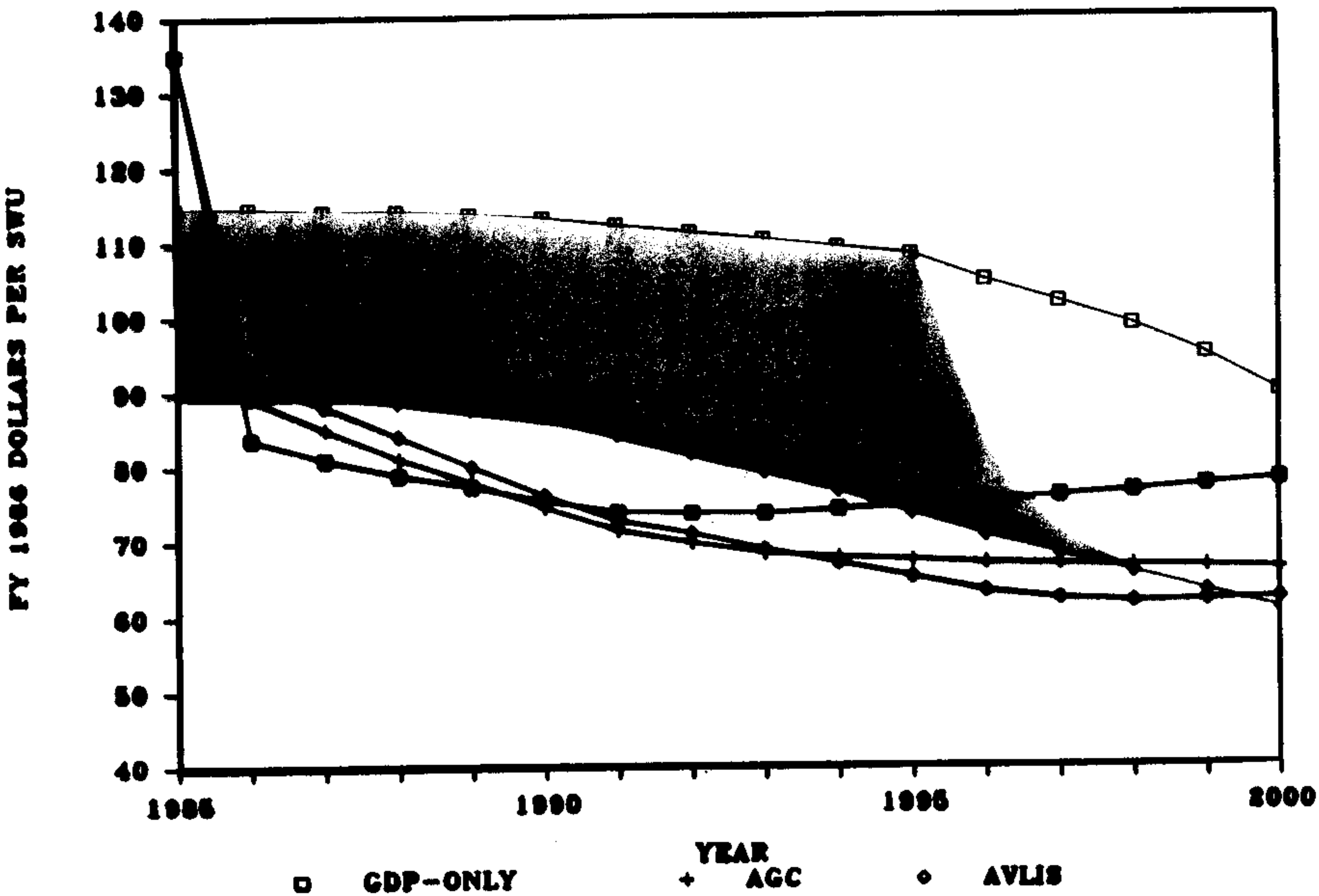
NOTES: The Current Pricing Policy assumes an annual interest rate of 10 percent.

Figure 3. PRICES: REVISED CURRENT POLICY



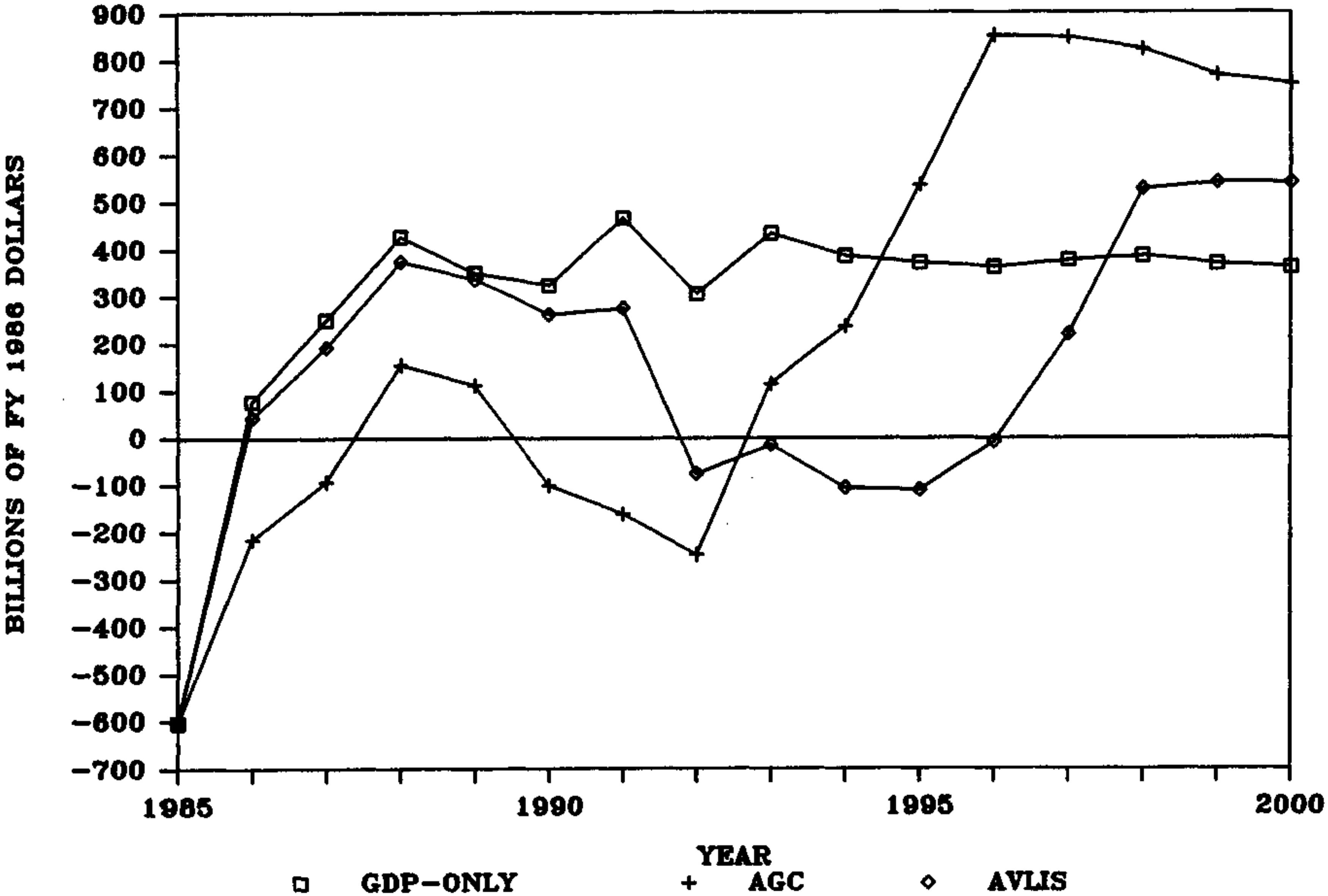
NOTE: The Revised Current Pricing Policy assumes an annual interest rate of 4 percent.

Fig. 4. PRICES: MARGINAL COST POLICY



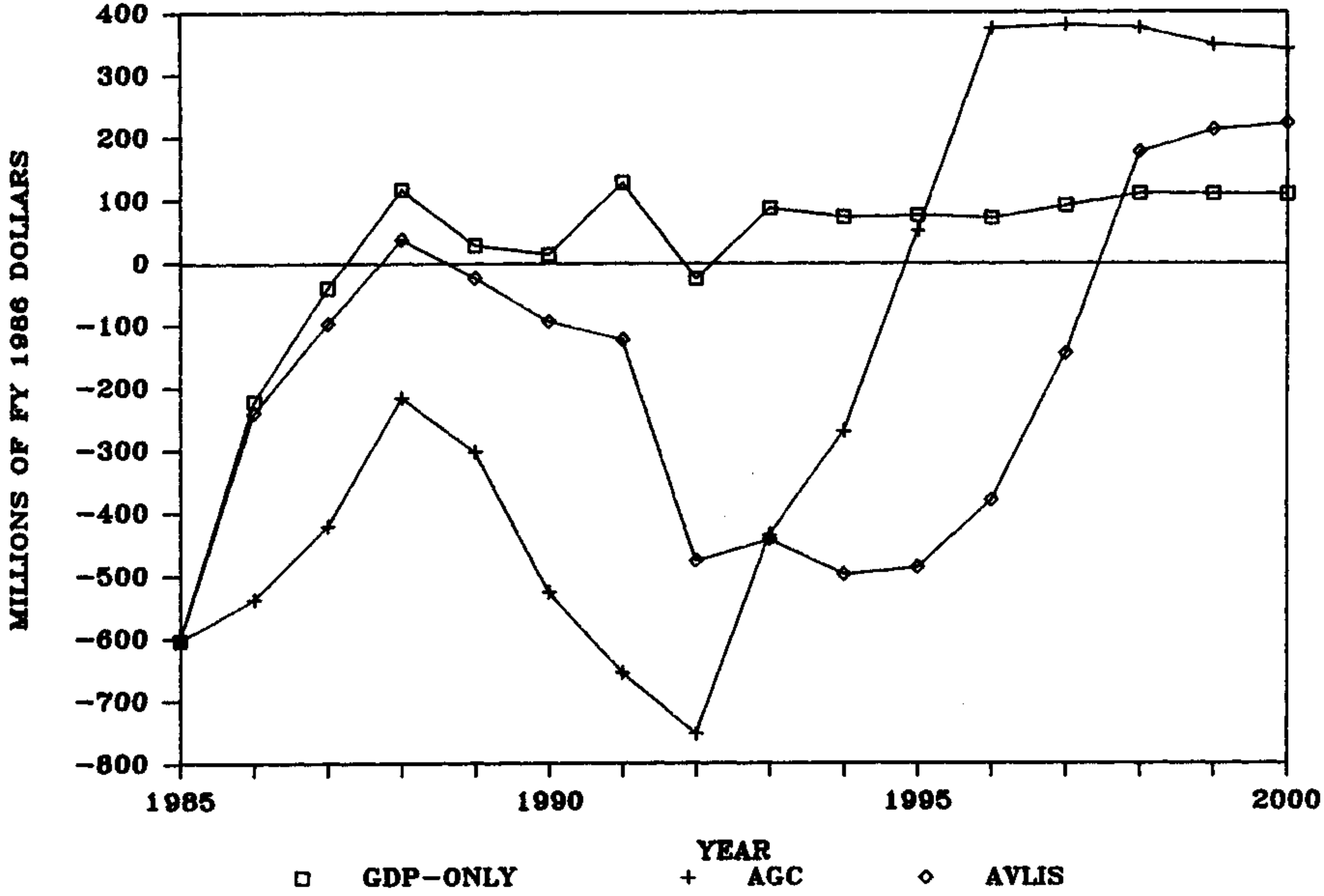
NOTE: The Marginal Cost Pricing Policy assumes that all sunk GDP and GCEP investment costs are written-off, and that a 4 percent annual interest rate is charged on all new investment.

Fig.5. ANNUAL CASH FLOW:CURRENT POLICY



NOTE: The Current Pricing Policy assumes an annual interest rate of 10 percent.

Fig.6. CASH FLOW:MARGINAL COST POLICY



NOTE: The Marginal Cost Pricing Policy assumes that all sunk GDP and GCEP investment costs are written-off, and that a 4 percent annual interest rate is charged on all new investment.

APPENDIX

TABLE 1. COST ESTIMATES FOR THE AGC, AVLIS, AND GASEOUS DIFFUSION TECHNOLOGIES THROUGH THE YEAR 2000 (In fiscal year 1986 dollars)

Cost	AGC	AVLIS	Gaseous Diffusion
Capital Investment-1985-2000 (Billions of dollars)	6.2 [a]	3.3	0.6 [b]
--Construction Costs	5.4	2.3	0.6
--Research & Development	0.8	1.0	0.0
--Total Dollars per SWU [c]	21.2	13.5	0.9
Operating Cost-Annual (Millions of dollars)	305.0 [d]	253.0 [e]	161-191 in fixed operating costs 300-1200 in power costs
--Total Dollars per SWU	26.1	25.8	7.0-8.3 in fixed operating costs 50-60 in power costs (excluding demand penalties)
Total Dollars per SWU	47.3	39.3	57.9-69.2

SOURCE: The Congressional Budget Office, based on the technology cost projections used by the Process Evaluation Board of the Department of Energy, obtained from the Office of Uranium Enrichment and Assessments in June 1985.

a. The federal government has already invested $2.3 billion in construction of the GCEP project. This amount is not included in the $6.2 billion additional investment of the AGC facility.

b. Capital investment in the three diffusion plants through fiscal year 1984 is about $4 billion. About $2 billion has been depreciated, and an additional $1.3 billion has been written off as "unrecoverable." The current undepreciated asset value of the three plants is about $0.9 billion.

c. The capital charge per SWU is based on the plant's total SWU production assuming maximum capacity over a 25-year operating life. The maximum production would be 683 SWUs for the three diffusion plants, 293 million SWUs for the AGC plant, and 245 million SWUs for the AVLIS facility.

d. The annual operating cost for the AGC or AVLIS plant includes both their fixed and variable (power) costs, and represents the plant's long-term unit operating costs when producing at maximum capacity.

e. The diffusion operating costs represent both the fixed costs of running either all three plants ($191 million per year) or 2 plants with one plant on stand-by ($161 million per year), plus annual power costs. Power costs vary dramatically depending on the annual SWU production from the diffusion plants, and also include energy demand penalities for power that DOE has contracted for but will not use.

TABLE 2. PROGRAM OUTLAYS UNDER THE GDP-ONLY PROGRAM (In millions of fiscal year 1986 dollars)

Years	GDP Capital	GDP Power a/	GDP Other Operating	AGC b/	Other c/	Total
1985-1990	352	5,080	1,055	823	162	7,472
1991-1995	125	4,758	949	--	135	5,967
1996-2000	125	5,449	955	--	135	6,664
Total	602	15,287	2,959	823	432	20,103

SOURCE: The Congressional Budget Office, based on technology cost projections used by the Process Evaluation Board of the Department of Energy, obtained from the Office of Uranium Enrichment and Assessment in June 1985.

NOTE: The GDP-only program would operate the Paducah and Portsmouth diffusion plants from 1986 to 1991, with the Oak Ridge plant on stand-by. From 1992 on, all three plants would operate because of higher production requirements.

a. The GDP power costs are based on DOE's assumption that they can continue to purchase some off-peak power to run the diffusion plants. Estimates based on DOE's power costs assuming its firm power contracts only would increase total power costs by about $670 million through the year 2000. Demand penalty charges for power that DOE has contracted for, but will not use, are also included.

b. The AGC costs represent the capital development and operating costs associated with the AGC program in fiscal year 1985, and the cost of closing down the GCEP facility in 1986.

c. Other program costs reflect the administration costs of managing the enrichment program.

TABLE 3. PROGRAM OUTLAYS UNDER THE AVLIS PROGRAM (In millions of fiscal year 1986 dollars)

	GDP Outlays			AVLIS OUTLAYS					
Years	Capital	Power [a]	Other Operating	Capital	Operating	Research Development	AGC [b]	Other [c]	Total
1985-1990	352	5,076	1,055	82	--	737	741	162	8,205
1991-1995	125	4,982	815	1,621	173	127	--	135	7,978
1996-2000	125	2,716	815	624	1,162	125	--	135	5,702
Total	602	12,774	2,685	2,327	1,335	989	741	432	21,885

SOURCE: The Congressional Budget Office, based on technology cost projections used by the Process Evaluation Board of the Department of Energy, obtained from the Office of Uranium Enrichment and Assessment in June 1985.

NOTE: The AVLIS program assumes that two diffusion plants remain operational, with the Oak Ridge plant on stand-by. The proposed AVLIS facility would have an annual capacity rate of 9.8 million SWUs, and would begin production in 1995, reaching full production by 1999.

a. The GDP power costs are based on DOE's assumption that they can continue to purchase some off-peak power to run the diffusion plants. Estimates based on DOE's power costs assuming its firm power contracts only would increase total power costs by about $287 million through the year 2000. Demand penalty charges for power that DOE has contracted for, but will not use, are also included.

b. The AGC costs represent the capital development and operating costs associated with the AGC program in fiscal year 1985, and the cost of closing down the GCEP facility in 1986.

c. Other program costs reflect the administration costs of managing the enrichment program.

TABLE 4. PROGRAM OUTLAYS UNDER THE AGC PROGRAM (In millions of fiscal year 1986 dollars)

	GDP Outlays			AGC Outlays				
Years	Capital	Power [a]	Other Operating	Capital	Operating	Research & Development	Other Program Outlays [b]	Total
1985-1990	352	4,878	1,055	2,222	288	630 [c]	162	9,587
1991-1995	125	2,782	815	3,150	710	125	135	7,842
1996-2000	125	1,728	815	1	1,340	125	135	4,269
Total	602	9,388	2,685	5,373	2,338	880	432	21,698

SOURCE: The Congressional Budget Office, based on technology cost projections used by the Process Evaluation Board of the Department of Energy, obtained from the Office of Uranium Enrichment and Assessment in June 1985.

NOTE: The AGC program assumes that two diffusion plants remain operational, with the Oak Ridge plant on stand-by. The AGC facility would have an annual capacity rate of 11.7 million SWUs, and would begin production in 1986 (using the Set III gas centrifuges). Production from the Set V advanced gas centrifuges would begin in 1988, and full production would be reached in 1996.

a. The GDP power costs are based on DOE's assumption that they can continue to purchase some off-peak power to run the diffusion plants. Estimates based on DOE's power costs assuming its firm power contracts only would increase total power costs by about $18 million through the year 2000. Demand penalty charges for power that DOE has contracted for, but will not use, are also included.

b. Other program costs reflect the administration costs of managing the enrichment program.

c. About $80 million of the research and development costs were allocated for the AVLIS process in fiscal year 1985.