373

Depreciation and the Regulated Firm

Shimon Awerbuch

Columbia Institute for Tele-Information
Graduate School of Business
809 Uris Hall
Columbia University
New York, New York 10027
(212) 854-4222

TABLE OF CONTENTS

III. Accounting and Economic Depreciation in Regulation

LIST OF TABLES

LIST OF FIGURES

EXHIBITS

I. EXECUTIVE SUMMARY

Accounting depreciation schedules have little economic significance and their use leads to sizable errors in the rate of return computation. Rules for determining accounting depreciation and income are promulgated by the Financial Accounting Standards Board (FASB) for the purpose of providing "fair and accurate" information specifically designed to help the millions of investors and creditors evaluate the future health and dividend-paying ability of business enterprises. Towards this end the simplicity of straight line depreciation (SLD) is useful and cost-effective in that it enables users to more easily interpret reported income.

The use of SLD in financial reporting reflects neither economics nor the needs of regulation. FASB, in fact, specifically finds that regulatory bodies are free to prescribe any depreciation system they wish and hence do not need to rely on financial reporting. **Yet regulators do not seem to be aware of the context in which accounting depreciation is set, and therefore are in the strange predicament of basing regulatory decisions on a "borrowed" accounting system that was designed for different**

purposes with economic properties that are inconsistent with the needs of regulation. And while regulators are free to implement more appropriate depreciation schedules they nonetheless feel that they must look to FASB for leadership, eventhough FASB has already indicated that its objectives do not include serving the needs of regulatory bodies.

Economic return is defined as the internal rate of return (IRR - that discount rate which equates the present value of future cash flows to the original cost of the asset). **The accounting rate of return (ROR) will equal IRR only when economic depreciation (ED) is used which makes ED the only "correct" depreciation scheme for ratemaking** */. (This argument does not imply that ED must also be used for reporting purposes - nothing prevents a regulated firm from using one depreciation schedule for reporting, a second for regulation and still a third for tax purposes.)

ED varies as a function of an asset's cash flow and the prevailing rates of return. When cash flow is level, ED is a back-loaded schedule known as annuity depreciation (AD). When cash flow is downward sloping ED becomes ordinary SLD. **When the "correct" economic depreciation schedule is used, ROR will equal IRR and will therefore be meaningful in ratemaking.**

---

*/ In this paper ED is based on the asset's original cost and nominal rate of return so that the schedule is not altered from year to year (as would be the case with pure economic depreciation). Only the original cost of the asset is recovered; there are no "asset writeups" as a result of changes in inflation.

In a single-asset context decelerating the rate of capital recovery decreases revenue-requirements early in an asset's life. This intuitive notion correctly guides the ratemaker's perceptions in such quasi single-asset environments as a nuclear power plant which dominates an electric utility's asset base. However, the revenue requirements of a firm with a mix of numerous smaller assets, such as a telecommunications firm, are not always predictable using intuition.

The ROR and revenue requirement (RR) of a firm (where the firm is a composite of individual assets) is a weighted average of the individual asset ROR and RR values, where the weightings are the book values of each asset. When such a firm grows rapidly, so that there are more "new" assets than "old", a policy of backloading depreciation will serve to reduce near-term RR since the "new" assets have lower RR early in their lives. If growth is slowed sufficiently however to a rate less than the IRR, (which is more practical - growth rates greater than IRR are not sustainable) the situation changes. Since there are now proportionately more "old" assets than new, **backloaded depreciation produces <u>higher</u> rates while more rapid depreciation <u>lowers</u> the revenue requirements. Existing theorems in the literature can be extended to yield this seemingly counterintuitive result.**

This result does not support a proposition that regulators <u>should</u> arbitrarily accelerate capital recovery simply to reduce rates. **Depreciation should be set "correctly" on the basis of the true**

change in an asset's value. Yet regulators need not unnecessarily avoid accelerated depreciation for fear that it will raise rates. It can readily be shown that when correctly computed over the life of the firm, **different depreciation policies all yield revenue requirements with the same present values** which reinforces the notion that depreciation choice should be made solely on the basis of the economics and cash flows of the underlying assets. This is particularly important since allowed ROR is meaningful (i.e. "correct") only when depreciation follows an ED profile which reflects the asset's change in value. **When depreciation is correctly set in this manner there are no "winners" and "losers" -- all cohorts of ratepayers pay their fair share.**

Assets with high rates of technological progress, such as those used in telecommunications, do not generally produce level or monotonically declining CFP's so that neither annuity nor straight-line depreciation schedules will be correct. Rather, such assets generate cash flows that rise at first as the technology becomes adopted, and then decline rapidly when a subsequent vintage of technology is introduced. **The correct ED schedule for such assets is more accelerated than SLD.** Current regulatory practice uses SLD widely, although with represcription SLD results in a backloaded recovery schedule. If allowed rates of return are to have any meaning it is imperative that the regulatory process move in the direction of estimating true asset depreciation rates.

Conclusion

The ratemaking process yields correct prices and rates of return only when economic depreciation is used. For assets with high rates of technological change economic depreciation profiles recover capital on an accelerated basis. This has led regulators to shun their use for fear that rates would rise in the near term. This concern is unfounded since the opposite is true: use of accelerated depreciation actually reduces rates where the firm is a composite of fairly similar assets.

Continued use of arbitrary, engineering-based recovery schedules will yield regulated returns that become increasingly less reliable as proxies of true economic profitability. Even worse are attempts to favor current ratepayer cohorts by using regulated lives that are arbitrarily long relative to expected economic usefulness. Such efforts, most likely, do not help anyone and probably result in additional costs to everyone. When depreciation is incorrectly specified the regulatory process becomes meaningless since the ROR loses economic significance. The increasing competitiveness of many markets heightens the importance of setting depreciation and hence economic rates of return correctly.

II. THE ROLE OF DEPRECIATION IN INCOME MEASUREMENT

1. Introduction

Accounting depreciation rates have little economic significance and will reflect an asset's true economic depreciation only by accident. These shortcomings of the accounting approach and their consequences, it seems, are not clearly recognized by regulators although the academic literature has been dealing with the problem for at least 50 years 1/.

Use of accounting depreciation leads to errors in the computation of rate of return (ROR) which are so significant that leading researchers have found that ROR "Provide[s] almost no information about the [true] economic rates of return" of American corporations [Fisher and McGowan 1983, 82]. Nonetheless, accounting depreciation continues to be used in regulation where it directly forms the basis for rates - a role for which it was certainly never intended and to which it is poorly suited [Awerbuch 1986, 20-21].

II.2. The Basis of Accounting Depreciation and Income Measurement

Accounting rules for determining depreciation and income are promulgated by the Financial Accounting Standards Board (FASB) whose objectives reflect a mandate to provide fair and accurate "information for investment and credit decisions" [FASB 1978, 14]. This "investor orientation" of financial reporting, which can be traced to the "full and fair" disclosure requirements of the Securities Acts of 1933 and 1934 [Beaver 1981, 13], results in an income measurement system that does not have the necessary economic properties and hence does not serve the needs of the ratemaking process.

This outcome is not accidental: FASB carefully defines its primary user group [FASB 1978, 11] to include investors, suppliers, creditors and financial analysts, while specifically excluding regulators who, FASB notes, have the capability to obtain required information independently [FASB 1978, 12]. And although regulators do prescribe a particular set of accounting standards for regulation, [U.S. Government Printing Office, 1970] it is theoretically indistinguishable from that which is used for financial reporting.

Financial reporting concentrates on the effective dissemination of information that will help investors and creditors to evaluate the "amounts, timing and uncertainty [FASB, Nov. 1978, 17]" of the firm's future cash flows. This objective is met using concepts such as straight line depreciation (SLD), historic cost, and revenue-expense "matching" which intentionally distort economic events and are therefore inconsistent with the needs of regulation.

For example, accounting treats depreciation as a "systematic and rational [Belkaoui 1981, 114]" allocation of historic costs, under the Matching Principle. Actual periodic change in the economic value of the asset is of no interest. Accounting depreciation is merely the process of spreading the historic costs so they are "matched" against revenues in some arbitrary but systematic fashion - usually SLD.

Use of SLD in accounting has nothing to do with economics or the needs of regulatory bodies 2/. It is used because it is simple. Since it is fairly easy to conceptualize SLD accountants can generate a simple income picture that is easily understood by investors and creditors. Economic depreciation with its potential for increasing asset values, by contrast, would make it harder for investors and creditors to sort out what has happened to the firm especially in inflationary times. SLD is therefore useful for reporting purposes [see, for example, Awerbuch, 1988] in that it helps users evaluate the future profitability of the firm in a cost-effective manner 3/.

Accounting reporting conventions are geared to meet other specific objectives. Among these is the "Stewardship" objective which requires that financial reports convey information to shareholders and creditors in a manner that enables them to evaluate how well management has handled their funds. Use of SLD and historic costs obviously enhance the stewardship objective, which provides the only justification for their use [J.R. Hicks 1969, 258]. Stewardship concerns are irrelevant in ratemaking thus eliminating one of the primary reasons for the use of accounting depreciation.

Financial reporting is clearly designed to provide information which helps shareholders and creditors. Reported periodic earnings are in reality less a measure of economic income and more an attempt to provide a conservative indication of future financial strength and dividend paying ability. This function is enhanced by the accounting Conservatism Principle which intentionally biases earnings and assets downward 4/ and therefore does not meet the needs of regulation.

The structure of accounting is thus designed to further accounting's role in financial reporting, in a manner consistent with the prescriptions of Kenneth Boulding [1962, 53-54] and others who advocate the use a "simple untruth" over a "complicated untruth" in accounting since this makes it easier for investors to "know what the accountant's answer means." However, there is nothing inconsistent about using different income definitions for different purposes [Boulding 1962, 45; M.J. Gordon 1960, 608]. Regulators need to recognize that FASB decisions have little merit for the regulatory process. For example, rate case proceedings, which routinely employ complex economic measures do not need to use depreciation concepts for their simplicity or their ability to enhance information transfer to millions of investors. There is nothing to keep utilities from reporting to their shareholders on the basis of SLD while ratemaking uses a different valuation approach. It is important therefore, for regulators to use depreciation schedules that have economic significance.

II.3. Depreciation in the Unregulated Environment

Regulators do not seem to be aware of the context in which accountants set depreciation. In an unregulated environment accounting depreciation is relatively unimportant and is set quite arbitrarily. The choice has no economic consequence since it only affects reported income (firms are presumed to always use the most beneficial treatment allowed for tax purposes). And while some accountants [e.g. Spacek 1959, Anthony 1983] think that reported earnings directly affect the decisions of investors and managers, the literature overwhelmingly supports the opposite view -- i.e., that capital markets are quite efficient in factoring out the effects of accounting decisions (including depreciation) on reported income. This means that investors are able to effectively "see through the accounting veil [Besnton & Krasney, 1978, 163] 5/, or, to use Treynor's [1972, 43] rich analogy, financial analysts are quite good at "removing the nails" put into the "soup" by the accountants, and determining the actual cash flow prospects for a firm.

While the capital markets understand the accountant's "secret code" and know how to interpret accounting income and depreciation, there is evidence that regulators and other public officials do not. For example, regulatory commissions (including FERC) routinely compare the ROR of regulated firms to those of other industries, and worse, to returns on financial instruments (e.g. bonds) [FERC 1980, 66; NARUC 1982, 19-21]. Both comparisons are highly misleading or even meaningless. Such apparent lack of understanding of the meaning of regulated "income" figures leads Winn [1976, 1978, 3] to observe that while the markets are not "fooled by accounting data," one should not assume that this extends to regulatory bodies.

Reported depreciation schedules do not affect the firm's income taxes since firms are free to use the most advantageous depreciation method available for tax purposes, independent of the method chosen for reporting purposes. Perhaps this explains the findings of a recent NRRI study that unregulated telecommunications firms spend little time or resources ("less than one man-year" of middle management time) for the purpose of evaluating depreciation and do not undertake regular reviews of depreciable lives [Lawton, (NRRI) 1988, 79, 81]. Since choice of depreciation in the unregulated firm has no economic consequence it would indeed be surprising to find otherwise.

Depreciation practices in unregulated firms offer little guidance towards the development of proper regulated schedules. The NRRI study [Lawton Chapter 3], provides additional survey results indicating that most unregulated firms use SLD to the virtual exclusion of accelerated methods. This outcome is entirely consistent with expectations as well -- recall that SLD is the backbone of financial reporting since it enhances the investor's ability to evaluate the future profitability of the firm. The fact that unregulated telecommunications firms issue financial reports using SLD tells us nothing about depreciation recoveries appropriate for ratemaking.

Regulation therefore finds itself in the predicament of using accounting depreciation constructs that were developed for an entirely different purpose. Yet regulators are in no way bound to continue using these inappropriate concepts. The entire issue lies in a no-man's land -- FASB clearly disowns it yet regulators feel bound by FASB depreciation precedents.

In attempting to meet its own reporting objectives FASB has grappled with the question of how best to define and report income. Regulators need to undertake a similar line of inquiry in an effort to develop more suitable depreciation and income definitions. This is particularly important since depreciation decisions in regulation have a far greater effect on economic efficiency than in any other setting 6/.

III. ACCOUNTING AND ECONOMIC DEPRECIATION IN REGULATION

One of the fundamental notions in regulation is that correct ratemaking occurs when the the firm is allowed to earn an accounting return on equity equal to the required cost of capital, k in the presumption that under these circumstances investors will also earn a rate k. Although this relationship is generally taken as axiomatic it is far from simple and will not hold in practice 7/. Unless depreciation and other factors are correctly specified an accounting return of k% does <u>not</u> result in an economic yield of k% to shareholders.

III.1. Economic and Accounting Return:

The correct framework for measuring economic return is given by the familiar capital budgeting approach. Solomon [1967, 1970] and Solomon and Laya [1966] illustrated the case in regulation. The economic measure of return is the IRR (internal rate of return) -- the discount rate that equates the present value (PV) of future cash flows with the investment outlays.

To illustrate consider a five-year project which requires an initial $1000 investment and yields five annual payments of $298.32. There is no salvage value. The economic return on this project (r*) can be computed through the relationship:

$$\$1000 = \frac{\$298.32}{(1+r^*)^1} + \frac{\$298.32}{(1+r^*)^2} + \ldots\ldots \frac{\$298.32}{(1+r^*)^5}$$

which can be solved to yield $r^* = 15\%$, the project's IRR.

Now, let us assume that this identical investment takes the form of a fixed asset, such as a generator, and all net cash flows are paid out each year. The accounting result, using SLD is shown in Table 1. Note that while investors are earning $k = 15\%$ for the five year period, (i.e. the cash flow produces an IRR = 15%) the ROR indicates an earnings of only 9.8% in Year 1 and nearly 50% in Year 5. It is felt by some that this error "averages out", yet the five year average of the ROR erroneously shows that investors realized an average 22.4% over the period which overstates their actual 15% yield by some 50%.

Table 1 clearly illustrates the problem originally raised by Solomon, and restated by Myers [1972, 76]: when CF is level, straight-line-depreciation significantly understates IRR early in an asset's life while overstating it later. ROR can be made "correct" by altering the depreciation schedule as Table 2 illustrates. It shows the same level cash flow (CF) with depreciation changed from SLD to annuity depreciation (AD). Now ARR = IRR each year. AD is identical to the schedule under which principal is repaid in simple mortgages -- small amounts at first, larger amounts near the end.

Why does it work? For level cash flow AD turns out to be the "economic depreciation" schedule which yields a rate base that is always precisely equal to the present value of remaining cash flows 8/. The term economic depreciation in this paper is used in a practical sense. It is assumed that an asset's expected cash flows have a PV equal to its original cost. The ED schedule recovers this original cost over the life of the asset in a manner that reflects the annual change in present values of the remaining cash flows. Table 2 illustrates the idea: note that the third year ratebase ($681.12), for example, is the present value of the three remaining cash flows:

$$\begin{aligned}\$681.12 &= \frac{\$298.32}{(1.15)} + \frac{\$298.32}{(1.15)^2} + \frac{\$298.32}{(1.15)^3} \\ &= \$259.40 + \$225.57 + \$196.15\end{aligned}$$

and that each year's depreciation charge is exactly equal to the <u>change</u> in present value of the remaining cash flows during that year.

It might be convenient to call this practical approach "Original Cost ED" (OCED), in order to distinguish it from the more theoretical approach under which remaining cash flows are revised periodically to reflect changing expectations and inflation. The theoretical approach can produce rising asset values (i.e.

negative depreciation) during inflationary periods. OCED (and pure ED as well) is different for every CF stream and rate of return. When properly used it yields an asset book value equal its market value in perfect markets.

The conditions under which depreciation is "correct" are hence quite straightforward. When depreciation is correctly specified nominal ROR will equal nominal IRR and the ratebase in each year will be precisely equal to the present value of remaining after-tax cash flows. This much has been known since Hotelling's seminal paper [1925], and has been restated effectively by Preinreich [1938], Anton [1956] and others subsequently.

III.2. The Regulated Case

In the regulated environment a utility that invests in a fixed, \$1000 asset with a 15% economic return does not realize the level cash flow profile (CFP) of Table 1, but rather sees the regulatory "sawtooth" CFP shown in Table 3. This CF stream, which ranges from \$350 in Year 1 down to \$230 in Year 5, will rise back to \$350 in year 6 assuming the asset is replaced with an identical version and there is no inflation.

The regulatory CFP of Table 3 has a present value of \$1000, like the level CFP of Table 1. Moreover, observe that it yields ROR = IRR using ordinary SLD. This illustrates a result first observed by Stauffer [1971], i.e.: for the particular CF time-shape provided by the ratemaking formula, SLD is the economic depreciation schedule. On this basis Stauffer [1971a p. V-35] concluded that use of SLD in regulation produces errors that "may not be too serious."

Stauffer's initial conclusions were considerably modified in later work, some of it his own [see: Navarro, Petersen and Stauffer 1981]. It turns out that a variety of factors serve to distort the precise CF profile shown in Table 3. Perhaps more importantly, deviations as small as 5% introduce sizable distortions and essentially invalidate the use of SLD in regulation [Awerbuch, 1988]. Yet regulation continues to operate under the incorrect assumption that actual CF profiles are "close enough" to the hypothetical CFP of Table 3.

Table 4A illustrates the problem. We assume the commission uses SLD and the "correct" allowed cash flow of Table 3 (i.e. $350, $320, $290, $260, $230). Revenues, however, vary so that first year actual cash flow ($341.56) is about 3% below the allowed while Year 5 actual CF ($242.00) is about 5% above the allowed. (Appropriate changes have also been made to the remaining CF values so that PV is unaltered and IRR still equals 15%). Note that this slight "rotation" in the actual net CFP, which leaves IRR = 15%, distorts ROR considerably so that it now ranges from 14.2% in Year 1 to 21.0% in Year 5.

Small changes in net cash flow as shown in Table 4A can easily be generated by imperfect revenue forecasts as well as a variety of ratemaking practices [Awerbuch and Boisjoly 1988] 9/. As a consequence, actual CF profiles will invariably be different from the allowed "correct" schedule of Table 3 so that SLD (or any other arbitrary schedule) will be correct only by accident.

While uncertainty and error may perhaps be seen as an indelible part of the regulatory process, the error illustrated here is particularly insidious since the regulator is not even aware of it. For the case of Table 4A regulators will observe, ex post, that the firm attained or surpassed its allowed return in three of the five years, and that the five year average ROR is 16.4% against an allowed 15%. This situation will generate ratepayer pressure to reduce rates in the future, eventhough the true economic return for the period is not above the 15% allowed. The regulated return of Table 4A mis-states the true economic return because SLD is not correct. Moreover, if the regulator responds to the pressure and reduces allowed revenues in Years 4 and 5 the firm will not realize an economic return of 15%.

This situation, though hypothetical, is not unlike the case of a firm operating in a partially competitive market where technological progress and new entrants can alter expected cash flows. Regulators can correct the situation of Table 4A and make ROR economically meaningful again by adjusting depreciation so that it properly reflects the new market conditions. Table 4B shows the results. Depreciation now has the properties it did in Tables 2 and 3: it correctly reflects the PV changes each year. As a consequence the regulated ROR is again meaningful in that it properly reflects the economic yield in each period.

IV. DEPRECIATION AND REVENUE REQUIREMENTS:
SIMPLE MULTI-ASSET CASES WITH NO GROWTH

IV.1 Introduction

Depreciation is a remarkably complex subject where reality and perception differ considerably. And although firms hold portfolios of different vintage assets, depreciation demonstrations tend to be made using single-asset models which perpetuate the misconceptions. Indeed this paper itself has used the single-asset model as a means of introducing the subject, although care has been taken not to distort reality. Generally speaking, however, it is useful to interpret single asset depreciation demonstrations with care.

Attempting to analyze depreciation with single-asset models is analogous to the problem of trying to represent three-dimensional objects on a two dimensional a sheet of paper. While it is inviting to think in the comfortable realm of the single asset (two-dimensional) world, researchers have long warned that the depreciation subject is "far too complex" for such simple constructs [Preinreich 1938, 149] and that more realistic, multi-asset approaches are needed. The purpose of this section is to extend the depreciation concepts of the previous section to the multi-asset case and illustrate how income, revenue requirements and return are related in a dynamic, multi-asset firm in growth.

IV.2. ROR as a Weighted Average of Individual Book Returns

The ROR of a multi-asset portfolio of fixed assets is a function of the ROR of each individual asset. Likewise, the overall ROR of a firm therefore will be the weighted average of the individual asset rates of return where the weights are the book values. This result follows from the work of Vatter [1966] and Kay [1976]. A formal proof of the proposition is given in Fisher and McGowan [F&M, 1983, 92-93] 10/.

For example, consider a firm which makes regular annual investments of $1000 in the asset of Table 1. For the first four years the firm shows a net increase of one asset each period. At the end of the fifth year the earliest vintage asset (i.e. the one installed in year 0) expires so that the firm remains in steady state - each year one new asset is added while one is dropped. At any point in time the firm holds one asset of each vintage in its portfolio. Overall TPIS therefore remains level at $5000 and ratebase at $3000 (The sum of each of the five book values in Table 1: $1000, $800, $600, $400, and $200.)

The steady state overall return (OROR) for this firm can be found as the weighted average of the individual asset ROR values:

$$\mathrm{OROR} = \overset{j=1}{\underset{n}{\mathrm{SUM}}} \quad \frac{[\ \mathrm{ROR}_j * \mathrm{RB}_j\ ]}{\underset{j=1,n}{\mathrm{SUM}}\ [\mathrm{RB}_j]} \qquad (1)$$

where ROR_j is the ROR for the j th asset, and where RB_j is the ratebase value for the jth asset. Values for ROR_j can be taken directly from Table 1 (9.8%, 12.3%, 16.4%, 24.6% and 49.2%).

Overall return can now be found using Equation (1):

$$\mathrm{OROR} = \frac{.098*1000 + .123*800 + .164*600 + .246*400 + .492*200}{3000}$$

$$= \frac{\$\ 491.60}{\$3000.00} = 16.4\%$$

The revenue requirement (RR) for the firm in steady state can be expressed in an analogous fashion:

$$\mathrm{RR} = \overset{j=1}{\underset{n}{\mathrm{SUM}}} \quad [\ (\mathrm{ROR}_j * \mathrm{RB}_j) + \mathrm{DEP}_j\ ] \qquad (2)$$

$$= 9.8\%*1000+200 + 12.3\%*800+200 + 16.4*600+200$$

$$+ 24.6\%*400+200 + 49.2\%*200+200$$

$$= \$1491.60$$

Table 5 uses a more traditional spreadsheet approach to obtain the same results. The firm begins with $1000 in capital and makes annual investments with new equity funds. TPIS grows the first four years and then reaches a steady-state level of $5000. The firm continues to add a new $1000 asset every year, while the oldest vintage asset is retired. The steady-state ratebase is $3000, with ROR at 16.4% and revenue requirements at $1491.60 as given by equations (1) and (2).

Equations (1) and (2) therefore make it possible to quickly determine the steady-state RR and return for different cash flow profiles and depreciation policies. (For simplicity, we limit ourselves to a firm which invests in only one type of asset although this is not a limitation of the approach). For example, we can determine the steady state RR and ROR assuming the firm of Table 5 is regulated with a 15% allowed return.

Proceeding as before, we can use the information in Table 3, (the single asset regulated case) coupled with equation (2) to find the revenue requirement analytically. So doing yields:

$$\begin{aligned} RR &= \underset{n}{\overset{j=1}{\mathrm{SUM}}} \; [\,(ROR_j * RB_j) + DEP_j\,] \\ &= 15\%*1000+200 + 15\%*800+200 + 15\%*600+200 \\ &\quad + 15\%*400+200 + 15\%*200+200 \\ &= \$1450.00 \end{aligned}$$

which indicates that under the ratemaking formula our no-growth firm generates an annual revenue requirement of $1450 <u>11</u>/. Table 6 shows this result using an accounting approach.

We can now extend the analysis and evaluate the steady-state revenue impact of various regulatory depreciation policies. For example, let us consider a policy of using accelerated depreciation such as Sum-of-the-Years Digits (SYD). Table 7 shows the results. The top panel of Table 7 presents the single-asset information. Note that revenue requirements under SYD (Column 1) are considerably more front-loaded than with SLD (Table 3). In the first two years SYD requires revenues of $483 and $367 as compared to $350 and $320 for SLD. Indeed this seems to support the regulator's practice of avoiding accelerated depreciation based on the impression that it raises near term rates.

However, when we examine the steady state multi-asset results using Equation (2) (Table 7 - bottom panel) we find that the outcome is quite different. In this more realistic context SYD generates a revenue-requirement of $1350 as compared to the $1450 under SLD! Although (or because) SYD recovers capital faster than straight-line, it requires **less revenue** in the steady state. This underscores the importance of fully evaluating depreciation effects using appropriate, multi-asset models. The results clearly can be counter-intuitive.

Tables 8 and 9 show the single-asset and steady-state results for two additional depreciation schedules and reveal that when depreciation is decelerated (i.e. "back-loaded") steady-state RR's increase. Table 8 shows the revenue effects of using annuity depreciation (AD), a back-loaded schedule first shown in

Table 2. AD yields a steady state revenue requirement of $1491.58, greater than the $1450 and $1350 needed with SLD and SYD respectively.

The depreciation profile of Table 9 represents a hypothetical represcription policy under which an 8-year SLD recovery is gradually reduced to a 5-year SLD recovery over the life of the asset. Though hypothetical, the schedule reflects experience with regulated telecommunications assets over the last decade. This represcribed schedule (REP) is even more backloaded than AD, recovering 30% of the original cost during the last year. The steady state revenue requirements for REP are $1515.25 per year, higher than for any of the other three depreciation schedules examined.

The multi-asset analysis of this section therefore suggests that contrary to common misconceptions, revenue requirements for a firm in steady state (i.e. no growth) are <u>inversely related</u> to the rate of depreciation recovery. The more rapidly assets are written off, the lower the perpetual annual revenue requirement.

IV.3. Conclusion

Depreciation can be fully understood only in terms of multi-asset models and it may be useful to remain circumspect about generalizations based on single asset demonstrations. This section has illustrated the relationship between the single asset and multi-asset case: overall rate of return and revenue requirements are weighted averages of individual asset returns, where the weightings are the net book values of the individual assets.

Analysis based on this relationship reveals that revenue requirements in the no-growth multi-asset case are inversely related to the rate at which depreciation is recovered. The more depreciation is accelerated the lower the steady state revenue needs. Does this result hold in reality where firms grow and expand rate base and total plant? If a firm is growing rapidly enough, then it is adding new assets at an increasing rate and its portfolio will have more new vintage assets than older vintage assets. Under such circumstances, accelerated depreciation will tend to raise rates since there are more new assets, with higher depreciation requirements, than old assets with low depreciation requirements.

However, consider a firm that is growing slowly enough, so that its portfolio at any given time has more "old" assets than new assets. In such a case, (of which steady-state no growth is the limit) accelerated depreciation policies lower revenue needs because now the predominant assets - the "old" assets - have correspondingly less of a depreciation requirement than they would have had under a backloaded policy. The next section explores this result graphically.

V. DEPRECIATION AND REVENUE REQUIREMENTS UNDER GROWTH

The previous section developed analytic expressions which can be used to compute multi-asset revenue requirements (RR) and ROR for various cash flows and depreciation schedules. The analysis helped establish the initially counter-intuitive results that steady-state regulated revenue requirements are inversely related to the rate of depreciation recovery so that accelerating depreciation lowers RR. In this section we explore the result further by introducing the case of firm growth.

Numerous authors have examined the relationship between accounting and economic measures of income and return (Fn. 1). Among these, Solomon [1967, 1970] and F & M [1983] draw some limited conclusions regarding the complex relationship between a firm's rate of growth and its accounting and economic rates of return. While these results are not stressed in the literature, they can be applied to examine the effects of different depreciation policies on the regulated revenue requirement.

Solomon, whose work explores the so-called "accounting measurement error" in regulation, illustrated the effect that three different depreciation policies would have on ROR in the case of level cash flows [1970, 75-76]: i) a policy of SLD; ii) a policy of SLD with half the asset being expensed immediately and the rest depreciated; iii) a policy of AD (which is the economic depreciation). We already know that SLD is more accelerated than AD. Case (ii) yields a recovery that is even more accelerated for any asset with a depreciable life greater two years since half of the asset's cost is recovered in the first year.

Solomon illustrates the relationship between the firm's total asset growth rate (g) and its ROR. The results are reproduced in Figure 1. "Curve A" in Figure 1 shows the firm's ROR when AD is used and IRR is 10%. Note that the ROR always equals IRR, so that it is invariant to the growth rate. This result extends our single asset findings (Table 2 and 3) which showed that ROR = IRR when ED is used. We now observe that the result holds in the multi-asset case independent of g.

Next we examine Curve B, which shows the firm's ROR under an SLD schedule, and Curve C, which represents the more accelerated 50%-expensing policy. Accelerated recovery leads to a higher ROR than does SLD for growth rates less than 10% (the IRR). This relationship reverses when g is greater than 10%, an outcome that Solomon demonstrates analytically [1970, 77] for other curves D, E...Z. The results enable us to conclude that when all else is held constant 12/ and g < IRR, (the region of practical significance) the same cash flow yields higher ROR when the capital recovery is accelerated 13/.

F & M [1983, 86] obtain supporting results, and show that when g < IRR, "asymptotic" ROR values are higher under SYD than SLD. The effect reverses for g > r, leading F&M to the following proposition [1983, 86]:

> More rapid depreciation **increases** the ROR when growth is less than the IRR and **decreases** the ROR when growth exceeds IRR.

Figure 2 illustrates the proposition. ROR rises as depreciation is accelerated for the region g < IRR. The change-over point is where g = IRR, which is also the point at which IRR = ROR (F&M Theorem 1 [1983 91-92]).

F&M and Solomon's seminal contributions focused on comparing IRR and ROR and did not address revenue requirements in a regulated setting. F&M's proposition however can be extended to accomplish this as follows. Figure 2 shows that accelerating depreciation recovery increases ROR (g < IRR). Therefore, with g held constant, we can get "more" ROR for a given level of revenue by increasing depreciation recovery. We can therefore reason that for a given level of ROR, an accelerated recovery should yield lower revenue requirement. It should therefore be possible to lower ROR by switching to accelerated depreciation which in turn will reduce RR as well.

We can state this result another way. In Figure 2, accelerated recovery yields higher ROR values than are given by SLD, eventhough the IRR, and hence cash flow, are the same. It should therefore be possible to reduce the revenue requirement under accelerated depreciation relative to SLD. Similarly, it should be possible to reduce the revenue requirement under SLD, as compared to what is required under the more decelerated annuity schedule 14/. This leads to the following proposition for the multi-asset firm:

> More rapid depreciation **decreases** revenue requirements when $g < IRR$ and increases them only in the unsustainable case of $g > IRR$.

Figure 3 shows this proposition. The region $g < IRR$ covers most practical situations involving reasonably mature regulated firms. Certain situations such as lumpy additions caused by nuclear plant completions may temporarily raise g above the IRR in which case more rapid depreciation will indeed increase rates until the growth rate diminishes again.

We have now been able to graphically extend the steady state analysis of the previous section to the firm in growth. The results - that accelerating capital recovery for the firm in growth lowers revenue requirements - again seem startling at first, yet can be made more intuitive using the outcome of the previous section.

Recall that the firm's RR is a weighted average of the individual asset revenue requirements using book value weightings (Equation 2). Let us assume, for the moment, that regulators use the traditional policy of back-loading depreciation. Under such a schedule individual assets will have revenue requirements that are lower than SLD early in the asset's life and higher subsequently. Introducing growth into the analysis will not change the individual RR values, only their weights relative to the total assets.

When growth rates are sufficiently high and depreciation is backloaded as we have assumed, there is an abundance of new, "low-revenue" assets with a higher book-value weight relative to older "high-revenue" assets. Backloading depreciation under these circumstances will indeed lower revenues. However, the presence of low-revenue assets (and hence their relative book-value weight) declines as the firm's growth declines. Now a backloaded depreciation policy will only cause revenue requirements to rise. The more decelerated the depreciation the larger the revenue requirement differences between the first and last years of the asset's life. This explains the fact that in Figure 3 the slope increases (decreases) as depreciation is accelerated (decelerated).

While the literature appears to be generally unaware of this result, it was in fact illustrated by Preinreich [1938] although the presentation is quite complex and does not note the significance 15/. This may explain why regulators are generally unaware of the correct relationship between revenue requirements and capital recovery rates. The next section uses a simulation approach to further test the findings and evaluate their usefulness under more varied conditions.

VI. A COMPARISON OF REVENUE REQUIREMENTS UNDER DIFFERENT DEPRECIATION POLICIES AND GROWTH RATES

VI.1. Introduction and Assumptions

This section extends the analysis using a straightforward simulation approach to develop annual revenue requirements for a hypothetical regulated firm. The approach is kept intentionally simple:

i) The firm begins operating and makes its first investment at the end of year 0;

ii) The firm is funded entirely by equity with k=12%;

ii) The firm invests in a portfolio of identical depreciable assets with IRR=12%;

iv) Tax considerations are omitted 16/;

v) The firm makes annual investments based on a specified, but not necessarily constant investment function;

vi) There are no operating expenses and no salvage values;

The revenue requirement calculations are made for four depreciation schedules. These are (in order of increasing deceleration): Sum-of-the-Years-Digits (SYD - most front-loaded), Straight-Line Depreciation (SLD), Annuity Depreciation (AD) and Represcribed Depreciation (REP - most back-loaded). Table 10 gives the annual depreciation coefficients for each case.

Each asset in the calculations has an original cost of $10, a five year life and an allowed return of 12%. First we consider the simple "base case" explored earlier: the firm grows until it owns 5 machines, one of each vintage. Figure 4 shows the revenue requirements associated with each depreciation schedule, the total plant in service (TPIS) and the growth rate in TPIS. Supporting output can be found in Exhibit 1. The firm's growth rate is infinite in the first year, when TPIS goes from $0.00 to $200.00. Thereafter it drops rapidly to about 25% for year 4 (the first point that lies on the graph), after which it falls to zero when growth levels off.

Revenue requirements during the growth phase (years 1-4) are directly related to the rate of capital recovery - SYD produces the highest rates, REP the lowest. This ordering is abruptly reversed between years 5 and 6 when the growth rate falls below 12% 17/. Thereafter SYD produces the lowest revenue requirement and REP the highest. This order continues in perpetuity and shows that for an established firm with no growth accelerated depreciation produces the lowest revenue requirement. Figure 4 thus corroborates the steady-state analytic results of Section IV.

VI.2. Present Value as a Guide to Depreciation Choice

Regulators frequently use PV (Benefit-Cost) analysis to evaluate policy, although in the case of depreciation policy PV results must be evaluated with considerable care. Generally speaking, higher net present value (NPV) investments are always more desirable than lower NPV projects. Depreciation is not an economic decision variable however, (in the sense of choosing a positive NPV investment) since its choice affects only the intergenerational apportioning of costs. PV analysis cannot help in this decision because it cannot eliminate inter-generational inequities [e.g.: Lind 1982, 12, 447]. Present value is therefore not a meaningful criterion for selecting depreciation although it seems frequently used for this purpose by regulators. Given its popularity we will examine this use of PV and make some suggestions that will yield PV results which are meaningful and applicable.

The benefit-cost (B-C) of a project or policy will obviously vary, depending on the point at which it is measured. Where the cohorts contributing or receiving benefits change over the life of the project traditional B-C analysis does not yield a definitive decision criterion since the cohorts cannot generally compensate each other. Under such circumstances it is important to apply B-C/PV analyses with care and to consult other decision making criteria as well.

VI.2.a. Present Value of the Perpetual Revenue Requirement

Given the above caveats -- that B-C/PV analysis is not generally useful for evaluating depreciation policy, but recognizing that it is often used for such purposes, we proceed to see whether it may be appropriate under certain circumstances. We begin by examining the PV of the steady-state revenue requirements in Figure 4 assuming that the levelized revenues continue in perpetuity, an assumption that makes sense for an ongoing corporation. The present values can now be computed as the PV of a perpetuity beginning in year 5 18/.

The results (Table 11 Panel A) show that for the steady-state regulated firm with no-growth the SYD-based revenue requirement produces the lowest PV, as expected. Any ratepayer that begins (or significantly increases) consumption after Year 4 therefore prefers accelerated depreciation since it reduces rates (and their Year-4 PV). In fact all ratepayers from year 4 to perpetuity prefer SYD over less accelerated methods. As we shall see subsequently, this ordering of Year 4 PV will not change if we arbitrarily shorten the life of the firm to some finite number of years.

First, however, let us continue with the perpetual firm and examine the PV as of the Year 0. The Year 0 PV is computed as the above PV of the perpetuity, discounted to the Year 0, to which we add the PV of the initial phase-in period (Table 11 Panel B). The results show that as of Year 0 present value is the same for all depreciation schedules examined. This makes sense: depreciation is merely a cost allocation whose PV over the life of the firm must be invariant with the rate of recovery. Clearly, if the C-B period is significantly longer than an asset's life and encompasses the life of the firm, all costs are recovered and the rate of recovery within each asset's life becomes quite immaterial.

Any cohort that fully participates in the costs and benefits, from Year 1 to perpetuity, will therefore be indifferent to depreciation choice. The analysis thus supports the arguments of the beginning of this section: B-C/PV methods are not useful criteria since over the life of the firm all depreciation policies have an equal present value cost.

This finding, however, does not suggest that we should be indifferent to depreciation choice since in practice no cohort can fully participate in the costs and benefits of a particular depreciation policy. Rather, as we have already seen, a household or business entity that abruptly begins or increases its consumption of the regulated output after Year 4 clearly prefers accelerated (SYD) depreciation (Panel A). Thus a perpetuity of cohorts prefer SYD, while only the cohorts of years 1 - 4 prefer some other method. Since there exists no mechanism by which these two groups can compensate each other for foregone benefits C-B/PV analysis does not help us find an optimal solution.

Yet depreciation choice is clearly important in that it determines the **shape** of cash flows and hence prices over the asset's life. This is particularly significant in a partially competitive setting [Awerbuch 1989], yet C-B/PV analysis cannot help guide the depreciation decision and the schedules must be based on the underlying economics -- specifically -- expected asset life and cash flow profile.

VI.2.b. Present Value of the Finite-Lived Revenue Requirement

Now let us shorten the life of the firm arbitrarily to 24 years to see whether PV remains invariant to depreciation choice. This is precisely the case shown in Figure 4. Table 12 gives the results. Column 1 shows the values for PV_O -- the present values of the revenue requirements for the 24 year life of this firm. At first, these results seem to suggest that revenue requirements rise as depreciation is accelerated -- PV_O(REP) is $1709 while PV_O(SYD) is $1726. This does not suggest that the previous perpetual analysis is incorrect. Rather, these finite PV values are misleading because they ignore closing values for the firm's assets which will vary with depreciation choice.

Focusing on revenue requirements in this manner, to the exclusion of ending asset values is correct only for the infinitely-lived firm whose ending asset values have $PV_O = 0$ and are thus not a factor. This error is commonly made in PV analyses. If we insist on using PV to analyze depreciation then it is imperative to recognize that depreciation policies carry costs and benefits into perpetuity. Arbitrarily limiting the analysis to a finite period (or "payback") biases the outcome unless the ending asset values are included.

The analysis of Table 12 incorporates corrections for ending asset values. The results reveal that present value of revenue requirements ($1756.86) is invariant with depreciation choice when measured from the beginning of the firm's life. This extends the previous result to the the case of the finite-lived firm and illustrates that when unrecovered ending asset values are correctly included the revenue requirements continue to show a constant PV regardless of depreciation choice. Thus on a present value basis choice of ratemaking depreciation continues to be irrelevant 19/. Indeed this must be so - over the life of the firm depreciation choice is not an economic variable. Actual asset life is the real economic variable so that the manner in which depreciation is arbitrarily allocated should not affect PV when the period is the life of the firm.

VI.2.c Conclusions

The major conclusions - that in the steady state accelerated depreciation leads to the lowest revenue requirements - remains in tact, although all depreciation policies have the same PV when the start-up period is included. This does not diminish the important outcome that after the initial start-up period ends, the firm's ratepayers enjoy a perpetuity of lower rates (and lower present values) under an accelerated depreciation schedule.

This section illustrated that PV techniques do not really help evaluate depreciation policy. Depreciation choice, therefore, must be made on the basis of economic criteria which reflect the asset's expected cash flow and useful life. The analysis clearly reveals that attempting to distort these economic criteria in order to try to help a particular cohort can hardly do justice to anyone in the long run.

VI.3. The Case of Constant Growth

This section continues the simulation approach and examines the relationship between depreciation and revenue requirements for various growth rates. The results are consistent with the previous (graphic) analysis of Section V, and continue to show that accelerated depreciation produces the lowest revenue requirement as long as growth remains less than the IRR (12%).

Figure 5 shows the revenue requirement for a firm that grows at a constant rate of 3% per year after year 4 (IRR = 12%; supporting information can be found in Exhibit 2). For this case accelerated depreciation again generates the lowest revenue.

VI.3.a. Present Value of the Revenues Under Constant Growth

As in the previous case, we compute the present value revenue requirements to see if they help evaluate policy, and to develop a benchmark for evaluating depreciation transition policies in the next section. Table 13 shows the present values of the revenue requirements for the "Steady State" portion, (years 5-24) the "Phase-In" portion (years 1-4) and for the for the "Full Range" (years 1 - 24). The steady-state PV shows that SYD is preferred. By contrast, the PV for the entire 24-year period ("Full-Range") shows REP to be the lower cost policy, although we again note that the finite PV (1-24) is misleading since depreciation policy decisions carry costs and benefits in perpetuity.

Panel B of Table 13 shows the correct B-C/PV methodology for evaluating the growth case. As before, the PV values must be based on perpetual revenues (or include correct ending asset values). The perpetual revenue-requirements for the growth portions of Figure 5 are equivalent to a constantly growing perpetuity, whose PV is given by the familiar Gordon Growth model:

$$PV_4 = \frac{RR_5}{K - g}$$

where RR_5 is the annual revenue-requirement in year 5, K is the discount rate (12%) and g is the revenue-requirement growth rate <u>20</u>/. The Year 4 infinite PV values (Table 13, Column 6) are then discounted back to year 0 and added to the Phase-In PV. The resulting value, PV_O, (Column 8) correctly reflects the infinite range of revenues. As before we find that PV_O is invariant with depreciation policy (the values in Column 7 vary slightly due to error in estimating G) indicating that over the life of the firm depreciation choice is irrelevant. These results form the basis for evaluating depreciation transitions in Section VII.

VI.3.b. Other Growth Scenarios

We can now examine several deviations from steady-state growth. Figure 6 shows how the revenue requirement relationships hold when the firm undergoes a series of "growth cycles" during which g increases significantly from the 3% steady-state value to a peak of 5%. Observe that during the growth cycles the difference between the various depreciation policies begins to dissipate, as growth rates get closer to the IRR (12%). At growth rates in excess of 12% the relative position of the four revenue requirements would be reversed with SYD requiring the greatest revenue.

Figure 7 examines such a case in which the growth rate rises from 2% to 15%. Note that the relative ordering of the revenue requirements remains unchanged (i.e. SYD needs the least revenue) until growth rises to 15%. At this point g exceeds the IRR, and the lowest revenue requirement is now generated by the most backloaded schedule - REP. The relationship reverses again as g drops below the IRR in Year 22.

VII. THE REALITY CASE: TRANSITIONS FROM INEFFICIENT TO EFFICIENT DEPRECIATION POLICIES

VII.1. Introduction

So far we have established that accelerating depreciation recovery reduces revenue requirements for a firm growing steadily at a rate less than IRR. We have also tested the proposition under various growth scenarios and found that it is sufficiently robust to have considerable practical usefulness. However, we have not examined transitions schedules from backloaded to accelerated depreciation. Indeed, this is the issue facing us for the practical case of a mature, regulated firm which has always used SLD. The purpose of this section is to study the revenue effects of a transition from an existing recovery schedule such as SLD or REP, to a more accelerated schedule such a SYD to see if the change is worthwhile. We examine how such a change alters the revenue-requirements, and discuss the extent to which PV analysis can provide decision-making support.

Consider the case of an established regulated firm that uses SLD. Regulators have decided that new assets placed in service after the beginning of year 9 should be depreciated on a more accelerated SYD schedule. The resulting revenue-requirements are shown in Figure 8a while Figure 8b shows the analogous transition from REP to SYD. The transition from SLD or REP to the less costly SYD is not frictionless. Once the accelerated policy goes into effect rates rise above what they would have been under SLD for about 4 years (compare to the 3% steady state growth results of Figure 5).

The reason a "bubble" is formed is that the first asset to be placed in service in year 9 requires more revenue, with the offsetting benefit of lower revenues not available until the end of this asset's life three or four years later. Indeed, a new steady state is reached at the end of four years so that the transition appears to be require a period equal to the average book life of assets.

The economic explanation of the result (i.e. the "bubble") is less clear cut, although transitions from inefficient to efficient paths in economics are often not frictionless. In this instance the temporary rise in revenue requirements can perhaps be seen as a way of balancing the benefits that SLD creates relative to SYD during the Phase-In (years 1 - 4). While the area under the "bubble" seems larger than the area between SLD and SYD in the first four years, we can safely speculate that their present values are are equal, since we have already found that PV over the firm's life must be the same for all depreciation policies. This principle also explains why the area under the REP-to-SYD bubble (Figure 8b) is larger the SLD-to-SYD bubble.

The relevant issues are whether the move from SLD or REP to SYD is "worth it", and the criteria by which this judgment can be made. The previous results indicate that the move from a backloaded to an accelerated schedule will have no benefit-cost implications over the life of the firm since PV_0 will be unaffected. The decision must therefore be made and evaluated on the basis of the underlying economics, e.g.: the asset's life and CF profile. The foregoing notwithstanding, regulators will want to know the PV implications of this transition from SLD to the lower cost SYD. This analysis is presented below.

VII.2 Benefit-Cost of the Transition from Inefficient to Efficient Depreciation

The analysis necessarily begins with the PV computations of Table 13 which are used as a benchmark against which to test the PV for the transition policy. The finite PV_{5-24} for the SLD-to-SYD transition is \$2493 (Exhibit 3), as compared to \$2469 for SLD (Table 13, Column 1) thus making it appear at first that ratepayers are slightly better off not to move from SLD to SYD. But the transition from SLD to SYD bears benefits <u>in perpetuity</u> as previously discussed so that the finite present values are biased and must be extended to perpetuity as well. Figure 9 shows how this is done.

Panels A and B of Figure 9 graphically show the infinite and finite Year-4 PV for SLD and SYD depreciation. The values are taken from Table 13. The PV of a transition policy involves knowing the $PV_{5\text{-infinity}}$ for SYD. This is computed in Panel B as the difference between the infinite and finite PV components - specifically, subtracting the finite PV_{5-24} from the infinite $PV_{5\text{-infinity}}$ leaves $536, the PV of the infinite revenue stream that begins in Year 25.

Panel C illustrates the PV computation for the SLD-to-SYD transition, by adding the $PV_{25\text{-infinity}}$ for the SYD schedule to the PV_{5-24} portion of the SLD-to-SYD schedule (Exhibit 3). The results show that a move from SLD to SYD leaves PV unchanged ($3029 versus $3032 for SLD - the difference is due to error in estimating g in Table 13). The outcome is similar for the REP-to-SYD transition: PV is essentially unchanged from $3173 for REP (Table 13, Column 6) to $3163. We have therefore demonstrated that the transition to SYD has no PV effect, although once the transition period is over rates are perpetually reduced.

VII.3. Other Transition Schedules

While the transition schedules do not alter PV, they do create temporary revenue increases. It is in everyone's interest - both ratepayers and firm - to minimize these dislocations since the resulting price signals are confusing. Section VII.2 suggested that the area under the "bubble" is simply the compounded area of savings that accrues by using SLD over SYD during the phase-in. Given this possibility, and the finding that PV is unaffected by a transition from one depreciation schedule to another, it should be possible to minimize the size of the "bubble" by altering its timing.

Figure 10a shows the revenue requirement results for an SLD-to-SYD transition beginning with assets put in service in year 4, while Figure 10b shows this result for a transition beginning in year 2. The size of the "bubble" is reduced as it is moved to the left so that the dislocations of the transition become less pronounced. When the transition begins in Year 2 (Figure 10b) the dislocation is practically eliminated and prices transition more smoothly to the lower revenue requirements associated with SYD. Regardless of the point in time at which a transition is begun, the initially higher rates are an efficient investment with a perpetual benefit stream. Transitions made closer to the phase-in period, however, cause smaller apparent rate increases and hence seem more attractive strategically.

VII.4. Conclusion

Transitions from decelerated to more accelerated depreciation schedules do not alter long-run PV results. This finding must not be allowed to overshadow the more significant outcome that such transitions yield a perpetually reduced revenue requirement. All ratepayers are perpetually better off after the transition, although cohorts participating only in the transition are hurt. Benefit-cost techniques do not help us resolve this conflict 21/.

We therefore conclude again that depreciation schedules must be determined on the basis of the underlying economics, and that any attempt to distort these in order to favor one cohort over another reduces efficiency and hurts the regulated firm and its ratepayers, particularly in a partially competitive environment. The principles for setting economically correct depreciation schedules were illustrated in Tables 2 and 3. The next Section applies these principles to the more realistic case of high technology assets in a partially competitive environment.

IV. THEORETICALLY CORRECT DEPRECIATION PROFILES FOR ASSETS WITH HIGH RATES OF TECHNOLOGICAL PROGRESS

The previous sections have demonstrated that the revenue requirements of mature regulated firms (with $g < IRR$) are inversely related to the rate of capital recovery. This result is not a sufficient reason for regulators to begin using accelerated recovery methods. It does however clearly imply that regulators need not be afraid to accelerate depreciation where such moves are justified on the basis of the fundamental economics of the asset base - i.e.: expected useful economic life and cash flow profile. Correct depreciation policy reflects the true costs of operation. When it is selected there are no "winners" and "losers" - all users pay the fair share.

Sections III discussed the role of depreciation in correctly setting the regulated return and showed that the regulated return is meaningful only when depreciation is correctly chosen as the economic depreciation - i.e. that schedule which properly reflects the change in present value of the asset's expected future cash flows. To the extent that an arbitrary depreciation policy, such a SLD or REP does not reflect the economic changes in asset values, the ROR will be distorted and will not correctly reflect economic rates of return.

As briefly discussed in Section III, there are potential difficulties that make the implementation of theoretical economic depreciation "totally impractical" [Fisher 1984, 510]. In order to clearly distinguish the more practical approach to ED envisioned in this paper, it may be useful to call it Original Cost Economic Depreciation - OCED. Under OCED there are no inflation-driven asset writeups and recovery is limited to the original cost. Absent inflation and uncertainty (neither of which is dealt with in this paper), OCED and ED are the same. This section addresses techniques for correctly estimating OCED in assets with high rates of technological change. Regulated ROR is meaningful only when this depreciation schedule is used.

It can be shown that for every cash flow profile (CFP) there exists a depreciation schedule which reflects the asset's periodic change in value as measured by the change in PV of the asset's remaining cash flows [Stauffer 1971]. Such a depreciation schedule will equalize accounting and economic returns so that ROR = IRR each year as previously shown.

The regulatory problem then is to determine the particular stream of depreciation charges which will best reflect the asset's expected economic depreciation pattern. An added benefit of selecting depreciation correctly is that it yields ROR = IRR each year (ignoring inflation), if cash flows materialize as expected. OCED is unlike arbitrary depreciation schedules in that it is actually a different schedule for every cash flow profile and rate of return. For the ratemaking CFP, for example (Table 3), OCED takes the form of ordinary SLD while for a level CFP the OCED schedule is AD (Table 2). Likewise there exists a CFP for which SYD is the economic depreciation and so forth.

Expected OCED profiles for an asset are estimated when it is placed in service, on the basis of its lifetime CFP. Regulators often feel that this procedure is inexact and therefore default to SLD, typically selecting lives that are arbitrarily long. However such an approach most likely produces the worst possible estimates of true depreciation. The arbitrarily long initial lives are subsequently represcribed as additional experience makes the initial error obvious. The result is a backloaded depreciation schedule not unlike the hypothetical REP profile used earlier. If allowed rates of return are to have any meaning it is imperative that the regulatory process move in the direction of estimating true asset depreciation rates.

Assets with high rates of technological change by definition have short economic lives with CF profiles that rise initially (after an introductory phase) and then rapidly decay towards the end of the asset's economic lifetime. This rapid deterioration occurs once the subsequent vintage technology is introduced. In a competitive environment producers who lack the most efficient technology can generally not reduce costs rapidly enough and therefore lose market share to participants who have acquired the new technology and have thereby lowered their marginal costs of production. This market share loss results in declining net cash flows for earlier-vintage assets -- either because sales have been lost or the producer reduces price without upgrading to the new technology. 22/.

Figure 11 shows a CF profile representative of the process. Known as the "Q-Profile," it was used by Fisher and McGowan [1983; See also Fisher, McGowan and Greenwood, 1983] as an outgrowth of the IBM anti-trust case. While the case apparently generated some controversy as to whether the Q-Profile in fact accurately represents the experience of IBM (with its System 360), we use it here as representative of the CF profile for an asset with a high degree of technological progress.

A regulated firm that uses a high-technology asset in a partially competitive environment may realize a CFP in the shape of the Q-Profile. For this profile SLD is not the economic depreciation schedule and its use will lead to meaningless ROR values which significantly distort economic returns.

Table 14, Panel A, illustrates the use of SLD in conjunction with the Q-Profile (tax considerations have been eliminated for clarity; for additional discussion with taxes see: Awerbuch [1988]. The combination of SLD and the Q-Profile generates an unreliable rate of return, ranging from 31.7% to -60.3% over the asset's life for a given IRR of 15%. It therefore offers no useful information to the regulator. Panel B corrects the depreciation so that ROR is meaningful. The OCED schedule of

Panel B is computed using the approach of Anton [1956] (for additional discussion see Awerbuch [1988]).

The OCED schedule of Panel B is concave down (inverted "U"), becoming greatest in years 2 and 3 during which significant portions of the asset's cash flow expectations are realized (Figure 11). The OCED schedule recovers capital more rapidly than SLD, in contrast to the case of a level CFP (Table 2) where AD is quite backloaded relative to SLD. This underscores the point that ED is not a unique schedule, but varies with CFP and rate of return.

Table 14 quite plainly indicates that for high-technology assets (with CFP's similar to the Q-Profile) correct depreciation must be front-loaded relative to a straight-line recovery. This result follows directly from the economics of rate of return measurement 23/. Economic return can always be expressed as cash flow plus (or minus) changes in asset values. The regulated return is therefore meaningful only when changes in asset values are correctly accounted for as is the case with OCED -- Panel B of Table 11 shows the correct ROR of 15% each year, equivalent to the internal rate of return.

As the traditional monopoly model of regulation erodes it becomes increasingly important for regulators to set depreciation correctly using the principles outlined in this section. Continued use of arbitrary, engineering-based recovery schedules which do not reflect economic changes in asset values will yield a regulated ROR that becomes increasingly less reliable as a proxy of true economic profitability. Even more distortive are attempts to favor current ratepayer cohorts by instituting regulated lives that are arbitrarily long relative to expected economic usefulness. When depreciation is incorrectly specified in this manner the principal regulatory indicator - the ROR - loses all economic significance and becomes unreliable.

NOTES

1. Early references to depreciation and economic returns are found in Hotelling [1925], Preinreich [1938] and Anton [1956]. The full range of literature is too voluminous to list here, but a good overview can be found in Beaver [1981], Sterling [1970], D. Solomons [1986]; for illustrations of the problem as it affects regulation see: E. Solomon [1970]; Kolbe, Read & Hall [1984]; Bower [1985], Awerbuch [1985, 1986].

2. Although Bower [1985] speculates that there may have been economic motivation when originally conceived.

3. FASB's dedication to the information transfer objective also precludes the use of other economically more meaningful reporting conventions such as inflation adjusted reporting, because such practices do not enhance the information content provided investors in a cost-effective manner[Beaver and Landsman 1983].

4. Recent evidence is even stronger, suggesting that the underlying structure of accounting is, to a large extent, driven by legal tort considerations under which accountants are held liable [see, for example: Sorter, Siegel and Slain 1988.] This suggests even more strongly that the income definition used in financial reporting, and which regulation borrows for its use, is intentionally biased downward.

Sorter, Siegel and Slain [1988 237-38] find that:

> The present accounting model can best be rationalized as an attempt to report to creditors and investors on the stewardship of the company with the least amount of ambiguity, and therefore with minimal exposure to legal liability. All matters that **must** be reported, and that can be reported with minimal ambiguity or disagreement, are included. Nearly all others are excluded.

GAAP, which is "conservative and cost-based", serves the purposes quite well since its use insures that liability based on "inadequacies of the model appears quite unlikely [239]."

5. However, the evidence also suggests that the selection of depreciation (and other accounting) rules in unregulated firms is a function of several variables [See: Salamon 1985] including firm size, and concentration of ownership (i.e. a firm controlled by professional managers is more likely to use depreciation practices that **overstate** income since this tends to make the managers' performance look better). The evidence extends to regulated utilities as well, where it suggests that these firms use accounting procedures that minimize their reported incomes [for example: Watts & Zimmerman 1986, 231-32].

6. Use of accounting-based depreciation is bad enough under an assumption of strict monopoly, where its use distorts price signals, leading to inefficient consumption and investment patterns over time [Bidwell 1985]. In the context of partially unregulated markets, however, the situation gets even worse and can detrimentally affect the firm and its customers [Kolbe 1985, Awerbuch 1989]. Such regulated rates can, if set too high, drive customers needlessly to unregulated competitors ("uneconomic bypass") and if set "too low" relative to economically based or market-driven rates, will result in unnecessary barriers to competition.

7. In order to evaluate the idea rigorously Gordon [1977] finds it necessary to invoke a set of somewhat unrealistic assumptions: no taxation, no inflation, all equity financing, the payout of all earnings, and an infinite asset life (in which case annual depreciation charges are zero). These assumptions, in effect, set accounting earnings equal to cash flow hence yielding a definition of profitability that is clear to both accountants and economists.

Indeed, with the above assumptions there is no dilemma, and the "regulator's axiom" holds: if a firm has a book value of $100 and earns a rate of return of ARR=k=10%, then, absent taxes, inflation, debt, retention growth and depreciation, shareholders will get a cash flow equal to the earnings (E) of $10 each year. It is then easy to show that the stock will trade at book value (i.e. the stock price (P_0) will be capitalized as $P_0=E/k$ = $10/.10 = $100) so that shareholders will obtain the required yield of 10%.

Gordon [1977, 1501-1511] finds that the consequences of withdrawing the previous assumptions, particularly those regarding asset lives, are not insignificant nor easily predictable. Nonetheless, the illustration is frequently cited by regulators and others without sufficient regard for the the assumptions. (See, for example: Kahn [1970, 46], Kolbe Read & Hall [26-27], Morin [1984, 21-22], Morton [1970]; Myers [1972, 74], uses the illustration but observes that it "is not intended as a paradigm of ideal regulation"). This conveys the erroneous idea that the illustration is representative of reality, and that the regulator's "axiom" works under real-world conditions of inflation, taxation, and regulatory imperfection - which it does not.

Accounting-based regulation can work -- but only only if we make enough simplifying assumptions. In such an unreal world shareholders obtain the correct yield of k because the accounting itself "works". In the absence of depreciation, debt amortization, inter-period tax allocations and other accounting decisions, earnings will be the same as the cash flow to investors. This happy set of circumstances, which renders accounting superfluous, is unimaginable in reality, and it is therefore doubtful that the regulatory axiom works correctly in a practical setting.

8. AD is the economic depreciation in the case of level cash flows only. (See, for example, [Awerbuch 1988]). However, because it is frequently (and incorrectly) called "economic depreciation" by accountants and engineers its proper application tends to confuse many regulators and other practitioners.

9. Including: ACRS tax depreciation, normalization accounting, AFUDC and CWIP treatments, debt amortization at a rate different from asset depreciation, accounting lives different from economic lives, and regulated rates that do not go into effect on the precise anniversary of the in-service-date. These all serve to alter the CF of Table 3 in practice thus essentially invalidating the use of SLD for ratemaking.

10. Kay [1976] showed that for an individual asset, or project, IRR is the weighted average of the annual book returns, with the weights being the annual book asset values. Vatter [1966] showed that that many averaging trajectories are possible, and that IRR is simply one of these. The average ROR will equal the IRR only when economic depreciation is used, or when the firm grows exactly at an exponential rate [Fisher & McGowan 93].

11. Note that this revenue requirement is simply the sum of each of the cash flows of Table 3, which is true only when every asset vintage is identical. Indeed this makes intuitive sense - the multi-asset firm described holds one of each vintage asset, so that we might expect the overall revenue requirement to be precisely the sum of the annual revenue requirements of Table 3.

12. e.g.: the CFP, the time lag between investment and the start of cash flow, asset useful life and the proportion of non-depreciable assets such as working capital.

13. For practical applications we are only interested in the case of g < IRR since firms cannot sustain growth rates above the IRR. In fact it can be shown that sustained g > IRR requires negative dividends [Salamon, 1973]

14. Observe that the accelerated schedule yields ROR values that **overstate** the true IRR which is correctly given only by the economic depreciation - in this case SLD.

15. Close examination of Preinreich's [1938] graphs reveals that for g=0 and g=5% (less than IRR), rate requirements decrease as capital recovery is accelerated. He observes:

> It can easily be shown that when the rate of expansion exceeds [the IRR] the rate levels will ultimately be reversed. In other words, a public utility expanding faster could claim the highest rate under [an accelerated] method and only the lowest under [a decelerated] method [1938, 156].

Preinreich notes that AT&T preferred SLD (its growth had been in excess of 9% per annum) which made the firm "Better off than if it had insisted upon the use of the retirement method, as many utilities in the same position still do [1938, 156]."

16. The elimination of taxes simplifies matters yet introduces no bias. Regulated depreciation alters taxes only by its effect on RR. Since tax depreciation remains unchanged, after-tax cash flow will always be a constant proportion of pre-tax cash flow.

17. The exact cross-over point may occur slightly before or after since we are dealing in discreet, not continuous time.

18. The PV of a perpetuity is the annual revenue requirement divided by the discount rate; for practical purposes the perpetuity results are attained in a relatively short period of time so that we do not need to think of the firm as actually lasting forever. After thirty years the PV of the revenues is only 5% less than for a perpetuity, after 50 years the answer is within 1%.

19. This result also presumes that book values are equal to the present value of remaining net cash flows; this is true in traditional regulation as illustrated in Table 3.

20. Discrete time seems to introduce slight error so that actual g is slightly different from the assumed 3% asset growth rate. Two different estimates of actual g are made in Exhibit 2, one using the compound growth approach ($g = [R_{25} / R_5]\hat{}(1/19)$), the other using the arithmetic average of annual growth rates, although the two are within .001. The PV computations in Table 13 are made using the compound-growth estimate of g.

21. Certainly not very easily in practice; for comment see [Lind 1982, 457].

22. For an ingenious example of technology costs to market entrants see Bower, [1985]; additional discussion of the economics of changing technologies can be found in Crew & Kleindorfer [1988].

23. Crew and Kleindorfer [1988] and others have argued for more rapid capital recovery on the basis of increasing competitive pressures which limit future recovery. The results herein are independent of those arguments.

REFERENCES

Anthony, Robert N., Tell It Like It Was, Homewood, Irwin, 1983.

Anton, Hector A., "Depreciation, Cost Allocation and Investment Decisions," Acct. Research, April 1956, 117-34.

Awerbuch, Shimon "Efficient Income Measures and the Partially Regulated Firm," in Michael Crew (Ed.), Deregulation and Diversification of Utilities, Norwell MA: Kluwer Academic Publishers; 1989.

Awerbuch, Shimon, "Accounting Rates of Return," American Economic Review, Vol. No. (June 1988), 581-87.

Awerbuch, Shimon, "Accounting Traditions and the Determination of Regulated Return," Advanced Workshop in Public Utility Regulation & Economics, Rutgers University, 1986.

Awerbuch, Shimon, "Return on Equity Ratemaking: Biased Earnings and Market-to-Book Ratios due to Obsolescence and Excess Capacity", Patrick V. Mann and Harry M. Trebing (eds.) The Impact of Deregulation and Market Forces on Public Utilities, Michigan State University, East Lansing, 1985.

Ball, R.J. "Changes in Accounting Techniques and Stock Prices" Empirical Research in Accounting: Selected Studies, 1972 (Supp. to the J. of Acc. Res.) 1-44.

Baxter, W.T. and Davidson, S., Studies in Accounting Theory, Homewood: Irwin, 1962.

Beaver, William H., Financial Reporting: An Accounting Revolution, Englewood Cliffs: Prentice Hall, 1981.

Beaver, William H. and Landsman, W.R., Incremental Information Content of Statement 33 Disclosures, Stanford, Conn: FASB, November 1983.

Belkaoui, Ahmed, Accounting Theory, N.Y.: Harcourt, 1981.

Benston, George, J. and Krasney, M.A. "The Economic Consequence of Financial Accounting Statements", in: Economic Consequence of Financial Accounting Standards, FASB, Stamford, CT, July 1978, 161-252.

Bidwell, Miles O., "Optimal Prices, Economic Depreciation, and Regulated Utilities", 23rd Annual Regulatory Conference, Ames, Iowa, 1985.

Boulding, Kenneth, E. "Economics and Accounting: The Uncongenial Twins", in Baxter and Davidson, 44-55.

Bower, Richard S., "The Capital Recovery Question," Resources and Energy, North Holland, 1985, Vol. 7, 7-42.

Brief, Richard, P. (ed.) Depreciation and Capital Maintenance, N.Y. Garland, 1984.

Crew, Michael and P. Kelindorfer, "Capital Recovery and the FCC's Price Cap Proposal," Newark: Center for Regulated Industries, Graduate School of Management, Rutgers University, 1988.

FERC Staff Study Group "A Discussion Paper on Electric Rate of Return," D.C., December 15, 1980.

Financial Accounting Standards Board "Statement of Financial Accounting Concept No. 1: Objectives of Financial Reporting by Business Enterprises", Stamford: Nov. 1978.

Financial Accounting Standards Board, "Statement of Financial Standards No. 71: Accounting for the Effects of Certain Type of Regulation" Stamford: December 1982.

Fisher, Franklin M. and McGowan, J.J., "On the Misuse of Accounting Rates of Return to Infer Monopoly Profits", AER, Vol. 73, No. 1, 82-97, March 1983.

Fisher, Franklin M., "On The Misuse of Accounting Rates of Return: Reply", American Economic Review, Vol. 74, No. 3 (June 1984), 509-517.

Fisher, Franklin M, J.J. McGowan, and Joen Greenwood, Folded, Spindled and Mutilated: Economic Analysis and U.S. vs. IBM, Cambridge: MIT Press, 1983

Foley, Michael "Discussion Report on the Current Financial Condition of the Investor Owned Electric Utility Industry," D.C., National Association of Regulated Utility Commissioners, August 1982.

Gordon, Myron J., "Comparison of Historical Cost and General Price Level Adjusted Cost Rate Base Regulation," Journal of Finance, Vol. 32, No. 5, (Dec. 1977).

Gordon, Myron J., "Scope and Method of Theory and Research in the Measurement of Income and Wealth," Accounting Review, Vol. 35, October, 1960, 603-18.

Gordon, Myron J. The Investment, Financing and Evaluation of the Corporation, Homewood: Richard D. Irwin, 1962.

Graham, Willard j. "Public Utility Valuation," The Journal of Business, Vol. VII, No. 2, (April 1934), Part 2, 1-95; Studies in Business Administration, Vol. IV, No. 3; Univ. of Chicago Press.

Hicks, J.R., "The Measurement of Capital" Proceedings of the 37th Session, London, Bulletin of the International Statistical Institute, Volume 43, 1969, 253-263; Reprinted in: Richard P. Brief, (Ed.) op. cit.

Hotelling, Harold "A General Mathematical Theory of Depreciation", J. of Am. Stat. Assoc. Vol. 20, Sept., 1925, pp. 340-53.

Kahn, Alfred, E., The Economic of Regulation, N.Y.: Wiley, 1970.

Kaplan, R.S. and Roll, R., "Investor Evaluation of Accounting Information: Some Empirical Evidence, Journal of Business, Vol. 45, (April 1972), p. 225-257.

Kay, J.A. "Accountants, Too, Could be Happy in a Golden Age: The Accountant's Rate of Profit and the Internal Rate of Return", Oxford Economic Papers, 28, (November 1976), 447-60.

Kolbe, A. Lawrence, Read, James A. Jr., and Hall, G., The Cost of Capital, Cambridge: MIT Press, 1984.

Kolbe, A. Lawrence, "How Can Regulated Rates (and Companies) Survive Competition?" (Draft Paper), Cambridge: Putnam, Hayes and Bartlett, Inc., (November 1984).

Lawton, Raymond W. (National Regulatory Research Institute), Telecommunications Modernization: Issues and Approaches for Regulators, Columbus: National Regulatory Research Institute, January 1988.

Lind, Robert C. Discounting for Time and Risk in Energy Policy," D.C. Resources for the Future (Baltimore: Johns Hopkins University Press), 1982.

Morin, Roger, A., Utilities' Cost of Capital, Arlington: Public Utilities Reports, Inc., 1984.

Morton, Walter, A., "Investor Capitalization Theory of the Cost of Capital", Land Economics, 46, (August 1970), 248-63.

Myers, Stewart C. "The Application of Finance Theory to Public Utility Rate Cases", Bell Journal of Economics, Vol. III, Spring 1972, 59-97.

Navarro, Peter, Peterson, B.C., and Stauffer, T.R., "A Critical Comparison of Utility-Type Ratemaking Methodologies in Oil Pipeline Regulation," Bell Journal, Vol. 12, No. 2, Autumn 1981 392-412.

N.Y. Times, "The FASB Comes Under Fire", Sunday, August 18, 1985, Business Section, 4-F).

Preinreich, Gabriel A.D. "The Principles of Public Utility Depreciation," Accounting Review, Vol 13, No. 2, June 1938, 149-165.

Preinreich, Gabriel A.D., "Annual Survey of Economic Theory: The Theory of Depreciation," Econometrica, July 1938, 6, 219-41.

Salamon Gerald, L. "Cash Recovery Rates and Measures of Firm Profitability" Acct. Rev., 62, No. 2 (April 82), 292-302.

Salamon, Gerald, L. "Accounting Rates of Return" AER, 75, No. 3, (June 1985), 495-504.

Salamon, Gerald L. "Models of the Relationship Between the Accounting and Internal Rate of Return: An Examination of the Methodology", Journal of Accounting Research, Vol. 11 (Autumn 1973), 296-303.

Solomon, Ezra and Laya, J.C., "Measurement of Company Profitability: Some Systematic Errors in the Accounting Rate of Return", Alexander A. Robichek, (Ed.) Financial Research and Management Decisions, New York: John Wiley and Sons, 1967, 152-83.

Solomon, Ezra "Alternative Rate of Return Concepts and Their Implications for Utility Regulation", Bell Journal of Economics and Management Science, Vol. I, No. 1, Spring 1970, 65-81.

Solomon, Ezra "Return on Investment: The Relation of Book Yield to True Yield" in R. Jaedick, Y. Ijiri, O. Nielsen (Eds.), Research in Accounting Measurement, American Accounting Association, 1966.

Solomon, David, Making Accounting Policy, N.Y., Oxford University Press, 1986.

Sorter, George H., S. Siegel and John Slain, "Accountants' Liability: A Determinant of the Accounting Model," Journal of Accounting Auditing and Finance, Vol. 3 No. 3, (Summer 1988) 233-249.

Spacek, Leonard, Address before the Financial Accounting Class, Graduate School of Business Administration, Harvard University September 25, 1959; cited in Richard Brealey and Stewart Myers, Principles of Corporate Finance, McGraw Hill, 1984.

Stauffer, Thomas, R. "The Measurement of Corporate Rates of Return," Bell Journal of Economics and Management Science, 2,(Autumn 1971), 434-469, (1971a).

Stauffer, Thomas, R. The Measurement of Corporate Rates of Return, Ph.D. Dissertation, Harvard 1971, reprinted by Garland (N.Y.) 1980.

Sterling, Robert R. Theory of the Measurement of Enterprise Income, Lawrence: University of Kansas, 1970.

Treynor, Jack L. "Discussion: Changes in Accounting Techniques and Stock Prices," Empirical Research in Accounting: Selected Studies, 1972, Graduate School of Business, Univ. of Chicago.

U.S. Government Printing Office, Uniform System of Accounts for Public Utilities and Licensees, D.C.: January 1970.

Vatter, William, "Income Models Book Yield and the Rate of Return," Accounting Review, October 1966, 681-698.

Watts, Ross and Zimmerman J.L., Positive Accounting Theory, Prentice-Hall, Inc., 1986.

Winn, Darryl "The Potential Effect of Alternative Accounting Measures on Public Policy and Resource Association", in Economic Consequences of Financial Accounting Standards, FASB Research Report, Stamford, July 1978.

Winn, Darryl "A Real Examination of Corporate Profits and Taxes", Business Economics, May 1976, 18-22.

EXHIBIT 1

NYTEL REVENUE MODEL FOR FIRM IN GROWTH I= 0.12
EACH MACHINE = 10.00
GROW-SMOOTH PATH

BALANCE SHEET

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
ngr=																									
S.L.D. ROUTINE	-	-	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BEGIN. RATEBASE	0.00	200.00	360.00	480.00	560.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00
NEW INVESTMENT	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
Y/E GROSS PLANT	200.00	400.00	600.00	800.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
ACC. DEP.	0.00	40.00	120.00	240.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00	400.00
Y/E NET PLANT	200.00	360.00	480.00	560.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00	600.00
NO. MACHINES Y/E	20	40	60	80	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
GROWTH RATE		1000	500	333	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	FULL RANGE		STEADY STATE ONLY (AS OF END-OF-YR 4)		ST-STATE ONLY (AS OF E-O-YR 0)	PHASE-IN PORTION ONLY
P.V. REV-REPRESC.	$1,709	99.5%	$2,151	105.9%	$1,367	$341
P.V. REV-A.D.	$1,714	99.8%	$2,072	102.0%	$1,317	$398
P.V. REV-SLD	$1,717	100.0%	$2,032	100.0%	$1,291	$426
P.V. REV-SYD	$1,726	100.5%	$1,912	94.1%	$1,215	$511

CASH FLOW (END YEAR)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
EARNINGS		24.00	43.20	57.60	67.20	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00	72.00
DEPRECIATION		40.00	80.00	120.00	160.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
TOTREV - SLD		64.00	123.20	177.60	227.20	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00	272.00
G-SLD 6-24 AVG.G=	1		1.925	1.441558	1.279279	1.197183	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TOTREV - SYD		90.67	160.00	209.60	241.07	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00
G-SYD AVG.G=	1		1.764705	1.31	1.150127	1.061946	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TOTREV - A.D.		55.48	110.96	166.45	221.93	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41
G-A.D 6-24 AVG.G=	1		2	1.5	1.333333	1.25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TOTREV - REPRESC		46.22	92.95	141.71	196.98	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00
G-REP 6-24 AVG	1		2.010989	1.524590	1.389964	1.462093	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ROE		12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%

EXHIBIT 1

S.L.D. DEPRECIATION

MACHINE/	0	1	2	3	4	5	6	7	8	9	10	11
1		0.20	0.20	0.20	0.20	0.20						
2			0.20	0.20	0.20	0.20	0.20					
3				0.20	0.20	0.20	0.20	0.20				
4					0.20	0.20	0.20	0.20	0.20			
5						0.20	0.20	0.20	0.20	0.20		
6							0.20	0.20	0.20	0.20	0.20	
7								0.20	0.20	0.20	0.20	0.20
8									0.20	0.20	0.20	0.20
9										0.20	0.20	0.20
10											0.20	0.20
11												0.20
TOTALS		0.20	0.40	0.60	0.80	1.00	1.00					

NET PLANT VALUE (SLD)

MACHINE/	0	1	2	3	4	5	6	7	8	9	10	11
1	1.00	0.80	0.60	0.40	0.20	0.00	0.00					
2		1.00	0.80	0.60	0.40	0.20	0.00					
3			1.00	0.80	0.60	0.40	0.20	0.00				
4				1.00	0.80	0.60	0.40	0.20	0.00			
5					1.00	0.80	0.60	0.40	0.20	0.00		
6						1.00	0.80	0.60	0.40	0.20	0.00	
7							1.00	0.80	0.60	0.40	0.20	0.00
8								1.00	0.80	0.60	0.40	0.20
9									1.00	0.80	0.60	0.40
10										1.00	0.80	0.60
TOTALS	1.00	1.80	2.40	2.80	3.00	3.00	3.00	3.00	3.00	3.00	2.00	1.20

EXHIBIT 1

S.Y.D ROUTINE

I= 0.15

BALANCE SHEET

	0	1	2	3	4	5	6	7	8	9	10	11
BEGIN. RATEBASE	0.00	200.00	333.33	413.33	453.33	466.67	466.67	466.67	466.67	466.67	466.67	466.67
NEW INVESTMENT	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
Y/E GROSS PLANT	200.00	400.00	600.00	800.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
ACC. DEP.	0.00	66.67	186.67	346.67	533.33	533.33	533.33	533.33	533.33	533.33	533.33	533.33
Y/E NET PLANT	200.00	333.33	413.33	453.33	466.67	466.67	466.67	466.67	466.67	466.67	466.67	466.67
NO. MACHINES Y/E	20	40	60	80	100	100	100	100	100	100	100	100

	12	13	14	15	16	17	18	19	20	21	22	23	24
BEGIN. RATEBASE	466.67	466.67	466.67	466.67	466.67	466.67	466.67	466.67	466.67	466.67	466.67	466.67	466.67
NEW INVESTMENT	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
Y/E GROSS PLANT	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
ACC. DEP.	533.33	533.33	533.33	533.33	533.33	533.33	533.33	533.33	533.33	533.33	533.33	533.33	533.33
Y/E NET PLANT	466.67	466.67	466.67	466.67	466.67	466.67	466.67	466.67	466.67	466.67	466.67	466.67	0.00
NO. MACHINES Y/E	100	100	100	100	100	100	100	100	100	100	100	100	100

CASH FLOW

	0	1	2	3	4	5	6	7	8	9	10	11
EARNINGS		24.00	40.00	49.60	54.40	56.00	56.00	56.00	56.00	56.00	56.00	56.00
DEPRECIATION		66.67	120.00	160.00	186.67	200.00	200.00	200.00	200.00	200.00	200.00	200.00
TOT. REVENUE REQ'D		90.67	160.00	209.60	241.07	256.00	256.00	256.00	256.00	256.00	256.00	256.00
ROE		12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%

	12	13	14	15	16	17	18	19	20	21	22	23	24
EARNINGS	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00
DEPRECIATION	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
TOT. REVENUE REQ'D	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00
ROE	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%

S. Y. D. DEPRECIATION

MACHINE	0	1	2	3	4	5	6	7	8	9	10	11
1		0.33	0.27	0.20	0.13	0.07	0.00	0.00	0.00	0.00	0.00	0.00
2			0.33	0.27	0.20	0.13	0.07	0.00	0.00	0.00	0.00	0.00
3				0.33	0.27	0.20	0.13	0.07	0.00	0.00	0.00	0.00
4					0.33	0.27	0.20	0.13	0.07	0.00	0.00	0.00
5						0.33	0.27	0.20	0.13	0.07	0.00	0.00
6							0.33	0.27	0.20	0.13	0.07	0.00
7								0.33	0.27	0.20	0.13	0.07
8									0.33	0.27	0.20	0.13
9										0.33	0.27	0.20
10											0.33	0.27
11												0.33
TOTALS		0.33	0.60	0.80	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00

NET PLANT VALUE (SYD)

MACHINE	0.00	1.00	2.00	3.00	4.00	5.00	6.00					
1	1.00	0.67	0.40	0.20	0.07	0.00	0.00					
2		1.00	0.67	0.40	0.20	0.07	0.00					
3			1.00	0.67	0.40	0.20	0.07	0.00				
4				1.00	0.67	0.40	0.20	0.07	0.00			
5					1.00	0.67	0.40	0.20	0.07	0.00		
6						1.00	0.67	0.40	0.20	0.07	0.00	
7							1.00	0.67	0.40	0.20	0.07	0.00
8								1.00	0.67	0.40	0.20	0.07
9									1.00	0.67	0.40	0.20
10										1.00	0.67	0.40
TOTALS	1.00	1.67	2.07	2.27	2.33	2.33	2.33	2.33	2.33	2.33	1.33	0.67

EXHIBIT 1

A.D. ROUTINE

BALANCE SHEET

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
BEGIN. RATEBASE	0.00	200.00	368.52	501.78	595.54	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08
NEW INVESTMENT	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
Y/E GROSS PLANT	200.00	400.00	600.00	800.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
ACC. DEP.	0.00	31.48	98.22	204.46	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92	354.92
Y/E NET PLANT	200.00	368.52	501.78	595.54	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08	645.08
NO. MACHINES Y/E	20	40	60	80	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
GROWTH RATE		1000	500	333	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CASH FLOW

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
EARNINGS		24.00	44.22	60.21	71.47	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41	77.41
DEPRECIATION		31.48	66.74	106.23	150.46	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
TOTREV - 15% A.D.		55.48	110.96	166.45	221.93	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41	277.41
ROE		12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%
TOTREV - SYD		90.67	160.00	209.60	241.07	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00

0.12 ANNUITY DEPRECIATION PMT= 0.2774

	0	1	2	3	4	5	6	7	8	9	10	11
MACHINE A		0.1574	0.18	0.20	0.22	0.25						
MACHINE B			0.16	0.18	0.20	0.22	0.25					
MACHINE C				0.16	0.18	0.20	0.22	0.25				
MACHINE D					0.16	0.18	0.20	0.22	0.25			
MACHINE E						0.16	0.18	0.20	0.22	0.25		
MACHINE F							0.16	0.18	0.20	0.22	0.25	
AD CHECK		1.00						0.16	0.18	0.20	0.22	0.25
TOTALS		1.16	0.33	0.53	0.75	1.00			0.16	0.18	0.20	0.22
										0.16	0.18	0.20
											0.16	0.18
												0.16

NET PLANT VALUE (A.D.)

	0.00	1.00	2.00	3.00	4.00	5.00	6.00		
MACHINE A	1000.00	999.84	999.67	999.47	999.25	999.00	998.00		
MACHINE B		1000.00	999.84	999.67	999.47	999.25	999.00		
MACHINE C			1000.00	999.84	999.67	999.47	999.25		
MACHINE D				1000.00	999.84	999.67	999.47		
MACHINE E					1000.00	999.84	999.67		
MACHINE F						1000.00	999.84	0.33	0.53
							1000.00		
TOTALS	1000.00	1999.84	2999.51	3998.98	4998.23	5997.23	6995.23		

EXHIBIT 1

D.D.B. ROUTINE

BALANCE SHEET

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
BEGIN. RATEBASE	0.00	200.00	377.78	530.16	652.06	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33
NEW INVESTMENT	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
Y/E GROSS PLANT	200.00	400.00	600.00	800.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
ACC. DEP.	0.00	22.22	69.84	147.94	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67	266.67
Y/E NET PLANT	200.00	377.78	530.16	652.06	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33	733.33
NO. MACHINES Y/E	20	40	60	80	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
GROWTH RATE		1000	500	333	250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CASH FLOW

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
EARNINGS		24.00	45.33	63.62	78.25	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00
DEPRECIATION		22.22	47.62	78.10	118.73	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
TOTREV DDB		46.22	92.95	141.71	196.98	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00
ROE		12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%
TOTREV - SYD		90.67	160.00	209.60	241.07	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00	256.00

REPRESCRIBED DEPRECIATION

	0	1	2	3	4	5	6	7	8	9	10	11
MACHINE A		0.1111	0.1270	0.1524	0.2032	0.4063						
MACHINE B			0.1111	0.1270	0.1524	0.2032	0.4063					
MACHINE C				0.1111	0.1270	0.1524	0.2032	0.4063				
MACHINE D					0.1111	0.1270	0.1524	0.2032	0.4063			
MACHINE E						0.1111	0.1270	0.1524	0.2032	0.4063		
MACHINE F							0.1111	0.1270	0.1524	0.2032	0.4063	
DEP CHECK		1.0000						0.1111	0.1270	0.1524	0.2032	0.4063
TOTALS		1.1111	0.2381	0.3905	0.5937	1.0000			0.1111	0.1270	0.1524	0.2032
										0.1111	0.1270	0.1524
											0.1111	0.1270
												0.1111

NET PLANT VALUE (A.D.)

	0	1	2	3	4	5	6					
MACHINE A	1.00	0.89	0.76	0.61	0.41	0.00	-1.00					
MACHINE B		1.00	0.89	0.76	0.61	0.41	0.00					
MACHINE C			1000.00	999.89	999.76	999.61	999.41					
MACHINE D				1000.00	999.89	999.76	999.61					
MACHINE E					1000.00	999.89	999.76				0.2381	0.3905
MACHINE F						1000.00	999.89					
							1000.00					
TOTALS	1.00	1.89	1001.65	2001.26	3000.67	3999.67	4997.67					

EXHIBIT 2

NYTEL REVENUE MODEL FOR FIRM IN GROWTH I= 0.12
EACH MACHINE = 10.00
GROW-SMOOTH PATH

BALANCE SHEET

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
xgr= S.L.D. ROUTINE	-	-	-	-	-	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
BEGIN. RATEBASE	0.00	200.00	360.00	480.00	560.00	600.00	630.00	654.90	674.55	688.78	697.45	730.37	758.28	781.03	798.46	810.41	846.73	878.13	904.47	925.61	941.38	981.62	1017.06	1047.58	1073.00
NEW INVESTMENT	200.00	200.00	200.00	200.00	200.00	230.00	230.90	231.83	232.78	233.77	264.78	266.72	268.72	270.78	272.91	305.10	308.25	311.50	314.84	318.29	351.83	356.39	361.08	365.91	370.89
Y/E GROSS PLANT	200.00	400.00	600.00	800.00	1000.00	1030.00	1060.90	1092.73	1125.51	1159.27	1194.05	1229.87	1266.77	1304.77	1343.92	1384.23	1425.76	1468.53	1512.59	1557.97	1604.71	1652.85	1702.43	1753.51	1806.11
ACC. DEP.	0.00	40.00	120.00	240.00	400.00	400.00	406.00	418.18	436.73	461.83	463.68	471.59	485.74	506.31	533.50	537.51	547.63	564.06	586.98	616.59	623.09	635.78	654.86	680.50	712.92
Y/E NET PLANT	200.00	360.00	480.00	560.00	600.00	630.00	654.90	674.55	688.78	697.45	730.37	758.28	781.03	798.46	810.41	846.73	878.13	904.47	925.61	941.38	981.62	1017.06	1047.58	1073.00	1093.19
NO. MACHINES Y/E	20	40	60	80	100	103	106	109	113	116	119	123	127	130	134	138	143	147	151	156	160	165	170	175	181
GROWTH RATE		1000	500	333	250	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

	FULL RANGE		STEADY STATE ONLY (AS OF END-OF-YR 4)		ST-STATE ONLY (AS OF E-O-YR 0)	PHASE-IN PORTION ONLY
P.V. REV-REPRESC.	$1,979	99.2%	$2,577	104.4%	$1,638	$341
P.V. REV-A.D.	$1,990	99.7%	$2,505	101.5%	$1,592	$398
P.V. REV-SLD	$1,995	100.0%	$2,469	100.0%	$1,569	$426
P.V. REV-SYD	$2,011	100.8%	$2,360	95.6%	$1,500	$511

CASH FLOW (END YEAR)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
EARNINGS		24.00	43.20	57.60	67.20	72.00	75.60	78.59	80.95	82.65	83.69	87.64	90.99	93.72	95.82	97.25	101.61	105.38	108.54	111.07	112.97	117.79	122.05	125.71	128.76
DEPRECIATION		40.00	80.00	120.00	160.00	200.00	206.00	212.18	218.55	225.10	231.85	238.81	245.97	253.35	260.95	268.78	276.85	285.15	293.71	302.52	311.59	320.94	330.57	340.49	350.70
TOTREV - SLD		64.00	123.20	177.60	227.20	272.00	281.60	290.77	299.49	307.76	315.55	326.45	336.97	347.08	356.77	366.03	378.45	390.53	402.24	413.59	424.56	438.74	452.62	466.20	479.46
G-SLD 6-24 AVG.G=1.030288			1.925	1.441558	1.279279	1.197183	1.035294	1.032556	1.03	1.027595	1.025320	1.034563	1.032205	1.03	1.027925	1.025963	1.033934	1.031902	1.03	1.028210	1.026518	1.033391	1.031641	1.03	1.028455
TOTREV - SYD		90.67	160.00	209.60	241.07	256.00	269.60	280.41	288.58	294.28	297.67	312.52	324.61	334.11	341.17	345.97	362.27	375.86	386.89	395.54	401.96	419.94	435.26	448.08	458.56
G-SYD AVG.G=1.031660			1.764705	1.31	1.150127	1.061946	1.053125	1.040089	1.029144	1.019742	1.011514	1.049888	1.038703	1.029260	1.021140	1.014055	1.047111	1.037508	1.029361	1.022349	1.016246	1.044727	1.036477	1.029448	1.023394
TOTREV - A.D.		55.48	110.96	166.45	221.93	277.41	285.73	294.30	303.13	312.23	321.59	331.24	341.18	351.41	361.96	372.82	384.00	395.52	407.39	419.61	432.20	445.16	458.52	472.27	486.44
G-A.D 6-24 AVG.G= 1.03			2	1.5	1.333333	1.25	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
TOTREV - REPRESC		46.22	92.95	141.71	196.98	288.00	294.93	302.15	309.89	318.84	333.41	341.71	350.33	359.52	369.95	386.06	395.94	406.18	417.04	429.21	447.09	458.80	470.93	483.74	497.90
G-REP 6-24 AVG 1.029251			2.010989	1.524590	1.389964	1.462093	1.024074	1.024471	1.025612	1.028869	1.045723	1.024881	1.025228	1.026215	1.029025	1.043551	1.025579	1.025881	1.026736	1.029159	1.041680	1.026182	1.026446	1.027184	1.029275
ROE		12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%

EXHIBIT 3

NYTEL REVENUE MODEL FOR FIRM IN GROWTH I= 0.12
EACH MACHINE = 10.00
GROW-SMOOTH PATH

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
mgr=	-	-	-	-	-	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
S.L.D. ROUTINE																									

BALANCE SHEET

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
BEGIN. RATEBASE	0.00	200.00	360.00	480.00	560.00	600.00	630.00	654.90	674.55	688.78	667.19	653.42	630.44	615.50	625.94	632.69	667.65	693.66	712.44	725.79	735.54	773.59	802.77	824.83	841.55
NEW INVESTMENT	200.00	200.00	200.00	200.00	200.00	230.00	230.90	231.83	232.78	233.77	264.78	266.72	268.72	270.78	272.91	305.10	308.25	311.50	314.84	318.29	331.83	356.39	361.08	365.91	370.89
Y/E GROSS PLANT	200.00	400.00	600.00	800.00	1000.00	1030.00	1060.90	1092.73	1125.51	1159.27	1194.05	1229.87	1266.77	1304.77	1343.92	1384.23	1425.76	1468.53	1512.59	1557.97	1604.71	1652.85	1702.43	1753.51	1806.11
ACC. DEP.	0.00	40.00	120.00	240.00	400.00	400.00	406.00	418.18	436.73	492.09	540.63	599.43	651.27	678.83	711.22	716.58	732.10	756.09	786.80	822.42	831.12	850.08	877.60	911.95	951.34
Y/E NET PLANT	200.00	360.00	480.00	560.00	600.00	630.00	654.90	674.55	688.78	667.19	653.42	630.44	615.50	625.94	632.69	667.65	693.66	712.44	725.79	735.54	773.59	802.77	824.83	841.55	854.78
NO. MACHINES Y/E	20	40	60	80	100	103	106	109	113	116	119	123	127	130	134	138	143	147	151	156	160	165	170	175	181
GROWTH RATE		1000	500	333	250	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

	FULL RANGE		STEADY STATE ONLY	
P.V. REV-REPRESC.	$1,979	98.4%	$2,577	103.4%
P.V. REV-A.D.	$1,990	99.0%	$2,505	100.5%
P.V. REV-SLD/SYD	$2,011	100.0%	$2,493	100.0%
P.V. REV-SYD	$2,011	100.0%	$2,360	94.7%

CASH FLOW

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
EARNINGS			24.00	43.20	57.60	67.20	72.00	75.60	78.59	80.95	82.65	80.06	78.41	75.65	73.86	75.11	75.92	80.12	83.24	85.49	87.10	88.27	92.83	96.33	98.98	100.99
DEPRECIATION			40.00	80.00	120.00	160.00	200.00	206.00	212.18	218.55	255.36	278.54	289.70	283.67	260.34	266.15	270.14	282.24	292.71	301.49	308.54	313.79	327.21	339.02	349.19	357.67
	GROWTH SLD			1.93	1.44	1.28	1.20	1.04	1.03	1.03	1.13	1.06	1.03	0.98	0.93	1.02	1.01	1.05	1.04	1.03	1.02	1.02	1.04	1.04	1.03	1.02
TOTREV - SLD			64.00	123.20	177.60	227.20	272.00	281.60	290.77	299.49	338.02	358.60	368.11	359.32	334.20	341.27	346.06	362.36	375.95	386.98	395.63	402.06	420.04	435.35	448.17	458.65
	GROWTH SYD			1.76	1.31	1.15	1.06	1.05	1.04	1.03	1.02	1.01	1.05	1.04	1.03	1.02	1.01	1.05	1.04	1.03	1.02	1.02	1.04	1.04	1.03	1.02
TOTREV - SYD			90.67	160.00	209.60	241.07	256.00	269.60	280.41	288.58	294.28	297.67	312.52	324.61	334.11	341.17	345.97	362.27	375.86	386.89	395.54	401.96	419.94	435.26	448.08	458.56
	GROWTH -AD			2.00	1.50	1.33	1.25	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
TOTREV - A.D.			55.48	110.96	166.45	221.93	277.41	285.73	294.30	303.13	312.23	321.59	331.24	341.18	351.41	361.96	372.82	384.00	395.52	407.39	419.61	432.20	445.16	458.52	472.27	486.44
	GROWTH-REP			2.011	1.525	1.390	1.462	1.024	1.024	1.026	1.029	1.046	1.025	1.025	1.026	1.029	1.044	1.026	1.026	1.027	1.029	1.042	1.026	1.026	1.027	1.029
TOTREV REPRESCRIP			46.22	92.95	141.71	196.98	288.00	294.93	302.15	309.89	318.84	333.41	341.71	350.33	359.52	369.95	386.06	395.94	406.18	417.04	429.21	447.09	458.80	470.93	483.74	497.90
ROE			12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%

EXHIBIT 4

NYTEL REVENUE MODEL FOR FIRM IN GROWTH   I= 0.12
EACH MACHINE = 10.00
GROW-SMOOTH PATH

BALANCE SHEET

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
xgr=	-	-	-	-	-	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
S.L.D. ROUTINE																									
BEGIN. RATEBASE	0.00	200.00	360.00	480.00	560.00	600.00	630.00	654.90	674.55	688.78	697.45	730.37	758.28	781.03	798.46	810.41	846.73	878.13	904.47	925.61	941.38	981.62	1017.06	1047.58	1073.00
NEW INVESTMENT	200.00	200.00	200.00	200.00	200.00	230.00	230.90	231.83	232.78	233.77	264.78	266.72	268.72	270.78	272.91	305.10	308.25	311.50	314.84	318.29	351.83	356.39	361.08	365.91	370.89
Y/E GROSS PLANT	200.00	400.00	600.00	800.00	1000.00	1030.00	1060.90	1092.73	1125.51	1159.27	1194.05	1229.87	1266.77	1304.77	1343.92	1384.23	1425.76	1468.53	1512.59	1557.97	1604.71	1652.85	1702.43	1753.51	1806.11
ACC. DEP.	0.00	40.00	120.00	240.00	400.00	400.00	406.00	418.18	436.73	461.83	463.68	471.59	485.74	506.31	533.50	537.51	547.63	564.06	586.98	616.59	623.09	635.78	654.86	680.50	712.92
Y/E NET PLANT	200.00	360.00	480.00	560.00	600.00	630.00	654.90	674.55	688.78	697.45	730.37	758.28	781.03	798.46	810.41	846.73	878.13	904.47	925.61	941.38	981.62	1017.06	1047.58	1073.00	1093.19
NO. MACHINES Y/E	20	40	60	80	100	103	106	109	113	116	119	123	127	130	134	138	143	147	151	156	160	165	170	175	181
GROWTH RATE		1000	500	333	250	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

	FULL RANGE		STEADY STATE ONLY (AS OF END-OF-YR 4)		ST-STATE ONLY (AS OF E-O-YR 0)	PHASE-IN PORTION ONLY
P.V. REV-REPRESC.	$2,011	100.8%	$2,627	106.4%	$1,669	$341
P.V. REV-A.D.	$1,990	99.7%	$2,505	101.5%	$1,592	$398
P.V. REV-SLD	$1,995	100.0%	$2,469	100.0%	$1,569	$426
P.V. REV-SYD	$2,011	100.8%	$2,360	95.6%	$1,500	$511

C A S H F L O W (END YEAR)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
EARNINGS		24.00	43.20	57.60	67.20	72.00	75.60	78.59	80.95	82.65	83.69	87.64	90.99	93.72	95.82	97.25	101.61	105.38	108.54	111.07	112.97	117.79	122.05	125.71	128.76
DEPRECIATION		40.00	80.00	120.00	160.00	200.00	206.00	212.18	218.55	225.10	231.85	238.81	245.97	253.35	260.95	268.78	276.85	285.15	293.71	302.52	311.59	320.94	330.57	340.49	350.70
TOTREV - SLD		64.00	123.20	177.60	227.20	272.00	281.60	290.77	299.49	307.76	315.55	326.45	336.97	347.08	356.77	366.03	378.45	390.53	402.24	413.59	424.56	438.74	452.62	466.20	479.46
G-SLD 6-24 AVG.G=1.030288			1.925	1.441558	1.279279	1.197183	1.035294	1.032556	1.03	1.027595	1.025320	1.034563	1.032205	1.03	1.027925	1.025963	1.033934	1.031902	1.03	1.028210	1.026518	1.033391	1.031641	1.03	1.028455
TOTREV - SYD		90.67	160.00	209.60	241.07	256.00	269.60	280.41	288.58	294.28	297.67	312.52	324.61	334.11	341.17	345.97	362.27	375.86	386.89	395.54	401.96	419.94	435.26	448.08	458.56
G-SYD AVG.G=1.031225			1.764705	1.31	1.150127	1.061946	1.053125	1.040089	1.029144	1.019742	1.011514	1.049888	1.038703	1.029260	1.021140	1.014055	1.047111	1.037508	1.029361	1.022349	1.016246	1.044727	1.036477	1.029448	1.023394
TOTREV - A.D.		55.48	110.96	166.45	221.93	277.41	285.73	294.30	303.13	312.23	321.59	331.24	341.18	351.41	361.96	372.82	384.00	395.52	407.39	419.61	432.20	445.16	458.52	472.27	486.44
G-A.D 6-24 AVG.G= 1.03			2	1.5	1.333333	1.25	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
TOTREV - REPRESC -->SYD		46.22	92.95	141.71	196.98	288.00	294.93	302.15	309.89	370.57	411.67	427.94	412.81	334.11	341.17	345.97	362.27	375.86	386.89	395.54	401.96	419.94	435.26	448.08	458.56
G-REP 6-24 AVG 1.027169			2.010989	1.524590	1.389964	1.462093	1.024074	1.024471	1.025612	1.195797	1.110925	1.039531	0.964631	0.809357	1.021140	1.014055	1.047111	1.037508	1.029361	1.022349	1.016246	1.044727	1.036477	1.029448	1.023394
ROE		12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%

FIGURE 1
ROR VS ASSET GROWTH RATES FOR VARIOUS DEPRECIATION POLICIES

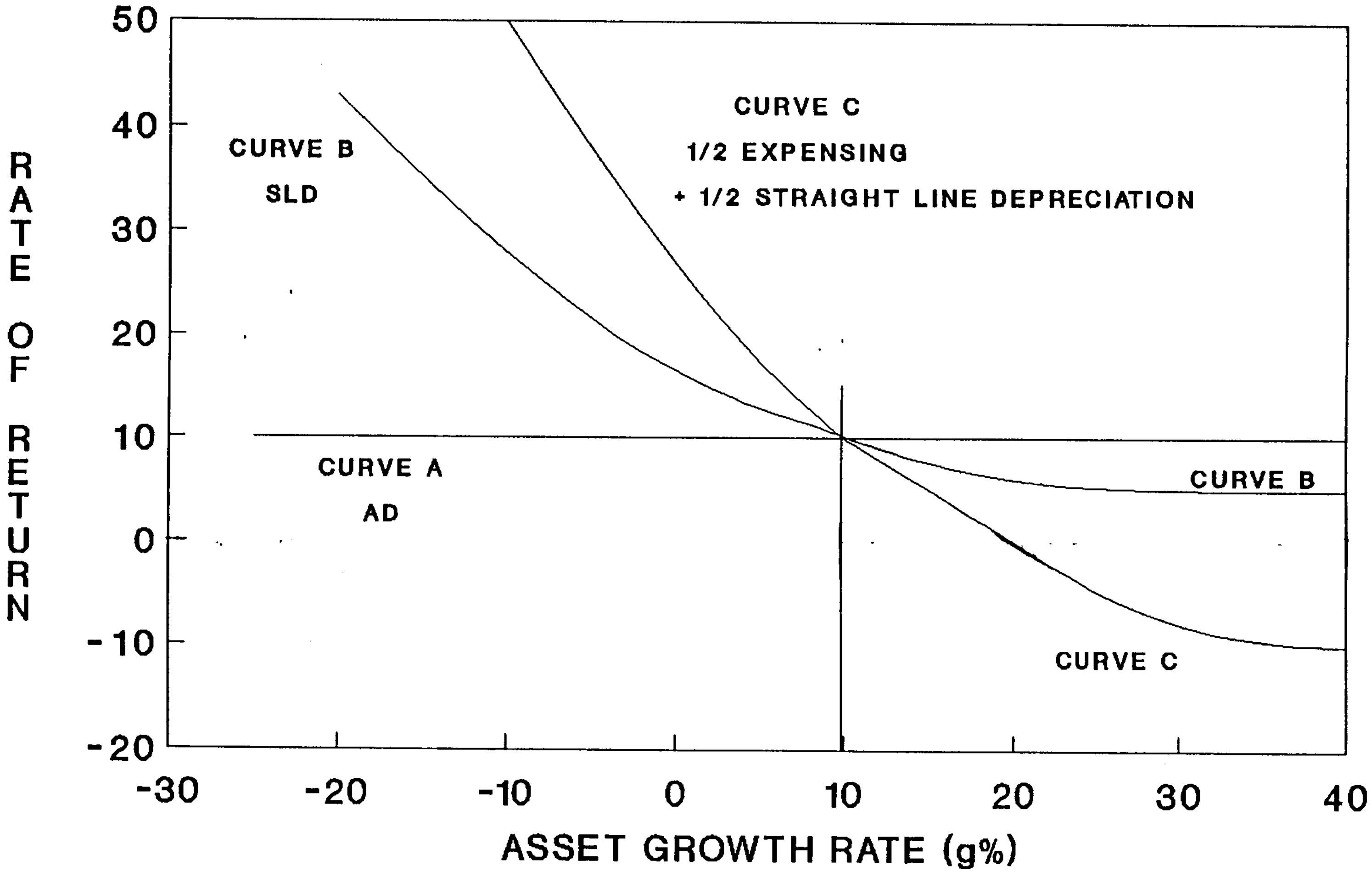


FIGURE 2

THE RELATIONSHIP BETWEEN ROR & GROWTH UNDER DIFFERENT DEPRECIATION POLICIES (RATE MAKING CASH FLOW)

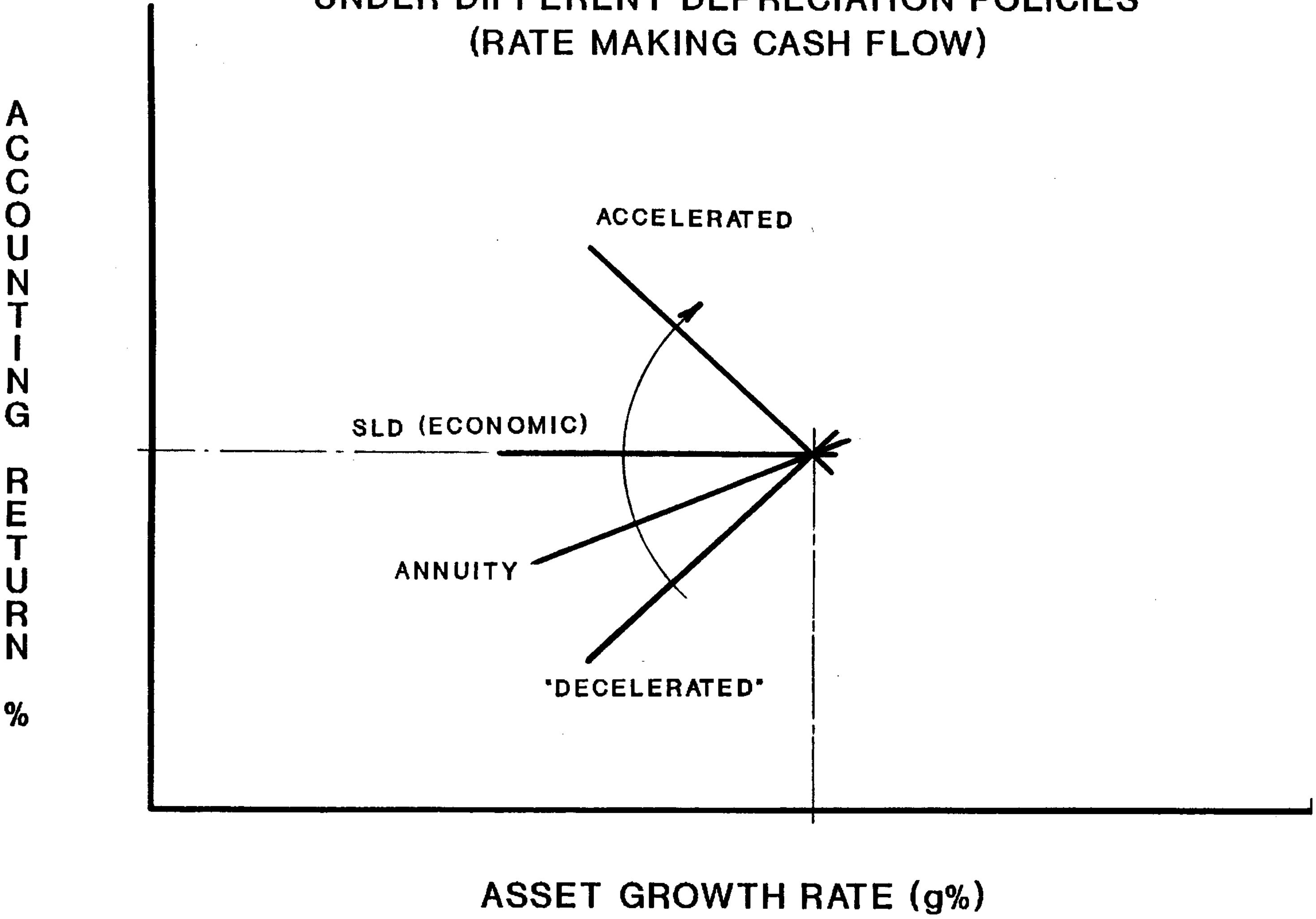


FIGURE 3

THE RELATIONSHIP BETWEEN REQUIRED REVENUE & GROWTH UNDER DIFFERENT DEPRECIATION POLICIES (RATE MAKING CASH FLOW)

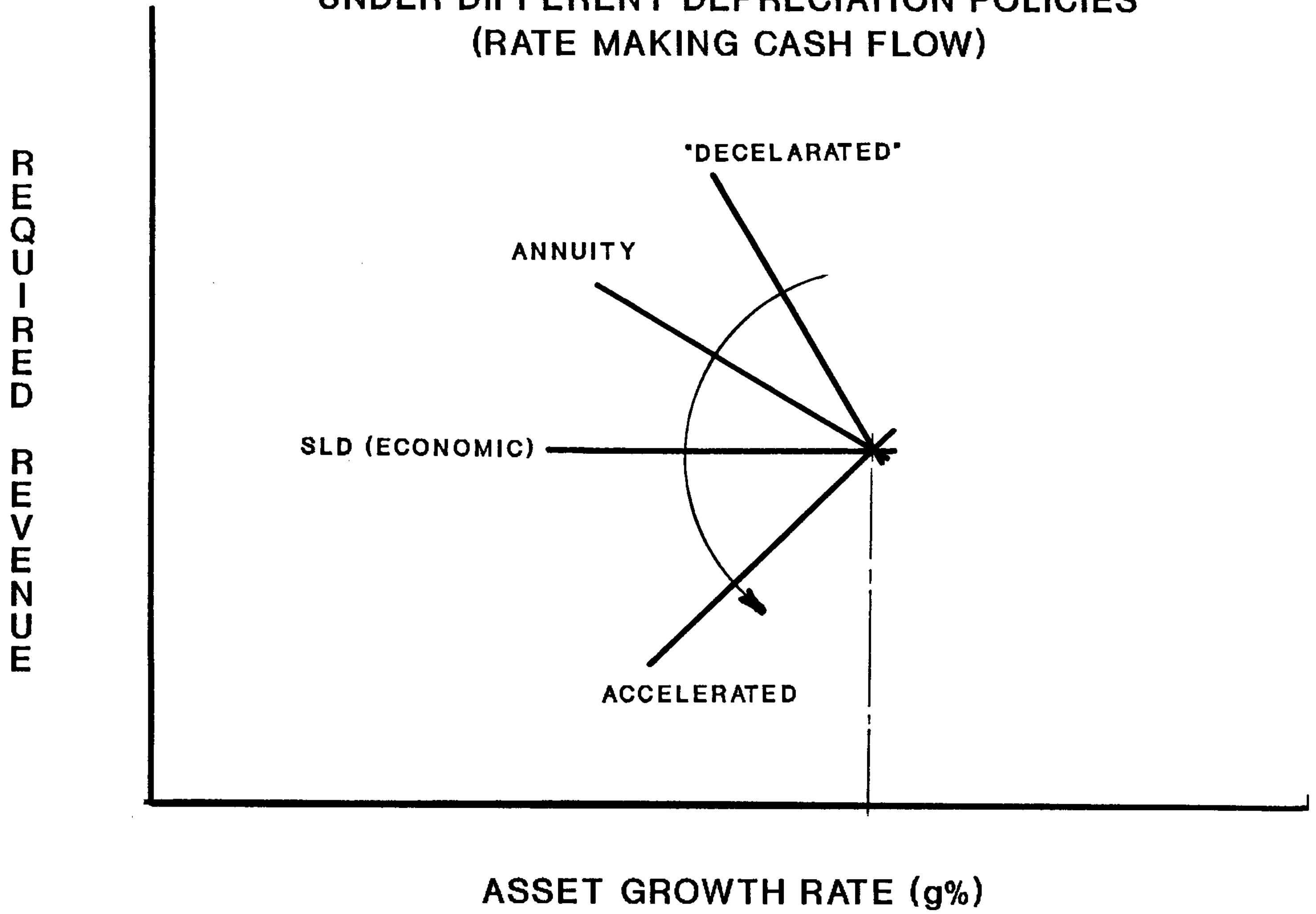
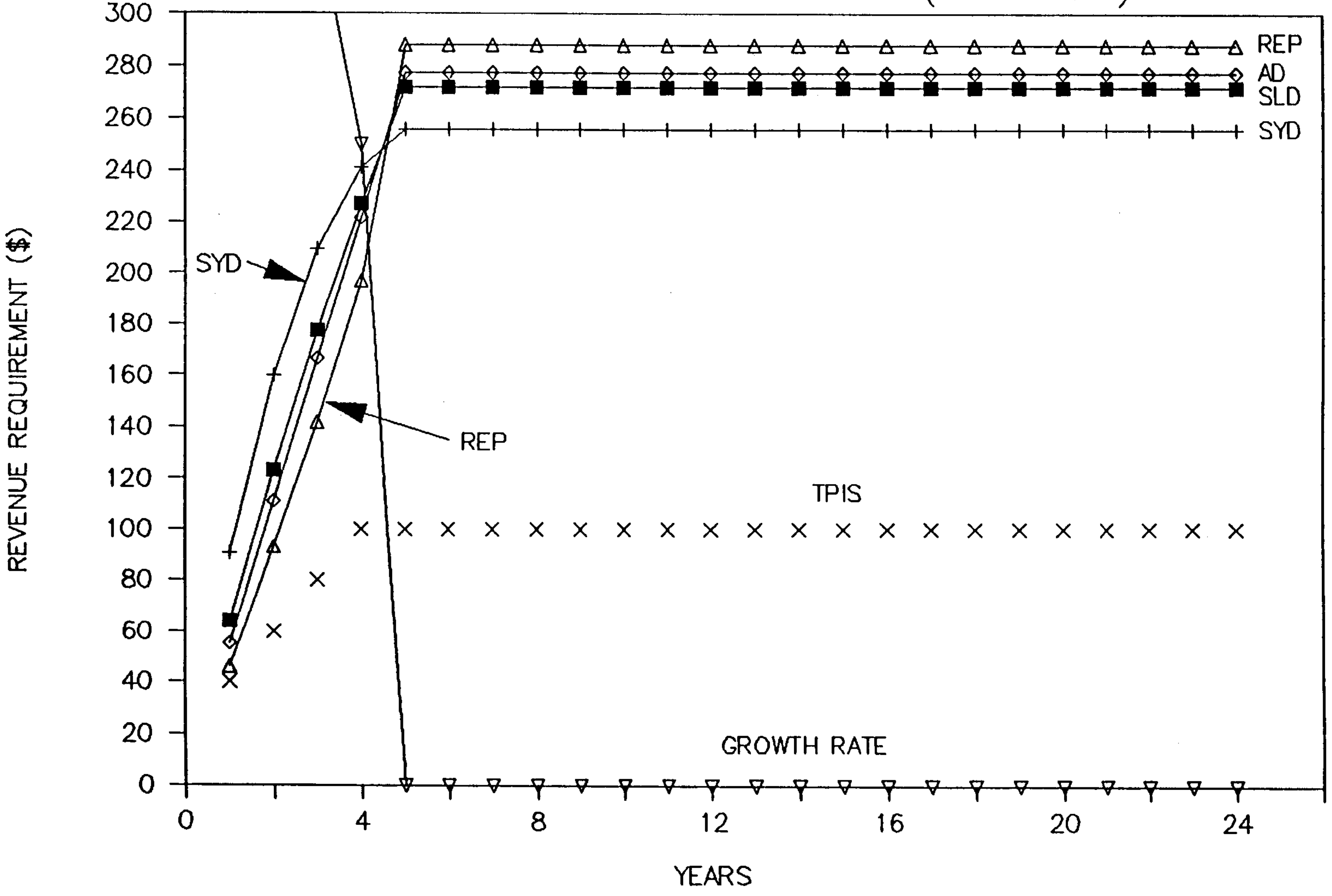


FIGURE 4



DEPRECIATION & REVENUE REQUIREMENT

STEADY STATE NO GROWTH (IRR=12%)

FIGURE 5

DEPRECIATION & REVENUE REQUIREMENT

3 PERCENT GROWTH (IRR=12%)

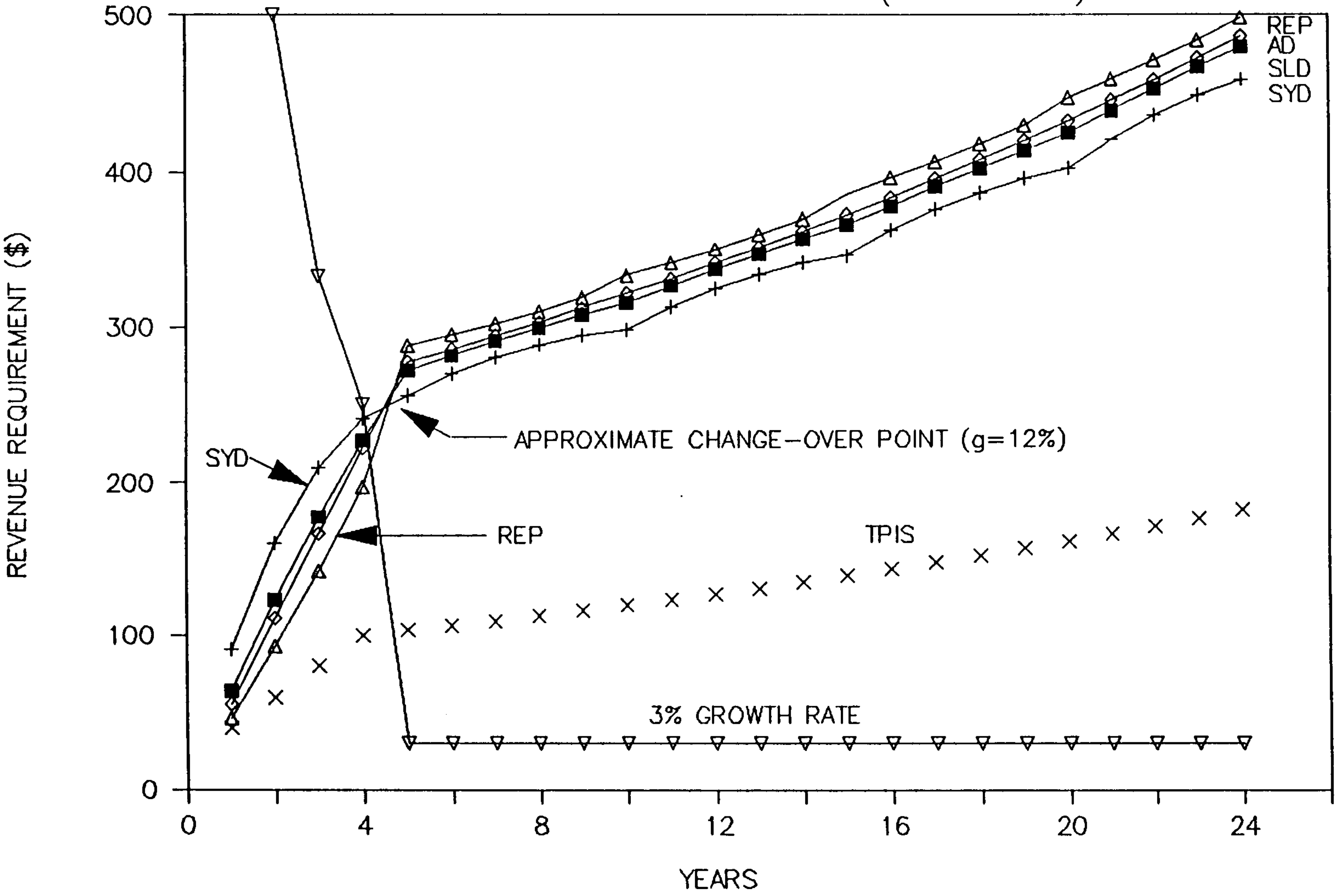
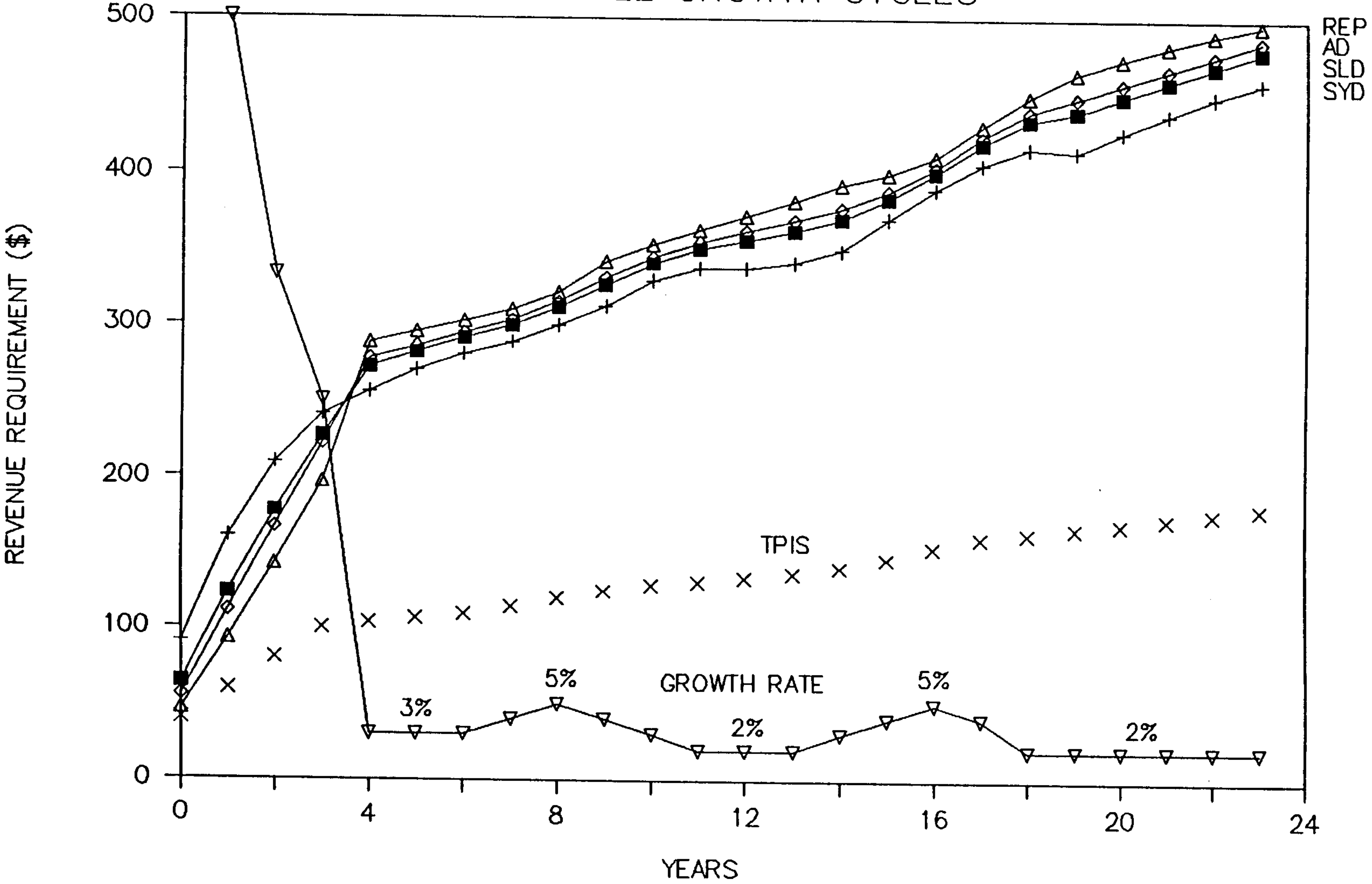


FIGURE 6

DEPRECIATION & REVENUE REQUIREMENT

MULTIPLE GROWTH CYCLES



I.D.

FIGURE 7

DEPRECIATION & REVENUE REQUIREMENT

GROWTH GREATER THAN IRR

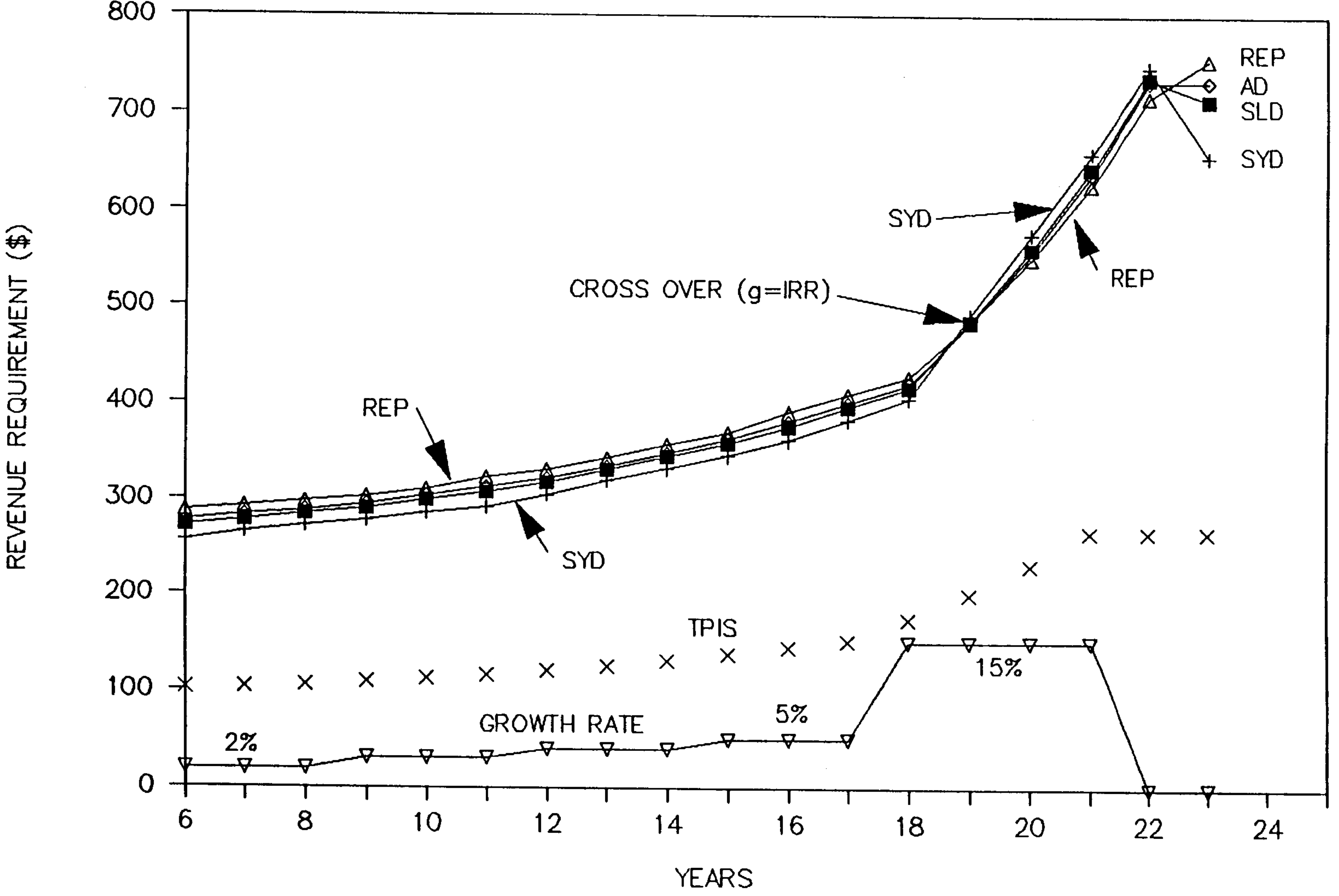


FIGURE 8A

DEPRECIATION & REVENUE REQUIREMENT

SLD TO SYD TRANSITION BEGINNING YEAR 9

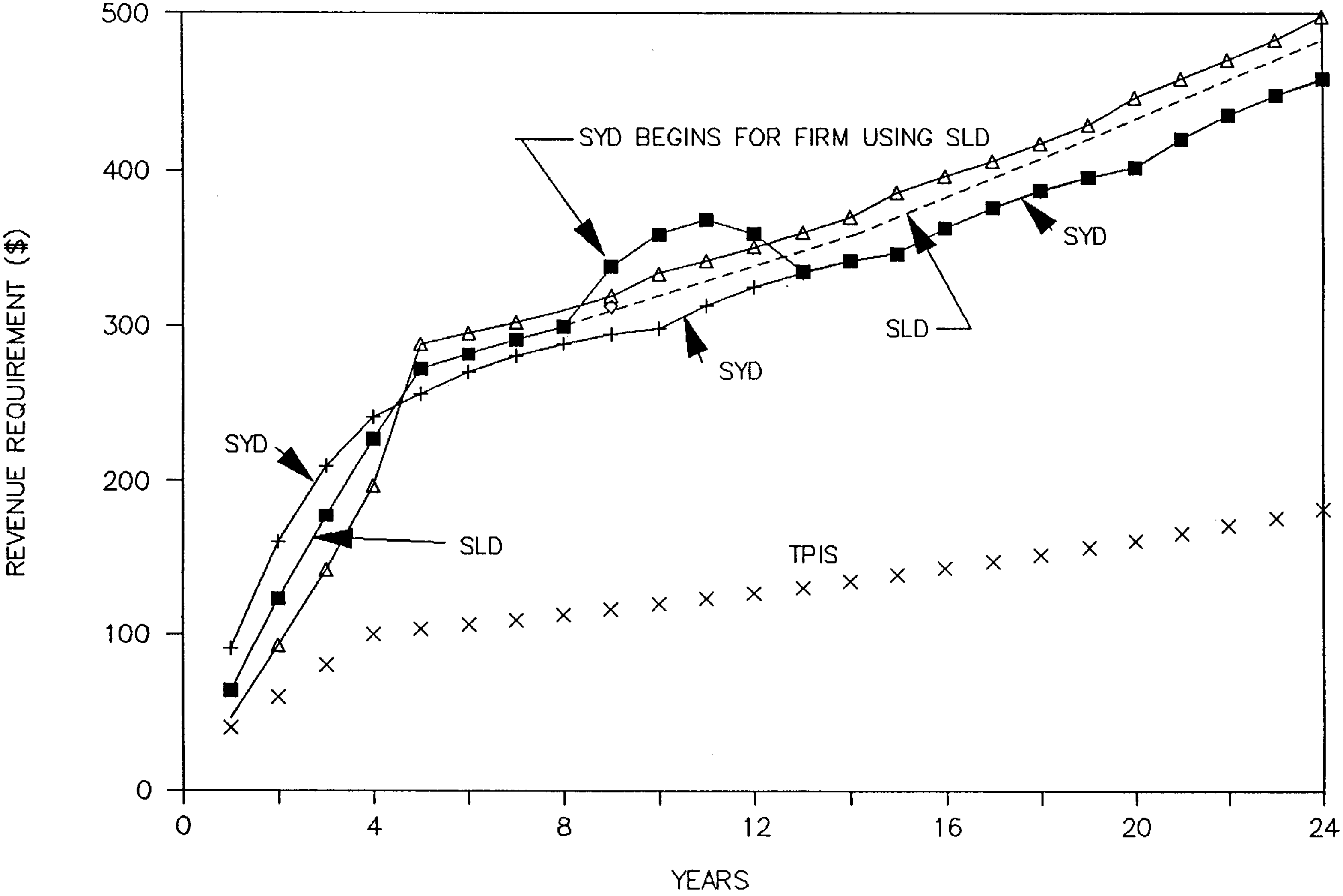


FIGURE 8B

DEPRECIATION & REVENUE REQUIREMENT

REP TO SYD TRANSITION BEGINNING YEAR 9

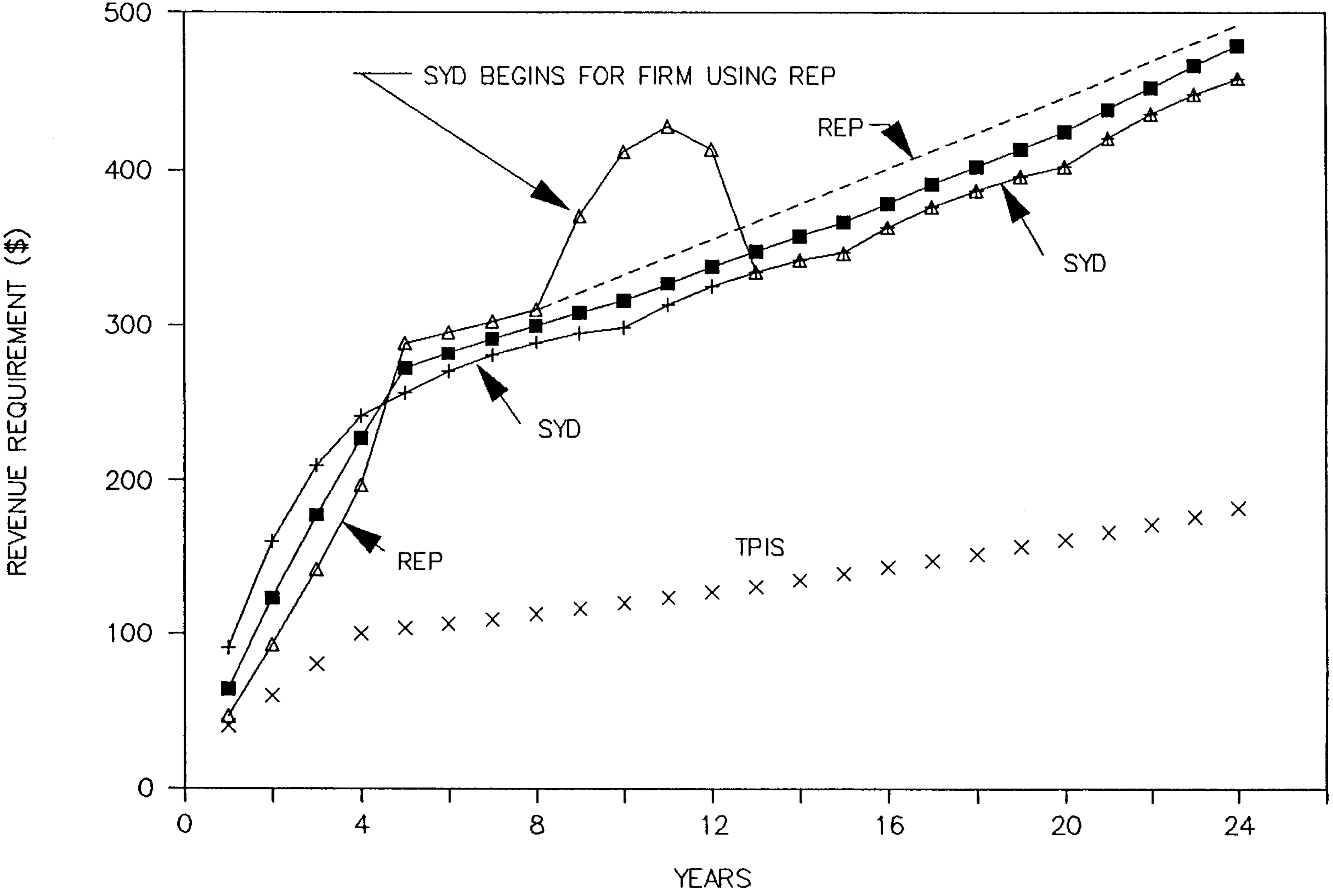
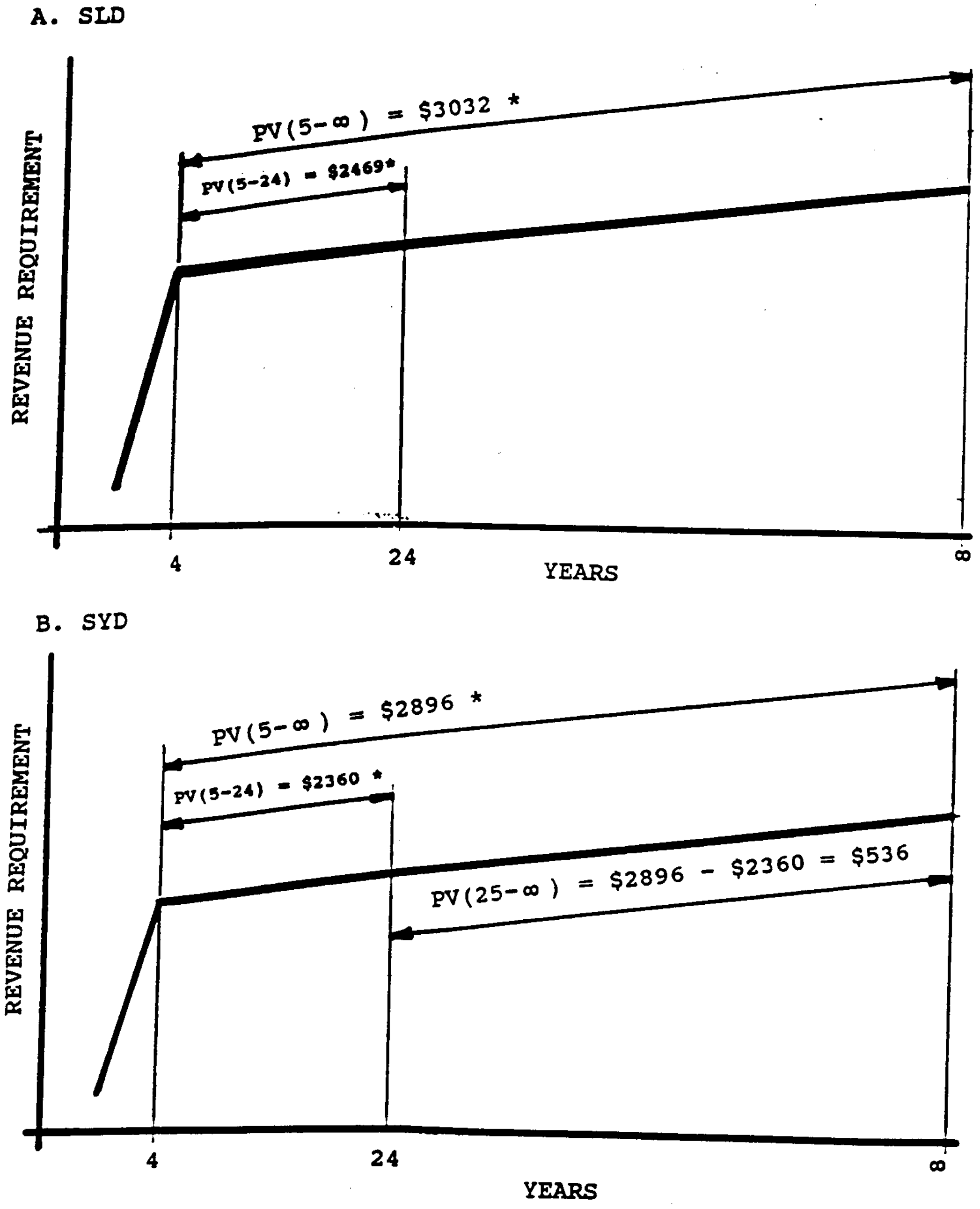


FIGURE 9

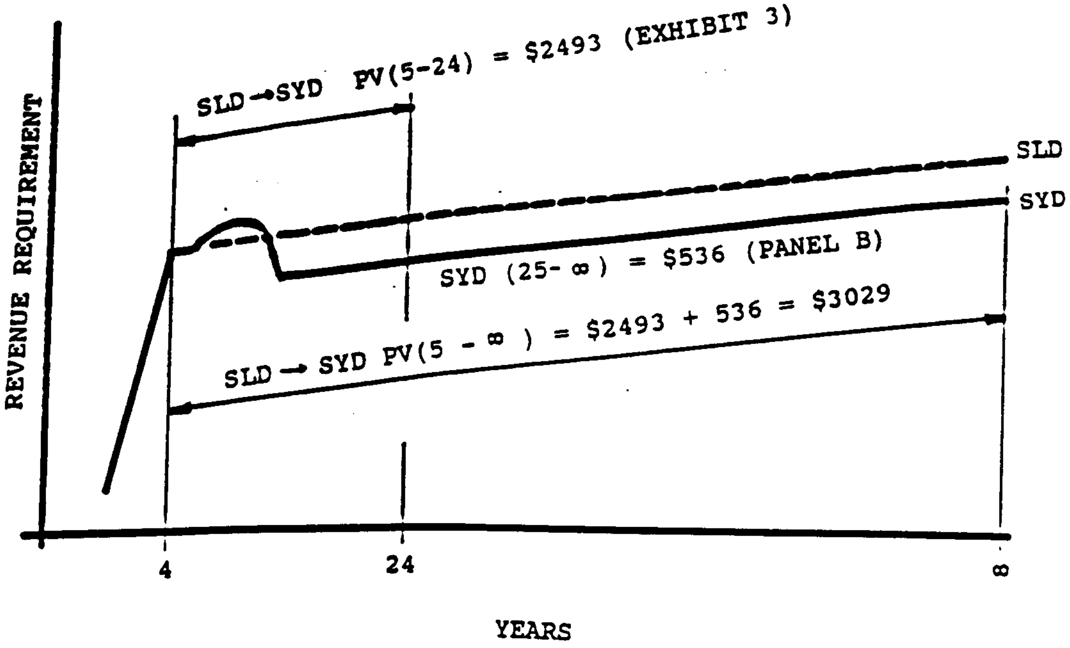
PRESENT VALUE OF REVENUES FOR DEPRECIATION TRANSITIONS



*PV VALUES FROM TABLE 13

FIGURE 9
(CONTINUED)

C. SLD TO SYD TRANSITION



D. REP TO SYD TRANSITION

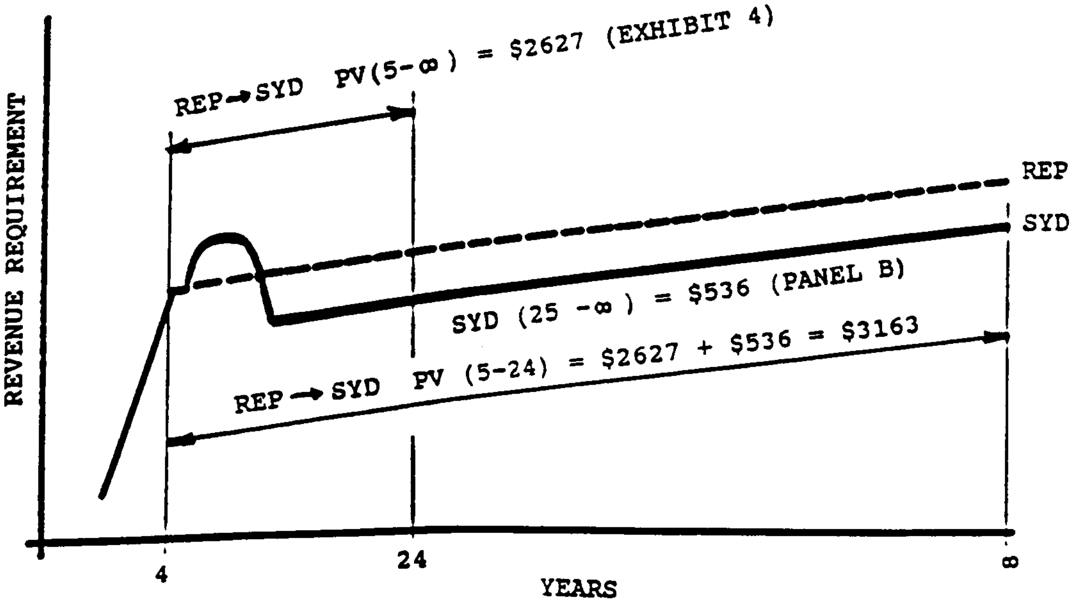


FIGURE 10A

DEPRECIATION & REVENUE REQUIREMENT

SLD TO SYD TRANSITION BEGINNING YEAR 4

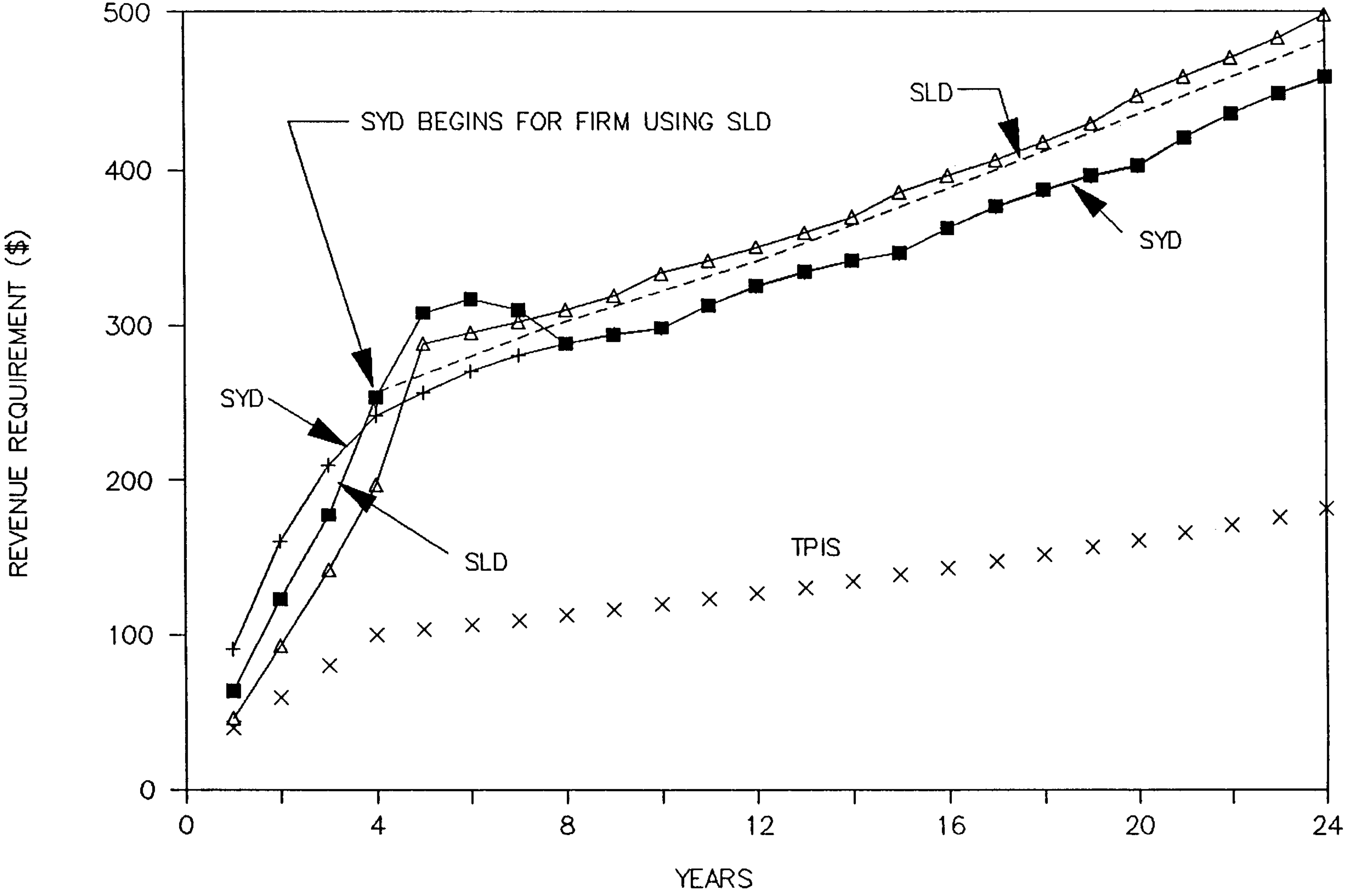


FIGURE 10B

DEPRECIATION & REVENUE REQUIREMENT

SLD TO SYD TRANSITION BEGINNING YEAR 2

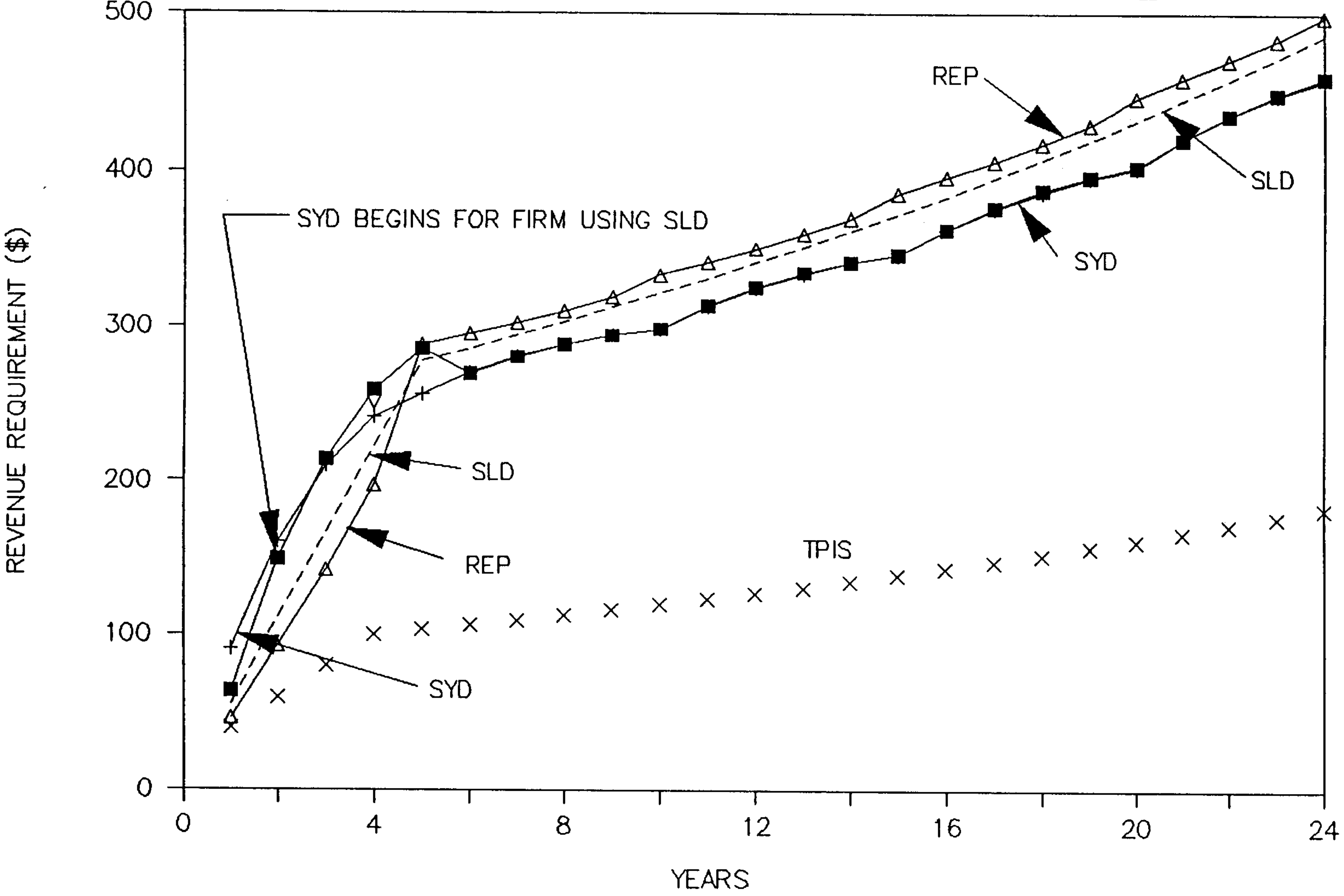


FIGURE 11

ECONOMIC DEPRECIATION & THE "Q-PROFILE"

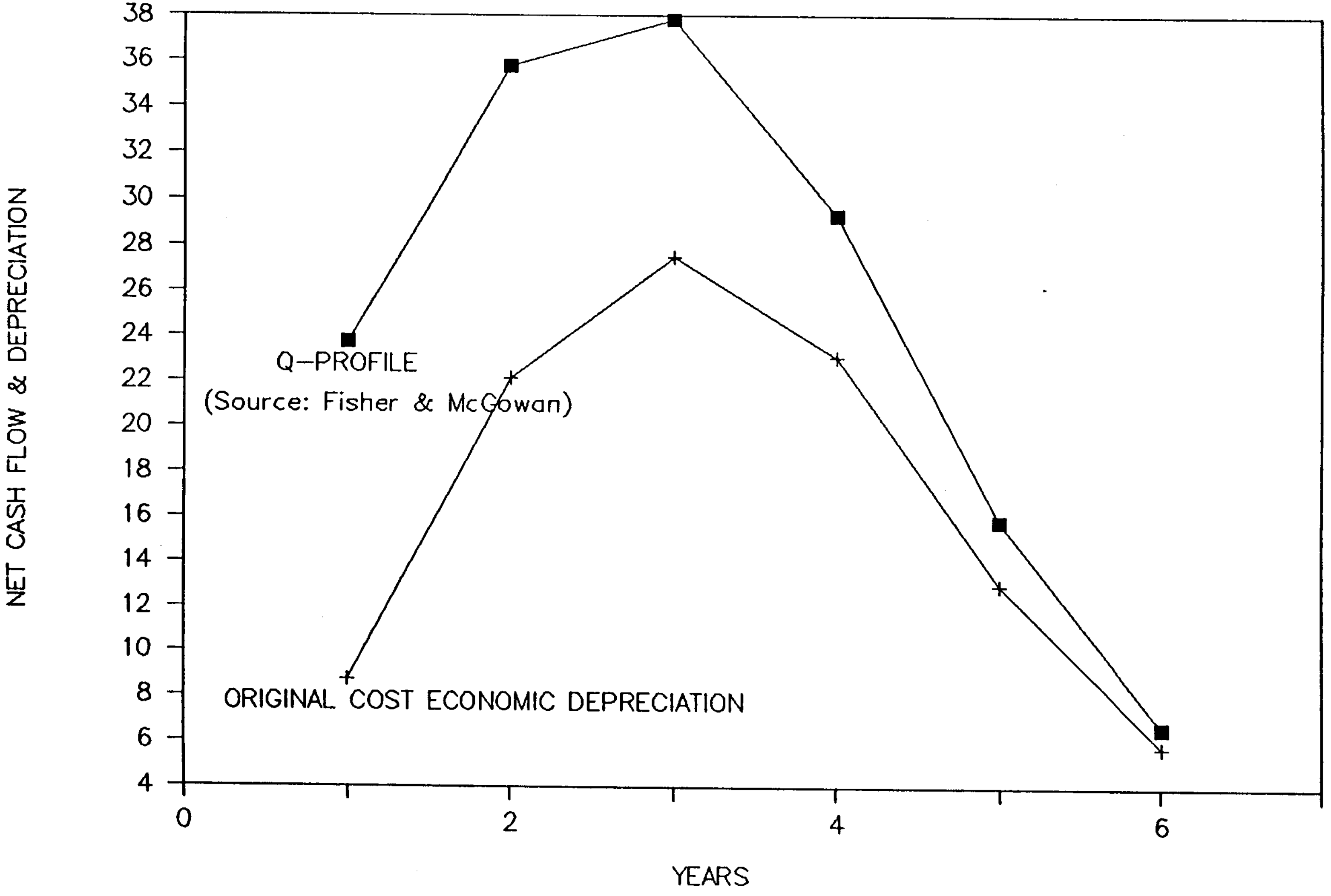


TABLE 1

ROR WITH LEVELIZED CASH FLOW AND STRAIGHT-LINE DEPRECIATION

YEAR	CASH FLOW	STRAIGHT LINE DEPRECIATION	ACCOUNTING NET INCOME	BEGINNING RATE BASE	ROR
0	$ -1000.00				
1	$ 298.32	$200.00	$98.32	$1,000.00	9.8%
2	298.32	200.00	98.32	800.00	12.3%
3	298.32	200.00	98.32	600.00	16.4%
4	298.32	200.00	98.32	400.00	24.6%
5	298.32	200.00	98.32	200.00	49.2%
TOTALS	$ 1491.60	$1,000.00			22.4% (AVERAGE ROR)
PV (15%)	$ 1000.00		329.58		

Five-year life, no salvage, no taxes;
Economic return (IRR) is 15%.

TABLE 2

ROR WITH LEVEL CASH FLOW AND ANNUITY DEPRECIATION

YEAR	CASH FLOW	15% ANNUITY DEPRECIATION	ACCOUNTING NET INCOME	BEGINNING RATE BASE	R O R
0	$ -1000.00				
1	$ 298.32	$148.32	$150.00	$1,000.00	15.0%
2	298.32	170.56	127.75	851.69	15.0%
3	298.32	196.15	102.17	681.12	15.0%
4	298.32	225.57	72.75	484.98	15.0%
5	298.32	259.40	38.91	259.41	15.0%
TOTAL	$ 1491.60	$1,000.00			
PV (at 15%)	$ 1000.00		355.15		

---

net income is paid out each year.

TABLE 3

ROR WITH A REGULATED CASH FLOW AND STRAIGHT-LINE-DEPRECIATION

YEAR	CASH FLOW	STRAIGHT LINE DEPRECIATION	ACCOUNTING NET INCOME	BEGINNING RATE BASE	R O R
0	$ -1000.00				
1	$350.00	$200.00	$150.00	$1,000.00	15.0%
2	320.00	$200.00	$120.00	800.00	15.0%
3	290.00	$200.00	$90.00	600.00	15.0%
4	260.00	$200.00	$60.00	400.00	15.0%
5	230.00	$200.00	$30.00	200.00	15.0%
TOTAL	$1,450.00	$1,000.00			
PV (at 15%)	$ 1000.00				

Five year life, no salvage, no taxes;
Economic Return (IRR) is 15%

TABLE 4A

ROR FOR SLIGHT VARIATIONS FROM ALLOWED REGULATED CASH FLOW
(Straight-Line-Depreciation)
(IRR=15%)

YEAR	ALLOWED CASH FLOW	ACTUAL CASH FLOW	DEPRECIATION (SLD)	RATEBASE	NET INCOME	ACTUAL ROR */
1	$350.00	$341.56	$200.00	$1,000.00	$141.56	14.2%
2	320.00	$313.50	200.00	800.00	113.50	14.2%
3	290.00	290.00	200.00	600.00	90.00	15.0%
4	260.00	271.00	200.00	400.00	71.00	17.8%
5	230.00	242.00	200.00	200.00	42.00	21.0%
TOTALS			1000.00		AVERAGE=	16.4%
PV=	$1,000.00	$1,000.00				

---

* ALLOWED ROR IS 15%

TABLE 4B

ROR FOR SLIGHT VARIATIONS FROM ALLOWED REGULATED CASH FLOW
(With Corrected Depreciation)
(IRR=15%)

YEAR	ALLOWED CASH FLOW	ACTUAL CASH FLOW	ECONOMIC DEPREC-IATION **/	RATEBASE	NET INCOME	ACTUAL ROR */
1	$350.00	$341.56	$191.56	$1,000.00	$150.00	15.0%
2	320.00	$313.50	192.23	808.44	121.27	15.0%
3	290.00	290.00	197.57	616.21	92.43	15.0%
4	260.00	271.00	208.20	418.64	62.80	15.0%
5	230.00	242.00	210.43	210.43	31.57	15.0%
TOTALS			1000.00		AVERAGE=	15.0%
PV=	$1,000.00	$1,000.00				

---

* ALLOWED ROR IS 15%

TABLE 5
REGULAR ANNUAL $1000 INVESTMENTS USING SLD AND LEVEL CASH FLOW

BALANCE SHEET

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
OPENING TPIS	1,000.00	2,000.00	3,000.00	4,000.00	5,000.00	5,000.00
ACC. DEP.	---	200.00	600.00	1,200.00	2,000.00	2,000.00
NET PLANT	1,000.00	1,800.00	2,400.00	2,800.00	3,000.00	3,000.00
COMMON STOCK	1,000.00	1,701.68	2,105.04	2,210.08	2,210.08	2,210.08
RETAINED EARN	---	98.32	294.96	589.92	789.92	789.92
NET WORTH	1,000.00	1,800.00	2,400.00	2,800.00	3,000.00	3,000.00

CASHFLOW STATEMENT

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
DEPRECIATION	200.00	400.00	600.00	800.00	1,000.00	1,000.00
EARNINGS	98.32	196.64	294.96	393.28	491.60	491.60
REVENUE RQMT.	298.32	596.64	894.96	1,193.28	1,491.60	1,491.60
DIVIDENDS	---	---	---	193.28	491.60	491.60
REVENUE RQMT.	298.32	596.64	894.96	1,000.00	1,000.00	1,000.00
NEW COMMON	701.68	403.36	105.04	---	---	---
CASH FLOW	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
NEW INVEST.	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
NET FLOW	---	---	---	---	---	---
R.O.R.	9.8%	10.9%	12.3%	14.0%	16.4%	16.4%

TABLE 6
REGULAR ANNUAL $1000 INVESTMENTS USING SLD AND RATEMAKING CASH FLOW

BALANCE SHEET

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
OPENING TPIS	1,000.00	2,000.00	3,000.00	4,000.00	5,000.00	5,000.00
ACC. DEP.	---	200.00	600.00	1,200.00	2,000.00	2,000.00
NET PLANT	1,000.00	1,800.00	2,400.00	2,800.00	3,000.00	3,000.00
COMMON STOCK	1,000.00	1,650.00	1,980.00	2,020.00	2,020.00	2,020.00
RETAINED EARN	---	150.00	420.00	780.00	980.00	980.00
NET WORTH	1,000.00	1,800.00	2,400.00	2,800.00	3,000.00	3,000.00

CASHFLOW STATEMENT

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
DEPRECIATION	200.00	400.00	600.00	800.00	1,000.00	1,000.00
EARNINGS	150.00	270.00	360.00	420.00	450.00	450.00
REVENUE RQMT.	350.00	670.00	960.00	1,220.00	1,450.00	1,450.00
DIVIDENDS	---	---	---	220.00	450.00	450.00
SUBTOTAL	350.00	670.00	960.00	1,000.00	1,000.00	1,000.00
NEW COMMON	650.00	330.00	40.00	---	---	---
CASH FLOW	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
NEW INVEST.	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
NET FLOW	---	---	---	---	---	---
R.O.R.	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%

TABLE 7

EARNINGS AND RETURN: REGULATED CASH FLOW WITH REGULAR ANNUAL INVESTMENTS OF $1000 and S.Y.D. a/

SINGLE ASSET RESULTS

YEAR	(1) CASH FLOW	(2) DEPREC- CIATION (SYD)	(3) BEGINNING RATE BASE	(4) ACCOUNTING NET INCOME	(5) ROR b/
0	-1000.00				
1	$483.33	$333.33	$1,000.00	$150.00	15.0%
2	366.67	266.67	666.67	100.00	15.0%
3	260.00	200.00	400.00	60.00	15.0%
4	163.33	133.33	200.00	30.00	15.0%
5	76.67	66.67	66.67	10.00	15.0%
TOTAL	1350.00	$1,000.00			
PV (15%)	1000.00			267.62	

STEADY-STATE RESULTS

VINTAGE	ROR	* RB	+ SYD	= REV. REQ.
1	0.15	1000.00	333.33	483.33
2	0.15	666.67	266.67	366.67
3	0.15	400.00	200.00	260.00
4	0.15	200.00	133.33	163.33
5	0.15	66.67	66.67	76.67
TOTAL REV.REQ. =		$2,333.33	$1,000.00	$1,350.00

---

a/. Based on 5-yr. life, no salvage, no taxes; net annual cash flow of $298.32 is paid out every year.

b/. Net Income / Rate Base

TABLE 8

EARNINGS AND RETURN: REGULATED CASH FLOW WITH REGULAR ANNUAL INVESTMENTS OF $1000 and 15% A.D. a/

SINGLE ASSET RESULTS

YEAR	(1) CASH FLOW .15*(3)+(2)	(2) DEPREC- CIATION (A.D.)	(3) BEGINNING RATE BASE	(4) ACCOUNTING NET INCOME	(5) ROR b/
0	-1000.00				
1	$298.32	$148.32	$1,000.00	$150.00	15.0%
2	298.32	170.56	851.69	127.75	15.0%
3	298.32	196.15	681.12	102.17	15.0%
4	298.31	225.57	484.98	72.75	15.0%
5	298.31	259.40	259.41	38.91	15.0%
TOTAL	1491.58	$1,000.00			
PV (15%)	1000.00			355.15	

STEADY-STATE RESULTS

VINTAGE	ROR	*	RB	+	AD	= REV. REQ.
1	0.15		1000.00		148.32	298.32
2	0.15		851.69		170.56	298.32
3	0.15		681.12		196.15	298.31
4	0.15		484.98		225.57	298.31
5	0.15		259.41		259.40	298.31
TOTAL RR=			$3,277.19		$1,000.00	$1,491.58

---

a/. Based on 5-yr. life, no salvage, no taxes; net annual cash flow of $298.32 is paid out every year.

b/. Net Income / Rate Base

TABLE 9

EARNINGS AND RETURN: REGULATED CASH FLOW WITH REGULAR ANNUAL INVESTMENTS OF $1000 and REPRESCRIBED DEPRECIATION a/

SINGLE ASSET RESULTS

YEAR	(1) CASH FLOW .15*(3)+(2)	(2) DEPREC-CIATION (REP) c/	(3) BEGINNING RATE BASE	(4) ACCOUNTING NET INCOME	(5) ROR b/
0	-1000.00				
1	$275.00	$125.00	$1,000.00	$150.00	15.0%
2	281.25	150.00	875.00	131.25	15.0%
3	298.75	190.00	725.00	108.75	15.0%
4	315.25	235.00	535.00	80.25	15.0%
5	345.00	300.00	300.00	45.00	15.0%
TOTAL	1515.25	$1,000.00			
PV (15%)	1000.00			369.44	

STEADY-STATE RESULTS

VINTAGE	ROR	*	RB	+	REP	= REV.REQ.
1	0.15		1000.00		125.00	275.00
2	0.15		875.00		150.00	281.25
3	0.15		725.00		190.00	298.75
4	0.15		535.00		235.00	315.25
5	0.15		300.00		300.00	345.00
TOTAL REV.REQ =			$3,435.00		$1,000.00	$1,515.25

---

a/. Based on 5-yr. life, no salvage, no taxes; net annual cash flow of $298.32 is paid out every year.

b/. Net Income / Rate Base

c/. 8-Year SLD Represcribed to 5-Year SLD

TABLE 10

DEPRECIATION SCHEDULES FOR REVENUE SIMULATION

	ANNUAL DEPRECIATION VALUES			
YEAR	S-Y-D	S-L-D	12% AD	REP
1	0.3333	0.2000	0.1574	0.1111
2	0.2667	0.2000	0.1763	0.1270
3	0.2000	0.2000	0.1975	0.1524
4	0.1333	0.2000	0.2211	0.2032
5	0.0667	0.2000	0.2477	0.4063
TOTALS	1.0000	1.0000	1.0000	1.0000

WORKSHEET:

1. SYD: using 5/15, 4/15, 3/15, 2/15, 1/15

2. ANNUITY DEPRECIATION:

PMT($1, 12%, 5YRS)	0.2774
LESS (12%*1)	0.1200
YEAR-1 AD	0.1574
YEAR-2 AD (YR-1 * 1.12)	0.1763
YEAR-3 AD (YR-2 * 1.12)	0.1975

3. REPRESCRIBED: 9-YR SLD TO 1-YR SLD

YEAR	RATEBASE	LIFE	(RB/LIFE)
1	1.0000	9	0.1111
2	0.8889	7	0.1270
3	0.7619	5	0.1524
4	0.6095	3	0.2032
5	0.4063	1	0.4063

TABLE 11

PRESENT VALUE OF THE REVENUE REQUIREMENTS FOR VARIOUS DEPRECIATION POLICIES

Perpetual Firm With No Growth

A. PV For the Steady-State Phase Only (Beginning Year 5)

PV4(REP) = $288.00 / .12 = $2400.00
PV4 (AD) = $277.41 / .12 = $2311.75
PV4(SLD) = $272.00 / .12 = $2266.67
PV4(SYD) = $256.00 / .12 = $2133.00

B. PV For the Entire Life of the Firm (Beginning Year 1)

PVo = PV[steady-state perpetuity] + PV[phase-in portion]*/

PVo(REP) = [$288 / .12] / 1.12^4 + PV[Years 1..4]
= $2400.00 / 1.57 + $341 = $1870

PVo(AD) = $2311.75 / 1.57 + $398 = $1870
PVo(SLD) = $2266.67 / 1.57 + $426 = $1870
PVo(SYD) = $2133.00 / 1.57 + $511 = $1870

/* Phase-in PV's are given in Exhibit 1.

TABLE 12

PRESENT VALUE OF REVENUE REQUIREMENTS AND ENDING ASSET VALUES FOR DIFFERENT DEPRECIATION SCHEDULES

(Finite-Lived Firm With No Growth)

SCHEDULE	(1) PVo[REV REQ] a/	(2) ENDING ASSET VALUES	(3) PV[ENDING VALUES] b/	(1) + (3) PV [REV.REQ + ENDING VALUE]
REP	$1,708.55	$733.37	$48.32	$1,756.87
AD	$1,714.36	$645.08	$42.50	$1,756.86
SLD	$1,717.33	$600.00	$39.53	$1,756.86
SYD	$1,726.12	$466.67	$30.75	$1,756.87

---

a/ Exhibit 1

b/ COLUMN (2) / 1.12^24

TABLE 13

PRESENT VALUE OF REVENUE REQUIREMENTS FOR DIFFERENT DEPRECIATION SCHEDULES -- THE CASE OF FIRM GROWTH

A. PV of the FINITE REVENUES ONLY

SCHEDULE	(1) STEADY-STATE PV(5-24)	(2) PHASE-IN PV(1-4)	(3) FULL RANGE PV(1-24)
REP	2577	341	1979
AD	2505	398	1990
SLD	2469	426	1995
SYD	2360	511	2011

B. PV of the CONTINUING FIRM a/

	(4) YEAR-5 RR	(5) G	(6) PV(4) = [RR(5)/(K-g)]	(7) PV(4)/1.12^4	(8) PV(0) (7)+(2)
REP	288.00	0.02923	3173	2016	$2,357
AD	277.41	0.03000	3082	1959	$2,357
SLD	272.00	0.03028	3032	1927	$2,353
SYD	256.00	0.03159	2896	1840	$2,351

---

a/. Using the Gordon Growth Model

Note: All Data Values Taken From Exhibit 2

TABLE 14

INCOME AND RETURN FOR THE Q-PROFILE USING SLD AND ED

A. STRAIGHT LINE DEPRECIATION

YEAR	ADJUSTED Q-PROFILE a/	DEPRECIATION	NET INCOME	BEGINNING YEAR RATEBASE	BEGINNING YEAR ROR
1	23.76	16.67	7.09	100.00	7.1
2	35.79	16.67	19.12	83.33	22.9
3	37.83	16.67	21.16	66.66	31.7
4	29.27	16.67	12.60	49.99	25.2
5	15.70	16.67	-0.97	33.32	-2.9
6	6.63	16.67	-10.04	16.65	-60.3

B. ECONOMIC DEPRECIATION

1	23.76	8.76	15.00	100.00	15.0
2	35.79	22.10	13.69	91.24	15.0
3	37.83	27.46	10.37	69.14	15.0
4	29.27	23.01	6.25	41.68	15.0
5	15.70	12.90	2.80	18.67	15.0
6	6.63	5.76	0.86	5.76	15.0

a/ To Yield a Present Value of $100 at a Discount Rate of 15%