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Society of Depreciation Professionals Goals and Objectives

Overall Goals

The objectives of the society shall be to recognize the professional field of depreciation and those individuals contributing to this field; to promote the professional development and professional ethics of those practitioners in the field of depreciation; to collect and exchange information about depreciation engineering and analysis; to provide a national forum of programs and publications concerning depreciation.

Activities

•Provide a forum for discussion of issues relating to depreciation policy.

•Recognize professionalism through membership and awards for service and contributions to the art of depreciation.

•Encourage papers on matters of interest to depreciation professionals.

•Sponsor regular conferences.

•Provide members with information and training that will enhance their skills as depreciation professionals.

•Sanction individually, or jointly with other organizations, educational forums on depreciation.

•Publish a regular newsletter.

•Provide electronic data sources such as bulletins boards or other electronic data services.

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JOURNAL

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Volume 5, Number 1, 1993

SUMMARY OF ABSTRACTS

Using Lives from Life Cycle Analysis in Remaining Life Rate Development

Gail E. Low, Staff Specialist-Capital Recovery, Cincinnati Bell Telephone Company

This article will discuss the type of remaining life produced when life cycle analysis is used. What is the link between life cycle analysis and vintage group and/or equal life group methods? How should the remaining life produced by life cycle analysis be used in developing depreciation rates?

Tables of Approximate Lives

Clarence Mougin, Wisconsin Public Service Commission

In line with previous submissions of mine to this publication, the following article deals with recommended ranges of service lives to be applied to railroad and utility plant. Although the article was originally published in 1922, many of the lives still seem reasonable today.

Forecasting Salvage and Cost of Removal

Bob White, Azim Houshyar, Shelly Brown, Western Michigan University

This paper describes the development of a forecasting model that can be used to assist in the forecasting of salvage or cost of removal, and in calculating the future average salvage to use in a depreciation calculation. The model uses a computer spreadsheet to analyze the effect of variables such as increases in the cost of new property, increases in the cost of removing property, and life and dispersion variability.

Changing Regulatory Requirements and Other Considerations Cause a Water Utility to Reexamine its Calculation of Depreciation Expense

F. Mark Schubert, P.E., American Water Works Service Company, Inc.

This paper will describe the effect that present and pending federal and state regulations pertaining to water treatment and water quality presently have on the calculation of depreciation expense. The importance of recognizing older treatment facilities with a potential short remaining life span and the impact on depreciation expense is discussed in significant detail through a recent example. The effect of other considerations which are causing water treatment facilities to be renovated (exclusive from regulation) and how they might increase depreciation expense is also reviewed. Finally, a discussion on cost of removal and salvage as related to structures and equipment is provided in order to properly recognize this significant contribution to increasing or decreasing depreciation expense.

Product Life Cycles: A New Approach

Ralph Bjerke and Ed Tel, Edmonton, Alberta

A new depreciation technique is developed called the mass-integrated method which is consistent with product life cycle analysis.

Certification Committee Report

Jerome C Weinert, P.E., AUS Consultants

This paper outlines a proposed certification program for the Society of Depreciation Professionals.

Power Plant Removal Costs
John S. Ferguson, Deloitte & Touche

The financial, regulatory, and political significance of the estimated high removal costs of nuclear power plants has generated considerable interest in recent years, and the political significance has resulted in the Nuclear regulatory Commission (NRC) eliminating the use of conventional depreciation accounting for the decontamination portion of the removal (decommissioning). While nuclear plant licensees are not precluded form utilizing conventional depreciation accounting for the demolition of non-radioactive structures and site restoration, state and federal utility regulators have not been favorably inclined to requests for this distinction.

The realization that steam generating units will be expensive to remove, relative to their original cost, predates the realization that nuclear units will be expensive. However, the nuclear issues have overshadowed this realization, but are unlikely to continue to do so. Numerous utilities have prepared cost estimates for steam generating units, and this presentation discusses the implications of a number of such estimates that are a matter of public record. These estimates cover nearly 400 gas, oil, coal, and lignite steam generating units, and over 100 internal combustion units. The earliest estimate was made in 1978, and for analysis purposes I have segregated the steam units between gas and oil units, and coal and lignite units, and the internal combustion units between diesel units and combustion turbine units.

A Direct Approach To Value Based Depreciation
Thomas A. Nousaine, Ronald B. Kalich, Constance Brady, Ameritech

Most sources define asset depreciation as the loss in service value or the ability of an asset to produce goods or services that fill needs in the marketplace. Loss in service value is caused by many factors including wear and tear, inadequacy or obsolescence none of which necessarily occurs at a fixed rate. Therefore, a reasonably precise depiction of loss in service value requires periodic appraisal which increases complexity and cost of administration. Analysis of market prices for used equipment shows that a simple rate schedule provides an easy to use and accurate measure of real loss in service value for assets used in the American economy today.

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1. Deadline for all abstracts is May 1, 1994.

2. All manuscripts will be reviewed by two reviewers.

3. Each manuscript should include an abstract of no more than 150 words.

4. Manuscript should be typed, double spaced, 8 1/2 x 11, wide margin.

5. Author(s) should use standard symbols and the English alphabet.

6. Footnotes should be listed at the end of the manuscript.

7. Each table should be titled at the top, each figure should be titled at the bottom, and each table and figure should be provided on a separate sheet.

8. Only references cited in the text should be listed.
   The format for references shall be:
   Author's last name, author's first name; additional author's last name, additional author's first name; title of article (in quotes), title of book/magazine (bold type or underlined), publisher, volume number and year, event at which paper was presented, city, state, month, day, year.

9. Author is requested to submit a brief biography listing credentials.

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The aims of the Journal of the Society of Depreciation Professionals are:

To serve as a forum for the exchange of information;

To illuminate through theoretical, empirical or professional analysis the effects of depreciation on public policy;

To encourage creative interdisciplinary understanding of depreciation and its impact;

To review and discuss current issues and controversies within the field of depreciation.

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The Society of Depreciation Professionals (SDP) publishes an annual Journal containing the most recent work in the field of depreciation for regulated industries.

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USING LIVES FROM LIFE CYCLE ANALYSIS IN REMAINING LIFE RATE DEVELOPMENT

Gail E. Low
Staff Specialist - Capital Recovery
Cincinnati Bell Telephone Company

ABSTRACT

This article will discuss the type of remaining life produced when life cycle analysis is used. What is the link between life cycle analysts and vintage group and/or equal life group methods? How should the remaining life produced by life cycle analysts be used in developing depreciation rates?

INTRODUCTION

Life cycle analysis is a method currently used to estimate the remaining life of a company's investments. This analysis produces a remaining life for the product category under study. After obtaining this remaining life, how should it be used in the development of a depreciation rate? Should the method vary depending upon whether the applicant is using vintage group (VG) or equal life group (GLD) methods?

This article will show that life cycle analysis produces a remaining life which is compatible with vintage group methodology. The remaining life resulting from life cycle analysis can be used directly in a VG remaining life formula. The life cycle remaining life is not compatible with equal life group methodology, and additional steps must be taken to develop an ELG remaining life.

WEIGHTING

The link (or absence of a linkage) between life cycle analysis and VG and/or ELG methods is dependent upon the weighting method used to develop the average of the component lives. We will need to look at two methods of developing an average remaining life: direct weighting[1] and accrual weighting[2]. To illustrate, let's develop the average lives associated with a purchase of 6 dollars of investment.

Graphically the direct weighted average life is the area under a plot of horizontal bars representing the various component lives, divided by the total investment.

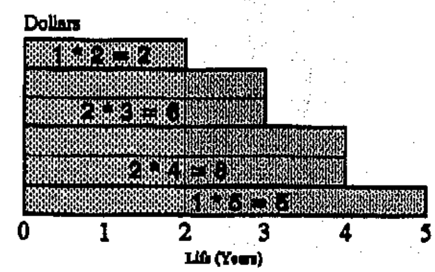

Figure 1 - Direct Weighting

At age 0, the area is ($1*2 yrs + $2*3 yrs + $2*4 yrs + $1*5 yrs) = 21, the investment is 6, and the service life is 21 / 6 = 3.5. At age 2 the area is ($2*1 yr + $2*2 yrs + $1*3 yrs) = 9, the investment is 5, and the remaining life is 9 / 5 = 1.8.

Table 1 - Development of Average Lives

Number of Dollars	Expected Service Life	Expected Rem Life (at age 2)	Dollar **times** Serv Life (at age 0)	Dollars **times** Rem Life (at age 2)	Dollars **divided** by Serv Life (accruals
1	2	0	2	—	0.500
2	3	1	6	2	0.667
2	4	2	8	4	0.500
1	5	3	5	3	0.200
6 (5 at 2 yrs)			21	9	1.867 (1.367 at 2 yrs)

Direct Weighted Average Service Life .... 21 / 6 = 3.5 years
Accrual Weighted Average Service Life: .... 6 / 187 = 3.21 years

After two years, the group with a two year life is gone. Calculation of remaining life is as follows:
Direct Weighted Average Remaining Life: (at age 2) .... 9 / 5 = 1.8 years
Accrual Weighted Average Remaining Life: (5 / 1.367) - age (2) = 1.658 years

VINTAGE GROUP

The vintage group method[3] uses the same **area** divided by the original investment, although the process may look different. In the projection life table, the VG remaining life and VG service life (remaining life at age 0) is calculated by developing the area using vertical bars which represent the dollars surviving at each age.

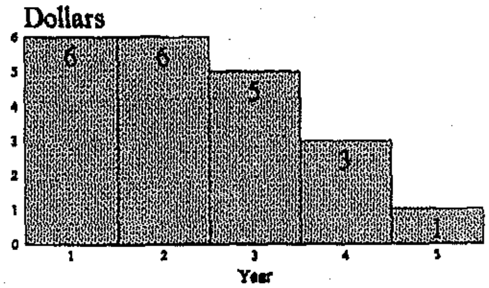

Figure 2 - Vintage Group Process

Notice that the area is still 21 ($6*1 yr + $6*1 yr + $5*1 yr + $3*1 yr + $1*1 yr). The average service life is 21 / 6 = 3.5. Also, the remaining life at age 2 is ($5*1 yr + $3*(1 yr + $1*1 yr) 5 = 1.8. As the definition for direct weighting requires, the area of each vertical bar is the product of multiplying the surviving dollars by 1 year, the width of the bar. Therefore, vintage group method is a direct weighting methodology.

EQUAL LIFE GROUP

The equal life group method is a method designed to match accruals with the consumption of "equal life" groups of investment. Remaining life is developed in a special manner that will assure proper accrual rates. In "accrual weighting," the emphasis is on accruals. To calculate the average life[4] the amount surviving is divided by the sum of the accruals for each of the equal life groups. The result of this calculation is the average service life. The remaining life is the service life less the portion of average life already consumed (the age). This accrual weighted method will produce a remaining life which, when used in the standard remaining life formula, will result in accruals that match the sum of the consumption rates of the individual "equal life" investment groups.

As shown earlier, the average service life (remaining life at age 0) for our example is 3.21 years. The remaining life at age 2 becomes 1.658 years. (The ELG average service life of the remaining $5 of investment is 3.658 years).

LIFE CYCLE ANALYSIS

Life cycle analysis is a well known alternative method of analysis used to guide and give insight to the selection of reasonable projection lives.[5] In this method, the anticipated surviving investment is developed for each future year, a sum is developed, and the sum is divided by the original investment. (Although this sum appears to be a sum of investments, the mathematical basis is that each of these investments represent the product of the investment multiplied times a year life. Therefore, the method matches the definition of direct weighting methodology). Using our same set of data, the remaining life at age zero is (6 + 6 + 5 + 3 + 1) / 6 = 21 / 6 = 3.5. The remaining life at age 2 is (5 + 3 + 1) / 5 = 9 / 5 = 1.8. Graphically, the remaining life is the area under the survivor curve divided by the surviving investment at the beginning of the study period.

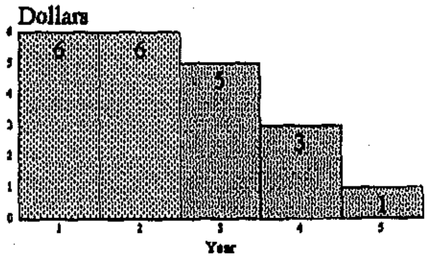

Figure 3 - Life Cycle Process

Area from age 0 is (6*1 + 6*1 + 5*1 + 3*1 + 1*1) = 21
Average life is 21 / 6 = 3.5
Area from age 2 is (5*1 + 3*1 + 1*1) = 9
Average rem life at age 1 is 9 / 5 - 1.8

CONCLUSION

It can be seen that life cycle analysis and vintage group life calculations both use direct weighting and are compatible. The remaining life developed from life cycle analysis can be used to develop a vintage group depreciation rate.

It can also be seen that life cycle analysis and equal life group methods are not directly compatible. An additional step is required to convert the direct weighted life from life cycle analysis to the accrual weighted life used in ELG methods. The process used by many local exchange carriers is as follows:

1) Using a trial and error process in a VG generation arrangement, find a projection life that produces the remaining life obtained from life cycle analysis.
2) Using an ELG generation arrangement, and the projection life found in step 1, develop an ELG remaining life.

Step 1 determines a projection life that is compatible with the life cycle direct weighted life. Step 2 performs the special accrual weighting which is designed to match depreciation accruals to consumption of the investment. Omitting this two step process effectively eliminates the benefits of ELG methods.

ACKNOWLEDGEMENT

Many thanks go to L. B. Carver, G. M. Crumling, N. F. Skinner, and V. M. DeMatteo who have provided various insights into this topic during the past five years. In addition, a thank you is extended to M. J. Buckley and D. M. Boyers for their helpful comments on the draft.

TABLES OF APPROXIMATE LIVES

ABSTRACT

In line with previous submissions of mine to this publication, the following article deals with recommended ranges of service lives to be applied to railroad and utility plant. Although the article was originally published in 1922, many of the lives still seem reasonable today.

Clarence Mougin

WISCONSIN STATE DEPARTMENT OF ENGINEERING RAILROAD AND UTILITIES DIVISION

Tables of Approximately Lives
To Be Assigned to Various Types of
Structures and Equipment
Revised June 1922

The following tables represent the experience of some years of study and investigation of the average lives of utility structures and equipment.

It should be borne in mind that these tables refer to averages.

To doubt many individual units will fall far outside the range of the figures used herein, the actual life being either less or more, but averages are of great assistance as a starting point from which the probable life of any unit under consideration may be estimated with more or less accuracy.

The depreciation of the various items depends so much upon the methods employed in their operation and upon the character of maintenance provided that it becomes extremely difficult to assign a definite life to them. It is necessary, therefore, when making use of these tables, to use the figures contained therein only as a basis from which to work. The final determination of life should be made only after giving careful consideration to the effect of local climactic conditions, character of maintenance provided, methods of operation employed, the use to which the unit has been and will be put, electrolysis, obsolescence, adequacy for the purpose for which it is intended, and any other conditions or fact which may influence the life of the unit.

When making investigations of the average age of groups of property, such, for instance, as poles, it will be found that certain units remain in service beyond the average age finally assigned. There must be found a method of rating such units and this can be done either by assigning a condition from actual inspection or by applying an arbitrary percentage. In general it has been found satisfactory to use the latter method except when great accuracy is necessary, and unless there is something to indicate that such a figure is not applicable, an arbitrary percentage of 20% will be applied to all units that have exceeded the average assigned and are yet rendering service. This is usually termed the "minimum service" condition and is independent of scrap or salvage value.

A careful distinction should be made between the "condition" of a unit for rendering service and its "condition" fro the point of view of value. For example, a meter or an air brake must be in a "service condition" of practically 100% or it is of little use, but its physical condition or some other factor may enforce its replacement within a short time.

Buildings & Structures

	Average Life In Years
Dams	
Concrete	75 - 100
Timber crib	40 - 60
Power Stations	
Frame	20 - 40
Brick	35 - 50
Fireproof	60 - 100
Substation	
Frame	20 - 40
Brick	40 - 70
Fireproof	60 - 100
Factories	
Frame	20 - 40
Brick	35 - 50
Fireproof	60 - 100
Office Buildings	
Frame	30 - 50
Brick	50 - 75
Fireproof	75 - 100
Dwellings	
Frame, ordinary type	30 - 50
Brick	40 - 75
Fireproof	100 - up
Sheds	
Frame	10 - 15
Stables	
Frame	15 - 20

Electric & Telephone Distribution

	Years Range	Years Average
Cable		
Aerial, lead covered, and messenger	15 - 20	20
Underground, lead covered	20 - 35	25
Submarine	20 - 40	35
Central Station Equipment (Telephone)		
Including distributing frame, power plant and wire		
Automatic type	15 - 25	20
Central energy type	15 - 25	20
Magnetic type	15 - 25	20
Conduits and Manholes		
Clay conduits enclosed in concrete	50 - 100	75
Brick or concrete manholes	50 - 100	75
Cross Arms		
Pine (Telephone)	10 - 15	12
Pine (Electric)	12 - 18	15
Fir (Telephone)	15 - 20	18
Fir or oak (Electric)	15 - 22	18
Guys and Pole Anchors		
Same as poles to which attached		
Lamps		
Arc lamps and mast arms	12 - 20	15
Arc lamps span equipment	12 - 20	15
Lightning Arresters and Fuse Boxes	8 - 15	12
Poles		
Cedar in earth, smaller than 12" butt	10 - 20	15
Cedar in earth, 12" or larger butt	15 - 28	20
Cedar in concrete	20 - 40	30
Cedar treated	20 - 35	25

Iron in concrete, tubular	30 - 50	40
Iron in concrete, lattice	30 - 40	35
Steel towers, galvanized, fabricated (incl. foundation)	30 - 50	40
Private Branch Exchanges (Telephone)	15 - 25	20
Subscribers Sets (Telephone)	15 - 25	20
Service Transformers	15 - 25	20
Service Wattmeters	15 - 25	20
Wire		
Bare copper (#6 and larger)	40 - 60-	50
Bare copper (smaller than #6)	30 - 50	40
Aluminum, steel coil	40 - 60	50
Copper clad steel	40 - 60	50
W.P. copper insulated	15 - 20	15
Iron in cities (Telephone)	10 - 15	12
Iron rural & toll (Telephone)	12 - 20	15
Iron W.P. (Telephone)	15 - 20	15

Gas Utilities

	Life	Average
Ammonia concentrators	15 - 20	35
Ammonia storage tanks wrought iron or steel	25 - 50	35
Benches	15 - 35	25
Centrifugal blowers (Waste gases)	5 - 10	8
(Air	25 - 50	40
Exhausters	25 - 50	40
Gas holders	35 - 75	50
Governors		
District	40 - 50	45
Service	40 - 50	45
Mains		
Cast iron mains, including specials		100
Black wrought iron & steel, including fittings	20 - 40	30
Meters - consumers	25 - 35	30
Purifiers		
Modern	40 - 60	50
Old style, according to size and condition	20 - 40	30
Retort house floors, depending on construction	20 - 30	25
Services		
Wrought iron and steel - black	15 - 35	25
Wrought iron and steel - galvanized	20 - 40	30
Scrubbers and condensers	30	
Station meter cases		
Cast iron	50 - 100	75
Steel	40 - 60	50
Station meter drums	25 - 50	40
Tar and ammonia wells	35 - 75	50
Tar extractors - P and A	30 - 50	40
Washers, cast iron	30 - 50	40
Water gas machines, complete	30 - 40	35

Machinery foundations are given the same life as the machines they support.

Water Distribution System

	Life		
	Minimum	Maximum	Average
Filters			
Slow sand or gravity			100
Mechanical pressure	30	50	40
Mechanical gravity	20	30	25
Wooden	20	30	25
Concrete			100
Hydrants	50	100	75
Mains			
Cast iron mains - including specials			100 up
Large riveted and lock bar steel mains	30	50	40
Small wrought iron or steel mains - black	20	40	30
Small wrought iron or steel mains - galvanized	30	50	40
Manholes - distribution system, same life as pipe on which located			
Meters	20	30	25
Meter boxes - wooden	10	20	15
vitrified or iron	25	45	35
Reservoirs			
Earth embankment			100 up
Stone masonry	50	100	75
Reinforced concrete			100 up
Services			
Lead			100 up
Galvanized	30	50	40
Wrought iron or steel	20	40	30
Standpipes and steel tanks on steel towers	35	75	50
Tanks			
Wooden, on wooden towers	15	25	20
Wooden, on steel towers	30	50	40
Pressure tanks buried	25	50	40
Valves	50	100	75
Wells			
Driven or drilled	50	100	75
Large open, stone or brick walled	50	100	75

Power Plant Equipment
Electric

	Life		
	Minimum	Maximum	Average
Generators and Motors (including motor generators, rotary converters and frequency changers)			
Alternating current	20	30	25
Direct current	20	30	25
Lightning arresters (Station type)			
Multigap	10	15	12
Electrolytic	15	25	20
Oxide film	15	25	20
Storage batteries (Life determined wholly by inspection)			
Switchboard and Equipment (including cable, conduit and wire) (Same as generators to which attached)			
Transformers (Station)			
Constant current arc transformers	15	25	20
Feeder regulators and compensators	15	25	20
Transformers without moving parts	20	30	25

Steam

Boilers			
Fire tube	15	30	20
Water tube	20	30	25
Coal conveyors	10	15	12
Condensers			
Surface	20	30	25
Jet	25	35	30
Engines - reciprocating steam			
High speed	15	25	20
Low speed	20	30	25
Gas or oil	15	20	18
Diesel motor	15	25	20
Producer gas	15	20	18
Feed water heaters	20	25	22

Leather belting - The condition per cent of leather balting is arrived at almost entirely by inspection. Twenty years is taken as the life of belting for the purpose of figuring the average life of the plant.

Piping - steam - The condition per cent of piping is arrived at by getting the dollar per cents of all the principal units in the plant that are piped and then finding the average condition per cent of the units, which per cent is taken as the condition per cent of the piping. Twenty years is taken as the life of steam piping for the purpose of figuring the average life of the plant.

Pipe Covering - steam			
Life same as steam piping			
Pumps			
Centrifugal and rotary	15	25	20
Geared power	20	30	25
Steam - direct acting	20	30	25
crank and flywheel	25	40	30
Shafting, pulley, etc.	20	25	22
Turbines			
Steam	20	30	25
Water (built before 1900)	20	30	25
Water (built after 1900)	30	50	40

FORECASTING SALVAGE AND COST OF REMOVAL

Bob White
Azim Houshyar
Shelly Brown
Western Michigan University

ABSTRACT

Salvage and cost of removal are important components in the calculation of book depreciation rules for both regulated and non-regulated companies. Historically, the approach used to recognize salvage and cost of removal in the capital recovery process has been to adjust the depreciation rate to include the estimated net salvage in the annual accrual. This is typically accomplished by using some form of the equation (1-Net Salvage)/Life. As long as salvage ratios are near zero, the effect on the annual accrual is minimal. The assumption of zero or near zero net salvage is commonly made, and as a result, little attention has been given to the estimation of salvage values, and even less attention is given to the problem of including cost of removal in the calculation of depreciation accruals.

Many regulated utilities are now experiencing salvage ratios materially different from those obtained in the past. A growing concern for many companies is the increase in the cost of removing plant from service. This increase is being driven by many causes including technological obsolescence, societal pressures for property restoration, and increases in labor costs. Increases in the cost of removal require increases in depreciation accrual rates, which result in increases in the cost of service to the customer.

Developing an overall average salvage rate to use in the depreciation calculation requires an historical analysis of past salvage, and a forecast of future salvage. In regulated utility accounts, the future salvage is typically the most important component in the salvage calculation because most accounts will retire more property in the future than has been retired to date. The dollar weighting of the salvage with retirements will then place more emphasis on the future retirements than past retirements. This makes it important to develop the best possible estimate of future salvage or cost of removal.

This paper describes the development of a forecasting model that can be used to assist in the forecasting of salvage or cost of removal, and in calculating the future average salvage to use in a depreciation calculation. The model uses a computer spreadsheet to analyze the effect of variables such as increases in the cost of new property, increases in the cost of removing property, and life and dispersion variability.

LITERATURE REVIEW

Determination of net salvage to use for depreciation purposes has been discussed as early as 1943 in the NARUC publication(1). Gonzalez(2), Epperlein(3), and Faust(4) later presented papers on how to determine salvage and cost of removal for depreciation purposes. Knight(5) presented an approach for accounting for salvage. Hempstead(6) presented a paper at a Negative Net Salvage Seminar that discussed ways to appropriately handle negative net salvage in the depreciation system. White(7) published a paper outlining the effect of salvage on depreciation. Chan and Cheng(8) addressed the issue of negative salvage and nuclear power plant decommissioning. Koester and Anderson(9) discussed accounting options for plant removal costs. White and Welke(10) published a paper that discussed how various accounting options for negative salvage can affect revenue requirements.

This previous work has focused on analyzing salvage for depreciation purposes, and the correct methodology to use to calculate depreciation accruals. Little has been published to date on specifically how to develop future salvage and cost of removal values that consider various inflation rates, and life and dispersion characteristics. This paper will present a conceptual model that can be used to assist in the forecasting of gross salvage and cost of removal. The model will be presented for various assumptions regarding growth rates, and property life and dispersion patterns.

FORECASTING SALVAGE

Calculation of the depreciation accrual requires inclusion of net salvage in the accrual equation. The salvage estimate required depends on the depreciation system used. The so called whole life system, requires a salvage estimate that weights past and future salvage by retirements. The remaining life system requires only an estimate of future salvage. The equal life group (ELG) grouping method requires salvage for each age interval for future retirements. Salvage estimates for the past and future must be dollar weighted by the retirements for each period to give the correct salvage value to use in the accrual equation. As an illustration, consider the example shown in Table 1.

Table 1. Salvage estimates.....

Year	Retirements	Net Salvage	Salvage
1	$ 200	10 %	$ 20
2	300	15	45
3	100	25	25
4	400	5	20
Total	$1000		$110

If this is a new account, the salvage estimates represent the expected future salvage when the property will be retired. The future average salvage is then $110/$1000 = 11%. After one year, the future average salvage will be the sum of the future salvage dollars divided by the sum of the future retirements. This is $90/$800 = 11.25%. This illustrates that at any point in this account's life, the future and past average salvage percents are changing depending on the age of the account. This also illustrates that calculation of past average salvage is simple if past retirements and past salvage dollars are known. The past average salvage is simply the quotient of the two. However, calculation of future average salvage requires the calculation of future retirements and future salvage. The salvage percents are then weighted with the appropriate retirement dollars to give the future average salvage in percent.

Future retirements can be estimated if the life and dispersion characteristics of the account are available. A known dispersion pattern such as an Iowa type survivor curve can be used to forecast future retirements. Future salvage values can be obtained by applying an assumed growth rate in gross salvage and or cost of removal. This growth rate can be applied to future retirements to determine the future salvage dollars by age, which can then be weighted by retirement dollars to give the future average salvage percent. This same approach can be used when multi-vintage accounts are under study. A simple four vintage numerical example will illustrate the concept. Assume that Table 2 represents a plant installed in 1989-1992.

Installation Year	Units Installed	Dollars Installed
1989	1000	$1000
1990	1000	1030
1991	1000	1061
1992	1000	1093

Table 2. Cost of installation....

These data assume that the account has no physical growth, but the cost of replacement units is increasing by 3% per year. Assume that the retirement ratios ($ retired / $ exposed) are .10, .278, .692, and 1.0 at ages 1-4 respectively. This results in the retirement matrix shown in Table 3.

		Retirement Matrix						
Installation		Dollar Retirements During Calendar Year						
Year	$ Installed	1989	1990	1991	1992	1993	1994	1995
1989	$1000	100	250	450	200			
1990	1030		103	258	464	206		
1991	1061			106	265	477	212	
1992	1093				109	273	492	219
Totals	$4184	100	353	814	1038	956	704	219

Table 3. An example of the retirement matrix.

Assume that cost of removal (COR) in 1989 is 20% of current retirements, and is expected to grow by 5% per year. The resulting COR matrix is shown in Table 4.

		COR Matrix						
		COR % During Calendar Year						
Calendar		20%	21%	22.1%	23.2%	24.3%	25.5%	26.8%
Year	Retired	1989	1990	1991	1992	1993	1994	1995
1989	$100	$20	$53	$99	$46			
1990	353		21	55	104	49		
1991	814			22	58	109	51	
1992	1038				23	61	115	54
Annual Totals		$20	74	176	231	219	166	54
Totals								940

Table 4. The COR Matrix.

It is important to note that the dollar COR for any vintage in any calendar year is obtained by multiplying the unit cost of removal times the number of units removed. As a result, in this example the COR percentage in any calendar year is not constant across the vintages retired in that year. For example, in 1992, the COR expressed as percentages for the four vintages are: 1989 is $46/$200 = 23.0%; 1990 is $104/$464 = 22.4%; 1991 is $58/$265 = 21.9% and 1992 is $23/$109 = 22.1%.

When the property is installed in 1989, all salvage (COR) is future salvage. The dollar weighted future salvage rate is the total future COR ($940) divided by the total future retirements ($4184), which is 22.47%. At any point in the account's life, the past and future salvage ratios will change, but the overall average salvage ratio will remain constant. As an example, assume it is now the end of 1990. Past retirements are $100 + $353 = $453, and past COR is $94. The past average salvage ratio is $94/$453 = 20.75%. Future retirements are $3731 and future COR is $846. The future average COR ratio is $846/$3731 = 22.67%.The overall average salvage ratio remains constant at ($94+$846) / ($453+$3731) = 22.47%. The overall average salvage ratio will not change as long as past and future COR occur as predicted.

MODEL DEVELOPMENT

A mathematical model has been developed that can be used to calculate the future salvage or cost of removal for property. The model assumes that once specified, the cost per unit growth rate, the rate of physical growth or decline of the property, and the rate of growth in cost of removal are constant over time (the future).

The model consists of two parts, a retirements matrix and a cost of removal matrix (both in dollars). Part of each of these matrices is used to compute future salvage ratios (FSR). The future average salvage ratio is calculated by using:

FSR = (Future Cost of Removal) / (Future Retirements)

The model was developed to include up to seven variables. They are: cost of removal ratio, cost of removal growth rate, cost per unit growth rate, starting number of units, growth or decline in number of units installed each year, type of survivor curve, and maximum life of the account which is a function of the average service life and the dispersion pattern. These variables are defined as:

F = initial cost of removal ratio
X = annual cost of removal growth rate
Y = annual cost per unit growth rate
V = initial number of units in the account
Z = annual growth/decline in number of units
C = annual retirements obtained from a survivor curve
ML = maximum life of the property currently in service

The cost of property installed is calculated using a starting price and then increasing the cost per unit by a fixed cost per unit growth rate Y. For instance, for the first through third years, the purchase price would be calculated using the following equations: (in this model, the price in year one is $1)

Year 1 Price * $(1+Y)^0$ First Year
Year 1 Price * $(1+Y)^1$ Second Year
Year 1 Price * $(1+Y)^2$ Third Year

The model allows cost of removal to increase year by year. The increase in cost of removal is a function of increases in wages, equipment, and supplies required for removal of property. The starting COR is given by F, which is a percentage of the purchase price of a unit of property installed today. The COR percent is allowed to grow the rate X, and the COR percent in any subsequent year is given by:

$F_1 = F * (1+X)^0$ First Year
$F_2 = F * (1+X)^1$ Second Year
$F_3 = F * (1+X)^2$ Third Year

The model has been constructed to allow the number of units installed to vary from year to year. In some accounts, the number of units installed may be growing as in the case of towers for cellular telephones. In other accounts, a reduction in demand may lead to a reduction in the number of units installed in future years. When the need for any type of property is relatively stable, the number of units installed may be constant for a period of time. The growth or decline in units is calculated in a manner similar to the growth or decline in the cost per unit. Defining V as the number of units installed in the first year of the account, and Z as the annual rate of growth or decline, the number of units installed in any subsequent year is given by:

$V_1 = V * (1+Z)^0$ First Year
$V_2 = V * (1+Z)^1$ Second Year
$V_3 = V * (1+Z)^2$ Third Year

Retirement characteristics can be represented by an Iowa or other type of survivor curve. The percent retired year by year is represented by the variable C. The subscripts for C go from 1 for the first year to ML for the maximum life of the vintage. The sum of all the retirements is 100%. The actual value of C is determined by the type of survivor curve used and the average service life of the property.

C_1 = First Year Retirements
C_2 = Second Year Retirements
•
•
C_{ML} = Final Year Retirements

The future salvage ratio is calculated by adding the future COR values for the property in service as of 1992 and dividing by the future retirements matrix. Figure One shows the retirement matrix and Figure Two shows the matrix for cost of removal.

Number of Units	Year	0	1	2	3	•	•	•	N-1	N
$V*(1+Z)^0*(1+Y)^0$	0	$C_1*V_1*I_1$	$C_2*V_1*I_1$	$C_3*V_1*I_1$	•	•	$C_{ML}*V_1*I_1$			
$V*(1+Z)^1*(1+Y)^1$	1		$C_1*V_2*I_2$	$C_2*V_2*I_2$	$C_3*V_2*I_2$	•	•	$C_{ML}*V_2*I_2$		
$V*(1+Z)^2*(1+Y)^2$	2			$C_1*V_3*I_3$	$C_2*V_3*I_3$	$C_3*V_3*I_3$	•	•	$C_{ML}*V_3*I_3$	
•	•				•	•	•	•	•	$C_{ML}*V_4*I_4$
•	•					•	•	•	•	•
•	•						•	•	•	•
$V*(1+Z)^{N-2}*(1+Y)^{N-2}$	N-2							$C_1*V_{N-1}*I_{N-1}$	$C_2*V_{N-1}*I_{N-1}$	$C_3*V_{N-1}*I_{N-1}$
$V*(1+Z)^{N-1}*(1+Y)^{N-1}$	N-1								$C_1*V_N*I_N$	$C_2*V_N*I_N$
$V*(1+Z)^N*(1+Y)^N$	N									$C_1*V_N*I_N$

Figure 1: Retirements Matrix

Number of Units	Year	$F*(1+x)^0$ 0	$F*(1+x)^1$ 1	$F*(1+x)^2$ 2	$F*(1+x)^3$ 3	•	•	•	$F*(1+x)^{N-1}$ N-1	$F*(1+x)^N$ N
$V*(1+Z)^0$	0	$C_1*V_1*F_1$	$C_2*V_1*F_2$	$C_3*V_1*F_3$	•	•	$C_{ML}*V_1*F_{ML}$			
$V*(1+Z)^1$	1		$C_1*V_2*F_2$	$C_2*V_2*F_3$	$C_3*V_2*F_4$	•	•	$C_{ML}*V_2*F_{ML+1}$		
$V*(1+Z)^2$	2			$C_1*V_3*F_3$	$C_2*V_3*F_4$	$C_3*V_3*F_5$	•	•	$C_{ML}*V_3*F_{ML+2}$	
•	•				•	•	•	•	•	$C_{ML}*V_4*F_{ML+3}$
•	•					•	•	•	•	•
•	•						•	•	•	•
$V*(1+Z)^{N-2}$	N-2							$C_1*V_{N-1}*F_{N-1}$	$C_2*V_{N-1}*F_N$	•
$V*(1+Z)^{N-1}$	N-1								$C_1*V_N*F_N$	$C_2*V_N*F_{N+1}$
$V*(1+Z)^N$	N									$C_1*V_N*F_N$

Figure 2: Cost of Removal Matrix

A general equation giving the sum of retirement dollars is given by: (assuming i represents the horizontal index and j the vertical index)

$$\textit{Total Cost of Retirements} = \sum_{j=1}^{N}\sum_{i=1}^{ML} C_i V_j I_j \qquad \textit{Equation (1)}$$

$$\textit{Substituting:} \quad V_j = V(1+Z)^{j-1} \quad I_j = (1+Y)^{j-1}$$

$$\textit{Yields: Total Cost of Retirements} = \sum_{j=1}^{N}\sum_{i=1}^{ML} C_i V(1+Z)^{j-1}(1+Y)^{j-1}$$

A general equation giving the sum of cost of removal dollars is given by:

$$\textit{Total Cost of Removal} = \sum_{j=1}^{N}\sum_{i=1}^{ML} C_i V_j F_{i+j-1} \qquad \textit{Equation (2)}$$

$$\textit{Substituting:} \quad V_j = V(1+Z)^{j-1} \quad F_{i+j-1} = F(1+X)^{i+j-2}$$

$$\textit{Yields: Total Cost of Removal} = \sum_{j=1}^{N}\sum_{i=1}^{ML} C_i V(1+Z)^{j-1}F(1+X)^{i+j-2}$$

The cost of removal ratio for the account is then obtained by the ratio of cost of removal dollars divided by retirement dollars. Equation three gives the result.

$$\textit{Cost of Removal Ratio} = \frac{\sum_{j=1}^{N}\sum_{i=1}^{ML} C_i V(1+Z)^{j-1}F(1+X)^{i+j-2}}{\sum_{j=1}^{N}\sum_{i=1}^{ML} C_i V(1+Z)^{j-1}(1+Y)^{j-1}} \qquad \textit{Equation (3)}$$

These equations allow any portion of the matrices to be analyzed. If we are interested in only a portion of the matrix, say at time t, then i≥t and j≤t are the only parts in the summation. A general equation for retirements which allows a flexible time scale is given by:

$$\textit{Future Cost of Retirements} = \sum_{j=1}^{t}\sum_{i=t+1-j}^{ML} C_i V_j I_j \qquad \textit{Equation (4)}$$

$$\textit{Substituting:} \quad V_j = V(1+Z)^{j-1} \quad I_j = (1+Y)^{j-1}$$

$$\textit{Yields: Future Cost of Retirements} = \sum_{j=1}^{t}\sum_{i=t+1-j}^{ML} C_i V(1+Z)^{j-1}(1+Y)^{j-1}$$

A general equation for cost of removal which allows a flexible time scale is given by:

$$\textit{Future Cost of Removal} = \sum_{j=1}^{t}\sum_{i=t+1-j}^{ML} C_i V_j F_{i+j-1} \qquad \textit{Equation (5)}$$

$$\textit{Substituting:} \quad V_j = V(1+Z)^{j-1} \quad F_{i+j-1} = F(1+X)^{i+j-2}$$

$$\textit{Yields: Future Cost of Removal} = \sum_{j=1}^{t}\sum_{i=t+1-j}^{ML} C_i V(1+Z)^{j-1}F(1+X)^{i+j-2}$$

The future cost of removal ratio for the account is then obtained by the ratio of future cost of removal dollars divided by future retirement dollars. Equation six gives the result.

$$\textit{Cost of Removal Ratio} = \frac{\sum_{j=1}^{t}\sum_{i=t+1-j}^{ML} C_i V(1+Z)^{j-1}F(1+X)^{i+j-2}}{\sum_{j=1}^{t}\sum_{i=t+1-j}^{ML} C_i V(1+Z)^{j-1}(1+Y)^{j-1}} \qquad \textit{Equation (6)}$$

NUMERICAL EXAMPLES

A numerical example of the model is as follows: Assume the values of the variables to be:

F = 0.20	Initial Cost of Removal Fraction
X = 0.05	Annual Cost of Removal Growth Rate
Y = 0.03	Annual Cost per Unit Growth Rate
Z = 0.00	Annual Growth/Decline in Number of Units
ML = 4	Maximum Life

C_1 = 10%	First Year Retirements
C_2 = 25	Second Year Retirements
C_3 = 45	Third Year Retirements
C_4 = 20	Fourth Year Retirements

The retirements and COR matrices that result from these data are shown in Figures three and four. For this example, property installed from 1989-1992 will be used. These figures are in the triangle in figure 3 and 4 below.

$ Property Installed	Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1000	1989	100.00	250.00	450.00	200.00										
1030	1990		103.00	257.50	463.50	206.00									
1061	1991			106.09	265.23	477.41	212.18								
1093	1992				109.27	273.18	491.73	218.55							
1126	1993					112.55	281.38	506.48	255.10						
1159	1994						115.93	289.82	521.67	231.85					
1194	1995							119.41	298.51	537.32	238.81				
1230	1996								122.99	307.47	553.44	245.97			
1267	1997									126.68	316.69	570.05	253.35		
1305	1998										130.48	326.29	587.15	260.95	
1344	1999											134.39	335.98	604.76	268.76
Annual Totals		100.00	353.00	813.59	1038.00	1069.14	1101.22	1134.26	1168.27	1203.32	1239.42	1276.60	1176.48	865.71	268.76
TOTAL															12,807.79

Figure 3. Retirement Matrix

Number of Units	COR / Year	-0.200 / 1989	-0.210 / 1990	-0.221 / 1991	-0.232 / 1992	-0.243 / 1993	-0.255 / 1994	-0.268 / 1995	-0.281 / 1996	-0.295 / 1997	-0.310 / 1998	-0.326 / 1999	-0.342 / 2000	-0.359 / 2001	-0.377 / 2002
1000	1989	-20.00	-52.50	-99.23	-46.31										
1000	1990		-21.00	-55.13	-104.19	-48.62									
1000	1991			-22.05	-57.88	-109.40	-51.05								
1000	1992				-23.15	-60.78	-114.87	-53.60							
1000	1993					-24.31	-63.81	-120.61	-56.28						
1000	1994						-25.53	-67.00	-126.64	-59.10					
1000	1995							-26.80	-70.36	-132.97	-62.05				
1000	1996								-28.14	-73.87	-139.62	-65.16			
1000	1997									-77.57	-146.60	-146.60	-68.41		
1000	1998										-31.03	-81.44	-153.95	-71.83	
1000	1999											-32.58	-85.52	-161.63	-75.43
Annual Totals		-20.00	-73.50	-176.40	-231.53	-243.10	-255.26	-268.02	-281.42	-295.49	-310.27	-325.78	-307.86	-233.46	-75.43
TOTAL															-3097.51

Figure 4. Cost of Removal Matrix

Using the above values in the model gives a future average salvage (COR) ratio of negative 22.9%. This means that the future cost of removal of property currently in service is equal to 22.9% of the original cost of that property. This value will change as the account ages, even if all the variables remain constant. If a study was done in 1994, based upon plant balances at 12/31/93, the future average salvage ratio for property in service as of that date would be 738.49 / 3094.69 = 23.9%.

If the cost per unit growth rate, the rate of growth or decline in units, and the cost of removal growth rate are all zero, the FSR will always be equal to its original value. When the cost per unit growth rate is greater than zero and the cost of removal growth rate is zero, the COR ratio will be less than its starting point for all values of unit growth rates. This is shown for some sample values for this example in Table 5.

Cost per Unit Growth Rate	Rate of Growth in Units (%) 0.0	1.0	2.0	3.0	4.0	5.0	10.0
0.0 %	20.00	20.00	20.00	20.00	20.00	20.00	20.00
1.0	19.61	19.61	19.61	19.60	19.60	19.60	19.59
2.0	19.23	19.22	19.22	19.22	19.21	19.21	19.20
3.0	18.85	18.85	18.85	18.84	18.84	18.83	18.81
4.0	18.49	18.49	18.48	18.47	18.47	18.46	18.43
5.0	18.14	18.13	18.12	18.11	18.11	18.10	18.07
10.0	16.49	16.48	16.46	16.45	16.44	16.43	16.37

Table 5. COR Ratios when COR Growth Rate = 0.0%

Cost per Unit Growth Rate	Rate of Growth in Units (%) 0.0	1.0	2.0	3.0	4.0	5.0	10.0
0.0	24.36	24.36	24.37	24.38	24.38	24.39	24.42
1.0	23.88	23.89	23.89	23.89	23.90	23.90	23.93
2.0	23.42	23.42	23.42	23.42	23.43	23.43	23.44
3.0	22.96	22.96	22.96	22.96	22.97	22.97	22.97
4.0	22.52	22.52	22.52	22.52	22.52	22.52	22.51
5.0	22.09	22.09	22.08	22.08	22.08	22.07	22.06
10.0	20.09	20.07	20.06	20.05	20.04	20.03	19.98

Table 6. COR Ratios when COR Growth Rate - 5.0%

This model has three variables that are changing by rates; the cost per unit growth rate, the growth in units rate, and the growth in cost of removal rate. Tables 5 and 6 have presented sample values of the COR ratio when one of these variables is held constant, namely the COR growth rate. Allowing all three variables to change simultaneously results in a multi dimensional surface. Plotting COR ratio as a function of two variables results in a three dimensional surface and is presented in Figure 5.

Table 2 and Figure 5 show that the calculated COR ratios are sensitive to the increase in the cost per unit and the COR growth rate, and somewhat insensitive to the unit growth rate. If the unit growth rate has little impact, the model becomes a function of two variables, and results can be plotted in two dimensions. Figure 6 shows the sensitivity of the COR ratios for this example as a function of the COR growth rate. Each line on the graph represents COR ratios for a different assumed increase in the cost per unit (inflation).

EXTENSIONS TO LARGE EXAMPLES

The small numerical example analyzed above showed that the COR ratios are relatively insensitive to changes in the unit growth rate. To determine if this insensitivity would carry over to larger accounts following different survivor patterns, the model was used to study COR ratios for several Iowa Curve type dispersion patterns with average service lives ranging from 10 to 20 years. Since the actual value of the future COR ratio is a function of where in time the account is analyzed, each curve type was analyzed at the point where the account had reached stability (i.e. where additions equal retirements if there is no growth).

In general it was found that the increase in the cost per unit (inflation rate) and the increase in the COR growth rate were the two variables with the greatest impact, and the rate of growth in units of the account has a small impact. As an example, consider an R5 Iowa curve with an average service life of 20 years and an initial COR ratio of -20%. For an inflation rate of 0%, a unit growth of 0%, and a COR growth rate of 5%, the resulting future COR ratio is -129%. Changing the unit growth rate from 0% to 5% increases the future COR ratio to -140%, or an 8.5% increase. However, making the same change in the inflation rate, from 0% to 5% (keeping the unit growth rate at 0%) decreases the future COR ratio to -54%, or a 59% decline. Similar results were obtained for other Iowa curve types and average service lives. Partial results of this research are presented in the appendix.

SUMMARY

Salvage plays an important part in the calculation of the depreciation accrual rate for public utilities. Traditionally, calculation of the salvage ratio to include in the accrual equation has not received as much attention as the life analysis portion. Increasing values of the salvage ratio, particularly negative values, has focused greater attention on the calculation of salvage and cost of removal ratios. This paper has presented a conceptual framework that can be used to calculate future average salvage ratios. The methodology presented works equally well for positive and negative salvage ratios. The model developed in this paper allows for several variables, and presents general equations that can be used to calculate the overall average future salvage ratio as a function of those variables.

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APPENDIX

Cost of Removal Ratio Tables

R5 Iowa Curve - 20 Year Average Service Life - Cost of Removal Growth Rate of 5% Per Year

Cost Per Unit Growth Rate	Rate of Growth in Units (%)										
(%)	0	1	2	3	4	5	6	7	8	9	10
0	-128.7	-131.0	-133.2	-135.5	-137.6	-139.8	-141.8	-143.9	-145.8	-147.7	-149.5
1	-108.6	-110.1	-111.6	-113.0	-114.4	-115.8	-117.1	-118.4	-119.7	-120.9	-122.0
2	-91.5	-92.4	-93.3	-94.2	-95.0	-95.8	-96.6	-97.4	-98.1	-98.8	-99.5
3	-76.9	-77.4	-77.8	-78.3	-78.7	-79.1	-79.5	-79.9	-80.3	-80.7	-81.0
4	-64.5	-64.7	-64.8	-65.0	-65.1	-65.3	-65.4	-65.6	-65.7	-65.8	-66.0
5	-54.0	-54.0	-53.9	-53.9	-53.8	-53.8	-53.8	-53.7	-53.7	-53.7	-53.7
6	-45.2	-45.0	-44.8	-44.6	-44.5	-44.3	-44.2	-44.0	-43.9	-43.8	-43.7
7	-37.7	-37.4	-37.2	-36.9	-36.7	-36.4	-36.2	-36.0	-35.9	-35.7	-35.5
8	-31.5	-31.1	-30.8	-30.5	-30.2	-30.0	-29.7	-29.5	-29.3	-29.1	-28.9
9	-26.2	-25.8	-25.5	-25.2	-24.9	-24.6	-24.4	-24.1	-23.9	-23.7	-23.5
10	-21.8	-21.4	-21.1	-20.8	-20.5	-20.2	-20.0	-19.7	-19.5	-19.3	-19.1

R5 Iowa Curve - 20 Year Average Service Life - Cost of Removal Growth Rate of 0% Per Year

Cost Per Unit Growth Rate	Rate of Growth in Units (%)										
(%)	0	1	2	3	4	5	6	7	8	9	10
0	-20.00	-20.00	-20.00	-20.00	-20.00	-20.00	-20.00	-20.00	-20.00	-20.00	-20.00
1	-16.88	-16.82	-16.75	-16.69	-16.63	-16.57	-16.52	-16.46	-16.41	-16.36	-16.32
2	-14.22	-14.11	-14.00	-13.90	-13.80	-13.71	-13.62	-13.53	-13.45	-13.38	-13.30
3	-11.95	-11.82	-11.69	-11.56	-11.44	-11.33	-11.22	-11.11	-11.02	-10.92	-10.84
4	-10.03	-9.88	-9.73	-9.60	-9.47	-9.34	-9.23	-9.12	-9.01	-8.91	-8.82
5	-8.40	-8.24	-8.10	-7.96	-7.82	-7.70	-7.58	-7.47	-7.37	-7.27	-7.18
6	-7.02	-6.87	-6.72	-6.59	-6.46	-6.34	-6.23	-6.12	-6.02	-5.93	-5.84
7	-5.86	-5.72	-5.58	-5.45	-5.33	-5.22	-5.11	-5.01	-4.92	-4.83	-4.75
8	-4.89	-4.75	-4.62	-4.50	-4.39	-4.29	-4.19	-4.10	-4.02	-3.94	-3.87
9	-4.07	-3.95	-3.83	-3.72	-3.62	-3.52	-3.44	-3.35	-3.28	-3.21	-3.14
10	-3.39	-3.27	-3.17	-3.07	-2.98	-2.89	-2.82	-2.74	-2.68	-2.62	-2.56

A-1

R1 Iowa Curve - 20 Year Average Service Life - Cost of Removal Growth Rate of 5% Per Year

Cost Per Unit Growth Rate (%)	Rate of Growth in Units (%) 0	1	2	3	4	5	6	7	8	9	10
0	-278.3	-284.3	-290.1	-295.6	-300.8	-305.8	-310.5	-315.0	-319.2	-323.1	-326.8
1	-210.0	-213.1	-216.0	-218.8	-221.4	-223.9	-226.3	-228.5	-230.5	-232.5	-234.3
2	-157.9	-159.1	-160.3	-161.5	-162.6	-163.6	-164.6	-165.5	-166.4	-167.2	-168.0
3	-118.3	-118.5	-118.7	-118.9	-119.2	-119.4	-119.6	-119.8	-120.0	-120.2	-120.4
4	-88.3	-88.0	-87.7	-87.4	-87.2	-87.0	-86.8	-86.7	-86.6	-86.4	-86.3
5	-65.8	-65.2	-64.6	-64.2	-63.7	-63.4	-63.0	-62.7	-62.4	-62.2	-61.9
6	-48.9	-48.2	-47.6	-47.0	-46.6	-46.1	-45.7	-45.4	-45.0	-44.7	-44.5
7	-36.3	-35.6	-35.0	-34.5	-34.0	-33.6	-33.2	-32.8	-32.5	-32.2	-32.0
8	-26.9	-26.3	-25.7	-25.2	-24.8	-24.4	-24.1	-23.8	-23.5	-23.2	-23.0
9	-19.9	-19.4	-18.9	-18.5	-18.1	-17.8	-17.5	-17.2	-17.0	-16.8	-16.6
10	-14.7	-14.3	-13.9	-13.5	-13.2	-13.0	-12.7	-12.5	-12.3	-12.1	-11.9

R1 Iowa Curve - 20 Year Average Service Life - Cost of Removal Growth Rate of 0% Per Year

Cost Per Unit Growth Rate (%)	Rate of Growth in Units (%) 0	1	2	3	4	5	6	7	8	9	10
0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0
1	-15.1	-15.0	-14.9	-14.8	-14.7	-14.6	-14.6	-14.5	-14.4	-14.4	-14.3
2	-11.3	-11.2	-11.1	-10.9	-10.8	-10.7	-10.6	-10.5	-10.4	-10.3	-10.3
3	-8.5	-8.3	-8.2	-8.0	-7.9	-7.8	-7.7	-7.6	-7.5	-7.4	-7.4
4	-6.3	-6.2	-6.0	-5.9	-5.8	-5.7	-5.6	-5.5	-5.4	-5.4	-5.3
5	-4.7	-4.6	-4.5	-4.3	-4.2	-4.1	-4.1	-4.0	-3.9	-3.8	-3.8
6	-3.5	-3.4	-3.3	-3.2	-3.1	-3.0	-2.9	-2.9	-2.8	-2.8	-2.7
7	-2.6	-2.5	-2.4	-2.3	-2.3	-2.2	-2.1	-2.1	-2.0	-2.0	-2.0
8	-1.9	-1.8	-1.8	-1.7	-1.6	-1.6	-1.6	-1.5	-1.5	-1.4	-1.4
9	-1.4	-1.4	-1.3	-1.3	-1.2	-1.2	-1.1	-1.1	-1.1	-1.0	-1.0
10	-1.1	-1.0	-1.0	-0.9	-0.9	-0.8	-0.8	-0.8	-0.8	-0.7	-0.7

A-2

L5 Iowa Curve - 20 Year Average Service Life - Cost of Removal Growth Rate of 5% Per Year

Cost Per Unit Growth Rate (%)	Rate of Growth in Units (%) 0	1	2	3	4	5	6	7	8	9	10
0	-221.7	-225.6	-229.5	-233.3	-237.0	-240.7	-244.2	-247.7	-251.0	-254.3	-257.4
1	-167.9	-170.1	-172.4	-174.6	-176.7	-178.8	-180.8	-182.8	-184.6	-186.4	-188.2
2	-126.9	-128.1	-129.3	-130.5	-131.6	-132.7	-133.8	-134.8	-135.8	-136.7	-137.6
3	-95.9	-96.4	-97.0	-97.5	-98.0	-98.5	-98.9	-99.4	-99.9	-100.3	-100.7
4	-72.4	-72.5	-72.6	-72.8	-72.9	-73.0	-73.2	-73.3	-73.4	-73.6	-73.7
5	-54.5	-54.5	-54.4	-54.3	-54.2	-54.2	-54.1	-54.1	-54.0	-54.0	-54.0
6	-41.1	-40.9	-40.7	-40.5	-40.3	-40.2	-40.0	-39.9	-39.8	-39.7	-39.6
7	-30.9	-30.7	-30.4	-30.2	-30.0	-29.8	-29.6	-29.5	-29.3	-29.2	-29.0
8	-23.3	-23.0	-22.8	-22.5	-22.3	-22.1	-21.9	-21.8	-21.6	-21.5	-21.3
9	-17.5	-17.3	-17.0	-16.8	-16.6	-16.4	-16.2	-16.1	-15.9	-15.8	-15.7
10	-13.2	-13.0	-12.7	-12.6	-12.4	-12.2	-12.0	-11.9	-11.8	-11.6	-11.5

L5 Iowa Curve - 20 Year Average Service Life - Cost of Removal Growth Rate of 0% Per Year

Cost Per Unit Growth Rate (%)	Rate of Growth in Units (%) 0	1	2	3	4	5	6	7	8	9	10
0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0
1	-15.1	-15.1	-15.0	-15.0	-14.9	-14.9	-14.8	-14.8	-14.7	-14.7	-14.6
2	-11.5	-11.4	-11.3	-11.2	-11.1	-11.0	-11.0	-10.9	-10.8	-10.8	-10.7
3	-8.6	-8.5	-8.4	-8.4	-8.3	-8.2	-8.1	-8.0	-8.0	-7.9	-7.8
4	-6.5	-6.4	-6.3	-6.2	-6.2	-6.1	-6.0	-5.9	-5.9	-5.8	-5.7
5	-4.9	-4.8	-4.7	-4.7	-4.6	-4.5	-4.4	-4.4	-4.3	-4.2	-4.2
6	-3.7	-3.6	-3.5	-3.5	-3.4	-3.3	-3.3	-3.2	-3.2	-3.1	-3.1
7	-2.8	-2.7	-2.7	-2.6	-2.5	-2.5	-2.4	-2.4	-2.3	-2.3	-2.3
8	-2.1	-2.0	-2.0	-1.9	-1.9	-1.8	-1.8	-1.8	-1.7	-1.7	-1.7
9	-1.6	-1.5	-1.5	-1.4	-1.4	-1.4	-1.3	-1.3	-1.3	-1.2	-1.2
10	-1.2	-1.1	-1.1	-1.1	-1.0	-1.0	-1.0	-1.0	-0.9	-0.9	-0.9

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Cost of Removal Ratio Tables

L1 Iowa Curve - 20 Year Average Service Life - Cost of Removal Growth Rate of 5% Per Year

Cost Per Unit Growth Rate (%)	Rate of Growth in Units (%) 0	1	2	3	4	5	6	7	8	9	10
0	-907.6	-926.3	-944.0	-960.6	-976.2	-990.8	-1004.5	-1017.3	-1029.2	-1040.4	-1050.9
1	-547.1	-553.7	-559.9	-565.8	-571.4	-576.6	-581.5	-586.2	-590.5	-594.6	-598.5
2	-328.7	-330.1	-331.5	-332.9	-334.2	-335.6	-336.9	-338.1	-339.3	-340.4	-341.6
3	-197.0	-196.5	-196.0	-195.7	-195.5	-195.4	-195.3	-195.3	-195.3	-195.3	-195.4
4	-117.8	-116.8	-115.9	-115.1	-114.4	-113.9	-113.4	-113.0	-112.6	-112.3	-112.0
5	-70.4	-69.4	-68.5	-67.7	-67.0	-66.4	-65.9	-65.5	-65.1	-64.7	-64.4
6	-42.0	-41.2	-40.5	-39.9	-39.3	-38.8	-38.4	-38.0	-37.7	-37.4	-37.2
7	-25.1	-24.5	-24.0	-23.5	-23.1	-22.7	-22.4	-22.2	-21.9	-21.7	-21.5
8	-15.0	-14.6	-14.2	-13.9	-13.6	-13.3	-13.1	-12.9	-12.8	-12.6	-12.5
9	-9.0	-8.7	-8.4	-8.2	-8.0	-7.9	-7.7	-7.6	-7.5	-7.4	-7.3
10	-5.4	-5.2	-5.0	-4.9	-4.7	-4.6	-4.5	-4.4	-4.4	-4.3	-4.2

L1 Iowa Curve - 20 Year Average Service Life - Cost of Removal Growth Rate of 0% Per Year

Cost Per Unit Growth Rate (%)	Rate of Growth in Units (%) 0	1	2	3	4	5	6	7	8	9	10
0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0
1	-12.1	-12.0	-11.9	-11.8	-11.7	-11.6	-11.6	-11.5	-11.5	-11.4	-11.4
2	-7.2	-7.1	-7.0	-6.9	-6.8	-6.8	-6.7	-6.6	-6.6	-6.5	-6.5
3	-4.3	-4.2	-4.2	-4.1	-4.0	-3.9	-3.9	-3.8	-3.8	-3.8	-3.7
4	-2.6	-2.5	-2.5	-2.4	-2.3	-2.3	-2.3	-2.2	-2.2	-2.2	-2.1
5	-1.6	-1.5	-1.5	-1.4	-1.4	-1.3	-1.3	-1.3	-1.3	-1.2	-1.2
6	-0.9	-0.9	-0.9	-0.8	-0.8	-0.8	-0.8	-0.7	-0.7	-0.7	-0.7
7	-0.6	-0.5	-0.5	-0.5	-0.5	-0.5	-0.4	-0.4	-0.4	-0.4	-0.4
8	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2
9	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1
10	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1

A-4

CHANGING REGULATORY REQUIREMENTS AND OTHER CONSIDERATIONS CAUSE A WATER UTILITY TO REEXAMINE ITS CALCULATION OF DEPRECIATION EXPENSE

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ABSTRACT

This paper will describe the effect that present and pending federal and state regulations pertaining to water treatment and water quality presently have on the calculation of depreciation expense. The importance of recognizing older treatment facilities with a potential short remaining life span and the impact of depreciation expense is discussed in significant detail through a recent example. The effect of other considerations which are causing water treatment facilities to be renovated (exclusive from regulation) and how they might increase depreciation expense is also reviewed. Finally, a discussion on cost of removal and salvage as related to structures and equipment is provided in order to properly recognize this significant contribution to increasing or decreasing depreciation expense.

INTRODUCTION

The water supply industry has always required a very high level of reliability. Water systems must consistently produce and deliver a high quality product on demand, 24 hours a day, seven days a week, 365 days a year. The American Water System, which is made up of 21 subsidiary operating water companies, provides service to 1.7 million customers in 640 communities in 21 states.

The Iowa-American Water Company is one such subsidiary and comprised of service areas located in the Davenport (Quad-Cities) area and the Clinton area in the state of Iowa. The plant facility being discussed in this paper is located in the Davenport service area and is identified as the East River Treatment Plant. This plant obtains its supply fro the Mississippi River and is nominally rated at a production capacity of 30 million gallons per day (MGD). This plant was originally constructed in the 1890s.

The Water Company underwent an extensive review of its facilities and operations in a Comprehensive Planning Study conducted in 1986. This study recommended improvements, where appropriate, in production facilities and the distribution network. This paper will describe the constructed improvements to the existing East River Treatment Plant and the corresponding relationship with and effect on depreciation accrual rates.

EAST RIVER TREATMENT PLANT

EXISTING FACILITIES

The existing plant is located on the west shore of the Mississippi River in Davenport, Iowa. The facilities include an intake structure; raw water pumping station; flocculation[1] and sedimentation basins; settled water pumping station; gravity filters; finished water pumping station; and associated chemical storage and feed systems. The plant is nominally rated at 30 MGD based on a filtration rate of 3 gallons per minute per square foot of filter area.

The original intake structure consists of two intakes located in the flood wall adjacent to the plant. A third intake extends approximately 400 feet into the river. During certain months of the year, icing was fairly common with the two intakes located in the flood wall. Four raw water pumps transferred the raw water to the pretreatment facilities. The pumps located in the basement of the plant were installed either in 1961 or were of earlier vintage and susceptible to flooding.

The pretreatment facilities consist of two conventional flocculation and sedimentation[2] basins. Chemicals are applied at two separate locations prior to the entrance of the basins. No mixing facilities were available. The sedimentation basins are equipped with circular sludge collectors. Icing on the surface of the uncovered basins was also fairly common during winter months.

After sedimentation, the water passes to a common forebay from which it is pumped to the filters by means of four transfer pumps. There are 20 gravity filters and each contains a media of granular activated carbon (GAC). All filters were equipped with mechanical rate of flow controllers and pneumatic loss of head gauges.

Finished water is stored in a 600,000 gallon clearwell which, at nominal plant capacity, provides about 30 minutes detention time for chemical disinfection prior to delivery into the distribution system by the distributive pumps. Water from backwashing and solids removed from the sedimentation basins are currently being discharged to an Army Corps of Engineers interceptor sewer which in turn discharges downstream of the plant into the Mississippi River.

PROPOSED IMPROVEMENTS

The proposed improvements to the East River Treatment Plant included intake modifications; a new raw water pump station with mechanical screens; new solids contact clarifiers (called Superpulsators[3]); modifications to the existing filters; modifications and additions to the chemical systems; modifications to existing distributive pumping equipment; a new distributed control system (DCS); modification to the electrical feed and distribution system at the plant; and the installation of new generators for stand-by power. The brief description above describes a complete rehabilitation and renovation at this facility. The various improvements and related components are described in further detail for each major portion of the plant to be replaced, renovated or rebuilt in the appendix at the end of this paper.

The following discussion elaborates on the numerous factors and forces which the industry is subject to an ongoing basis. No doubt the reader will agree these factors have a direct impact on depreciation accrual rates and expense.

RELIABILITY CONSIDERATIONS

The major construction program for the East River Treatment Plant was driven by the need to improve the reliability and quality of water service and to assure compliance with governmental water quality regulations. A Comprehensive Planning Study conducted in 1986 evaluated the water supply system and identified the improvements necessary to ensure a reliable water supply system throughout a specified future planning period. The study analyzed the existing treatment plant to ensure an appropriate level of reliability. Consideration was also given to the new drinking water regulations being proposed by the U.S. Environmental Protection Agency (USEPA) and the 1986 Safe Drinking Water Act amendments.

These evaluations documented the investigation into constructing a separate plant and the significantly greater cost of that approach as compared to the approach of improving the existing plant to make it reliable. Consequently, the selection approach was to construct some new facilities at the East River Treatment Plant, replace existing equipment, modify existing facilities, as required, to ensure adequate water treatment processes are available for any water quality condition in the Mississippi River and construct pumping and electrical facilities to meet maximum day demands of the Davenport service area. It should also be stated that all of the East River Treatment Plant improvements were implemented to improve reliability and efficiency of operations.

The reliability of the raw water supply has been improved by the construction of the new raw water pump station which replaced the existing raw water pumps. The raw water pumps were old, relatively inaccessible and below the flood elevation.

The new raw water pump station, which was completed and placed in operation in January 1991, now has four pumps located above both the 100-year flood level[4] and the 1993 flood level. As a result, an adequate supply of water can be pumped with one pump out of service. The new raw water pump station was designed with mechanical screens to remove fish, debris and the icing events which historically have plagued the treatment plant during certain times of the year.

Although the East River Treatment Plant met all water quality standards, the existing flocculation-sedimentation basins were not capable of adequately treating all water quality conditions in the Mississippi River at certain times. The plant improvements program provided adequate pretreatment chemical mixing, improved the hydraulic characteristics of the existing basins by replacing part of the sedimentation basin capacity with Superpulsators (which eliminated the need to pump settled water to the filters for 50 percent of the plant flow), guaranteed adequate plant capacity with one basin out of service and removed the freezing potential in the settled water forebay. The Superpulsators and properly rated sedimentation basins with improved chemical mixing now are able to treat any water quality condition in the Mississippi River at any time.

The filtration process was improved by modifying the filter boxes, installing a sand media beneath the granular activated carbon media (for improved particle removal), installing an air wash system for backwashing, and replacing the associated filter control valves, rate controllers, loss-of-head gauges and control consoles.

Distributive pumping was improved by adding one pump to ensure reliable pumping capacity to meet maximum day demands with one pumping unit out of service for each pressure gradient. Electrical facilities were made more reliable by replacing certain switchgear and relocating the switchgear to an area above the 100-year flood level. Medium voltage motors were rewound for 4160 volts, a standard voltage, to replace the outdated 2300 volt windings and improve overall safety. Transformers were replaced to eliminate overloading conditions and potential PCB[5] contamination problems. Standby power facilities were installed at the raw water pump station and the main pump building to ensure a reliable water supply during any power disruption of the electric utility's supply to the East River Treatment Plant.

A discussion on reliability considerations other than those associated with plant equipment should include water quality and the on-going evolution of drinking water regulations. Changes in USEPA's drinking water regulations were anticipated, and provisions were included in the design of the improvements to the East River Treatment Plant to ensure adequate finished water quality and the ability to meet the new drinking water regulations. The primary concern was the capability to meet the new turbidity standard of 0.5 NTU[6] in 95 percent of filter water samples. The chemical mixers, Superpulsators, filter modifications and much of the plant instrumentation were designed to achieve the appropriate filter effluent turbidity levels. Filter-to-waste valves and piping were installed to control the filtered water turbidity after backwashing as required by the new drinking water regulations. The Superpulsators process can be used to remove synthetic organic chemicals from the Mississippi River by adding powdered activated carbon which is retain in the Superpulsator's sludge budget, a capability not available with the existing flocculation-sedimentation basins. Water quality monitors and chemical feed pacing systems were installed to fine-tune the chemical treatment process on a continuous basis. For example, a potassium permanganate[7] residual analyzer will ensure adequate oxidation of the raw water allowing intermediate chlorination which in turn helps control the formation of THMs[8]. The layout of the new facilities allows future construction of a larger clearwell.

The improvements to the instrumentation and controls included detailed design investigations which revealed numerous requirements for replacement and addition of instrumentation and control associated with the new and existing facilities and regulation requiring increased monitoring requirements. For example, the majority of the control equipment is associated with the filters. This included replacing rate-of-flow controllers, loss-of-head equipment and filter operating and backwash controls. All of this equipment is essential to properly operate a filter. The instrumentation and control equipment also includes online water quality monitors for turbidity, pH, potassium permanganate and coagulation control. These components assist in optimizing the water quality produced by the treatment process and result in more efficient use of chemicals.

All of the components provided in this project were necessary to maintain a safe, reliable and quality water service for the Davenport service area of Iowa-American. As described earlier, alternate approaches to the project were investigated during the project development, and the design effort and project scope were carefully managed and scrutinized throughout the project. The technical quality of the project is excellent. State-of-the-art treatment processes and control equipment were used to provide a cost-effective project which meets regulatory requirements, improves the plant operation and provides flexibility for future expansion and regulations.

DEPRECIATION STUDY

As part of the general rate case filed in October, 1990, with the Iowa Utilities Board, the Water Company commissioned a new depreciation study of the property and plant of the Water Company. The study considered the impact of the major construction program at the East River Treatment Plant in the development of new proposed depreciation rates. It was determined the regulatory review of the rate case would be completed subsequent to completion of construction activities at the plant. Therefore, the study focused on key components of the treatment plant and associated facilities, including the fact these facilities were approaching the limits of their useful lives; and that water quality standards were becoming more stringent because of improved technical ability to detect contaminants and because of increased health effects awareness. The study included the total recognition of the $19 million cost of this project.

The depreciation study, prepared for the Water Company by John Russell Associates, Inc., recommended a change in the method of calculating depreciation rates. Historically, depreciation rates for the Water Company have been calculated by the average service life or whole life method. The study, however, recommended the use of the remaining life method of calculating depreciation expense. The major reason presented to the Iowa Utilities Board was that it is a more effective and timely method of capital recovery than the average service life method. The use of the remaining life method usually eliminates the need for any special amortization of costs to supplement annual depreciation expense. The Iowa Utilities Board concurred in its decision account of those additions and retirements related to the construction project is provided in Table 1.

Table 1
Iowa-American Water Company - Davenport
Summary of East River Treatment Plant
Construction Costs

Account	Additions	Retirements*
321 - Pumping Structures	$ 2,246,000	$ 26,000
325 - Electric Pumping Equipment	$ 2,072,000	$ 509,000
331 - Treatment Structures	$ 4,828,000	$ 45,000
332 - Water Treatment Equipment	$ 9,815,000	$ 508,000
Total	$18,961,000	$1,088,000

*Represent the original installed cost of those items being retired.

Source: Iowa-American Water Company,
Report on Depreciation Rates, Table 5-4, Page 1 of 1.

DEPRECIATION RESERVE

The depreciation reserve balances for Accounts 321, 325, 331 and 332 at December 31, 1989, were approximately $376,000, $5632,000, $116,000 and $673,000 respectively. The continued used of the whole life methodology for calculating depreciation expense has resulted in these values being below expected levels. The depreciation reserve deficiencies vary by account. A comparison of Account 321 is fairly close to the estimated theoretical reserve value; however, Accounts 325, 331 and 332 were estimated to be from 20 to 30 percent deficient prior to the depreciation study. The use of the remaining life methodology will correct this reserve deficiency over the period of years the proposed depreciation accrual rates are in effect.

A comparison of these values to approximate utility pant balances for these accounts (prior to the new construction) are as follows:O Account 321 - $481,000; Account 325 - $1,723,000; Account 331 - $342,000; and Account 332 - $1,727,000.

AVERAGE SERVICE LIVES

Table 1 clearly shows the major difference in the original installation costs of the majority of the facilities replaced or renovated at the East River Treatment Plant. Based on the earlier discussion related to reliability and water quality standards, it was appropriate to adjust average service lives for all plant accounts, especially the accounts shown in Table 1 (321, 325, 331 and 332). These accounts were segregated to reflect the existing structures remaining in service and the new facilities recently placed in service. A composite rate for these accounts was developed to reflect this separation.

For Account 321, the buildings housed the pumps in both service areas consist of older structures that once contained steam pumping equipment. The simulated plant study indicated an average service life of 75 years could be assigned to this account based on past retirements. However, because of the additional experience of retirements associated with the project, a 40 year average service life was recommended to reflect this situation.

For Account 325, the present depreciation accrual rates reflect a 40 year average service life. However, due to the high number of pumping equipment motors which will be rewound to a higher voltage versus outright replacement, an average service life of 30 years was recommended for this account. It was anticipated that a certain level of investment will continue into the future to reflect this ongoing work.

For Account 331, an average service life of 40 years was recommended to reflect the experience of retirements occurring as a result of the construction program at the East River Treatment Plant.

For Account 332, an average service life of 35 years was recommended to reflect the retirement of certain existing equipment and to recognize the new equipment which was installed. Table 2 illustrates the average service lives, the remaining lives, net salvage factors and the overall composite rate for these accounts just described.

Table 2
Iowa-American Water Company
Summary of Average Service Lifes, Remaining Lives, Net Salvage Factors and Accrual Rates

Account	Average Service Life (Years)	Remaining Life (Years)	Net Salvage Factor	Depreciation Accrual Rates
321-Existing	40	20.9	-15%	1.81%
321-New	40	39.5	-15%	2.88%
Total Composite			-15%	2.65%
325-Existing	30	16.0	-10%	5.30%
325-New	30	29.5	-10%	3.66%
Total Composite			-10%	4.43%
331-Existing	40	23.8	-5%	3.02%
331-New	40	39.5	-5%	2.63%
Total Composite			-5%	2.65%
332-Existing	35	16.5	-10%	5.12%
332-New	35	34.5	-10%	3.15%
Total Composite			-10%	3.41%

Source: Iowa-American Water Company, Report on Depreciation Rates, Table 5-1, Page 1 of 2.

In its Final Decision and Order, the Iowa Utilities Board approved the use of these average service lives, net salvage factors and the utilization of the remaining life methodology of calculating depreciation expenses. There was opposition to this change in methodology versus the whole life method from the Consumer Advocate in Iowa; however, the Iowa Utilities Board recognized "the remaining life method is more flexible than the average service life (whole life) method." Estimates are necessary when developing initial accrual rates. The Utilities Board believes these estimates are subject to change over time as conditions change or more knowledge is gained regarding the retirement characteristics of the various plant accounts.

NET SALVAGE FACTORS

In the remaining life method, past net salvage is incorporated into the calculation of depreciation accruals through the use of the book reserve into which past salvage has been credited and against which past cost of removal has been debited. Ideally, future salvage should be estimated by trending past salvage data through the period representing the remaining life of the plant presently in service. During the course of the salvage analysis conducted for the Water Company, it became apparent the cost of removal for certain items of plant being retired was much higher than any likely salvage value. As a result, the subtraction of the cost of removal from any salvage amount was a negative value and the subsequent calculation resulted in a negative net salvage factor. The negative net salverage factor percentage appeared in all the accounts related to the construction project at the East River Treatment Plant.

There are a number of reasons why cost of removal has been so high in recent history. These reasons include, and are not limited to: increasing labor costs, inflation, low market prices for certain salvageable items and the cost of materials and equipment used in the retirement process. Examples of significant cost of removal expenditures include health/safety concerns to the public (i.e., the removal, handling and disposal of asbestos cement pipe), or environmental regulations (i.e., modifying water treatment plant structures and equipment to ensure a better overall water quality).

The review of the historical salvage data indicates that with the very low original cost of the various plant items being retired, a negative net salvage factor will continue to result in the future when further studies are conducted. Therefore, the salvage factors utilized in the calculation of depreciation accruals for the different accounts were judged as the best estimate of the future trend in net salvage. Table 2 shows the net salvage factors selected and approved by the Iowa Utilities Board for Accounts 321, 325, 331, and 332.

SUMMARY

The total annual increase in depreciation for Accounts 321, 325, 331 and 332 in the Davenport service area of the Water Company over present rates was approximately $283,000. Table 3 provides a summary of the present and proposed depreciation rates and expense for the Davenport portion of Iowa-American Water Company.

Table 3
Iowa-American Water Company - Davenport
Summary of Present and Proposed Depreciation Rates and Expense

Account	Utility Plant Balance` @6/30/90	Present Rates Accrual Rate	Present Rates Expense Rate	Proposed Rates Accrual Amount	Proposed Rates Expense	Difference
321	$2,701,658	1.92%	$51,872	2.65%	$71,667	$19,795
325	3,284,864	2.50%	82,122	4.43%	145,559	63,437
331	5,124,571	1.33%	68,157	2.65%	135,992	67,835
332	11,034,349	2.22%	244,963	3.41%	376,505	131,643

Source: Iowa-American Water Company, Report on Depreciation Rates, Table 5-2, Page 1 of 2.

In summary, all components provided in the project were necessary to provide reliable and quality water service to current rate payers. Although the project is prudently designed to accommodate future expansion, none of the facilities which were constructed provide solely for future use or were constructed to provide additional capacity above the current level of demands. Furthermore, all rate payers, both current and future, benefit from the design of a plant which will permit future expansion at the lowest possible cost. The cost for total replacement of the plant was estimated to be 70 percent greater than the rehabilitation project at the East River Treatment Plant.

Finally, with today's changing environment, the need to conduct periodic depreciation studies is extremely important. Conditions are constantly changing. Water utility managers are under continuous pressure to optimize operations, both in providing service to customers and in maintaining the financial integrity of the enterprise. Depreciation rate adequacy is one important factor in maintaining economic viability and financial integrity. Periodic updating is necessary to maintain a continuous surveillance on actual service life and salvage experience, especially when significant changes are occurring to various utility plant accounts. The results of new studies must be compared with the existing capital recovery rates to determine whether further adjustments are necessary. The final result of this ongoing process is that the customer receives the ultimate benefit, due to the improved service and reliability of the water system.

ACKNOWLEDGEMENTS

The author expresses his gratitude to the invaluable assistance and guidance provided by Thomas G. McKitrick, Director — Rate Studies, American Water Works Service Company, Inc., and John S. Young, Jr., Vice President — Engineering, American Water Works Service Company, Inc., in the preparation of this paper.

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F. MARK SCHUBERT
BIOGRAPHICAL SKETCH

Mr. Schubert is presently the Assistant Director — Rate Studies of American Water works Service Company, Inc., headquartered in Voorhees, New Jersey. He is responsible for developing and preparing reports and studies in the areas of cost-of-service, depreciation and rate design for the regional operating water companies of American Water Works Company. Prior to accepting his current position, Mr.Schubert was a Senior Planning Engineer in the System Engineering Department, responsible for preparing comprehensive planning studies for these same water companies.

He has a Bachelor of Science Degree in Civil and Environmental Engineering from Clarkson University and a Master of Science Degree in Civil Engineering from Northeastern University. Mr. Schubert is a registered professional engineer in three states and a member of ASCE, AWWA and the Society of Depreciation Professionals.

APPENDIX
DETAIL DESCRIPTION OF IMPROVEMENTS TO EAST RIVER TREATMENT PLANT IOWA-AMERICAN WATER COMPANY

A. Raw Water and Intake Arrangement

Raw Water	Mississippi River
Existing Intake	Concrete intake structure built into sea wall containing one upper and two lower intakes.
Proposed	Modification to the intake arrangement was performed under separate contract included: 1. Add two new motorized sluice gates[A1] to intake wall openings. 2. Construct new chamber with third sluice gate to permit routing of flow from the 30-inch main and upper intake to the proposed Raw Water Pump Station. 3. Modify "Emergency" Chamber to permit routing of flow from the lower intake wall opening to the proposed Raw Water Pump Station. Permanent power and control for Intake Structure equipment was installed.

B. Raw Water Pump Station

Existing	The low service pump station directs the raw water to the existing flocculation/sedimentation basins. Existing equipment includes:
Pump No. 13	Capacity of 12.1 MGD.
Pump No. 15	Capacity of 18.0 MGD.
Pump No. 21	Capacity of 15.0 MGD.
Pump No. 26	Capacity of 6.1 MGD. The existing Raw Water pumping facilities will be removed and the flow redirected to the proposed Raw Water Pump Station.
Proposed	Two 36-inch raw water mains from the new and modified intake chambers will direct flow through the new mechanical screens to the dual wetwells in the new Raw Water Pump Station.

1. Raw Water Pumping

Raw Water Pumps	Three variable speed, vertical turbine pumps rated at 5-15 MGD.
Pump No. 1 (Wet Well No. 1)	Distributes flow to the proposed Superpulsator clarifiers.
Pump No. 2 (Wet Well No. 1)	Distributes flow to either the proposed Superpulsator clarifier or the existing flocculation/sedimentation basins. Serves as standby unit for raw water pumps Nos. 1 and 3.
Pump No. 3 (Wet Well No. 3)	Distributes flow to the existing flocculation/sedimentation basins.
Pump No. 4 (Wet Well No. 2)	Space is provided for future addition.
Firm Pump Capacity	30 MGD.

2. Emergency Power Engine generator will provide standby service for a 15 MGD production rate.

C. Flocculation/Sedimentation Basins

Existing	Two existing flocculation and sedimentation basins are presently in service rated at 30 MGD total.
Proposed	No change in basins. Reduce the normal production for maximum day conditions to 15 MGD to improve process performance. Add static mixer for the introduction of chemical coagulant.
Mixer	Located in 36 inch raw water line for the flocculation/sedimentation basins.
Number of Elements	4
Flocculation Basin Flow Control	Modify existing 24-inch flow at

Flocculation Basin No. 2. Add 24-inch motor operated butterfly valve to control flow to Flocculation Basin No. 2.

D. **Solids Contact Clarifiers**
Proposed
1. Pretreatment — Space provided along side the Raw Water Pump Station for the future addition of lamella plate settling basins[A2] for grit removal, if required.
2. Mixing/Detention Chambers — Two chambers in series are provided for chemical application and mixing.
3. Clarifiers
Number and Size — Two solid contact (Superpulsator) clarifiers.
Description — A high rate upflow solids contact clarifier that continually pulses the suspended solids blanket. Raw water is chemically treated and then mixed with previously flocculated solids in the sludge blanket. The pulsing action optimizes unit performance.
Design Capacity — 7.5 MGD/unit, 15 MGD total, ultimate high rated design capacity of 20 MGD.

E. **Settled Water Pump Station**
Existing — The Settled Water Pump Station pumps settled water from Sedimentation Basins 1 & 2 to the existing filters.
Settled Water Pumps
Pump No. 8 — Vertical turbine pump rated at 6 MGD.
Pump No. 14 — Vertical turbine pump rated at 12 MGD.
Pump No. 22 — Vertical turbine pump rated at 15 MGD.
Pump No. 23 — Vertical turbine pump rated at 15 MGD.
Firm Capacity — 33 MGD.
Proposed — No change in pump station operation. New engine generator to provide standby service for the largest pumping unit. The Settled Water Forebay will be covered to minimize freezing in the Forebay. It should be noted the outflow from the Superpulsators bypasses this pump station.

F. **Filters**
Existing — The filters are located within two filter buildings.
Number and Type — (20) single media, gravity filters; 10 filters per building.
Media — Gravel and granular activated carbon (GAC).
Gravel — 12 inch depth.
Proposed — Modify existing filters.
1. Media — Replace existing gravel and GAC media.
Gravel — 8 inch depth.
Sand — 6 inch depth.
Granular Activated Carbon (GAC) — 33 inch depth.
2. Filter Effluent Controllers — Replace existing mechanical controllers with electric motor operated rate controllers.
3. Troughs — Replace and raise existing steel troughs.
4. Filter-to-Waste Capabilities — Install appropriate piping to meet appropriate regulations.
5. Valves — Furnish or replace valves.
6. Miscellaneous Equipment — Add or replace as necessary with the appropriate equipment.

G. **Main and High Service Pumps**
Existing
1. High Service Gradient
Pump No. 11 — Pump rated at 4 MGD.
Pumps No. 19&20 — Pumps each rated at 5 MGD.
Pump No. 25 — Pump rated at 7 MGD.
2. Main Service Gradient
Pump No. 12 — Pump rated 4 MGD.
Pump No. 16 — Pump rated 5 MGD.
Pump No. 17 — Pump rated 5.8 MGD.
Pump No. 18 — Pump rated 7.2 MGD.
Proposed
1. High Service Gradient
Pump No. 11 — To be replaced by water company. Existing 480 V motor to be reused. New constant speed centrifugal pump rated 3 MGD installed.
Pumps No. 19, 20, and 25 — To be rehabilitated with existing motors rewound for 4160V service.
Pump No. 27 — New constant speed centrifugal pump rated at 4 MGD installed.
2. Main Service Gradient
Pump No. 12 — No change.
Pump No. 16 — Replace motor.
Pumps No. 17&18 — To be rehabilitated with existing motors rewound for 4160V service.
3. Emergency Power — Engine generator to provide standby power for (2), 480V High Service Gradient pumps and (2), 480V Main Service Gradient pumps for a standby capacity of approximately 17 MGD.

H. **Chemical Treatment** The following chemical systems will be available:

Chemical	**Use**
(3) Potassium Permanganate	Taste & odor control, oxiding agent
(1)(2) Alum/Ferric\ Chloride	Coagulant
(2) Caustic (Post)	pH adjustment
(2) Lime (Pre)	pH & alkalinity adjustment
(3) Chlorine (Pre & Intermediate)	Control biological growth, oxiding agent
Chlorine (Post)	Disinfection
Ammonia	Control THM formation
Fluoride	Dental health
Zinc Orthophosphate	Corrosion inhibitor
(3) PAC	Taste and odor control
(2) Polymer	Coagulant aid
(3) Polymer	Filter aid
(2) Polymer	Solids Blanket

(1) Presently being used for the existing treatment process. Alternate coagulant ferric chloride use was also considered.
(2) New System.
(3) Modifying existing controls or application point.

A new pretreatment chemical area will be provided at the Superpulsator for feeding coagulant (alum or ferric chloride), coagulant aid polymer, solids blanket polymer, filter aid polymer and acid (future if required). A pre lime area will be furnished adjacent to the Superpulsators. A new caustic area will be furnished adjacent to the Pump House. The balance of the chemical systems will remain at their present location.

I. Electrical Improvements

Existing Electrical Distribution	Main incoming service from 2 13.8 KV lines are fed via transformers located north of the pump room divided into uninterconnected systems.
Proposed Electrical Distribution	The electrical distribution system for the modified plant will be replaced by two (2) systems.

J. Control, Metering and Instrumentation

In general, the plant process and production will be controlled automatically by a Distributed Control System (DCS) with backup manual controls. Field instruments will monitor the process and production and send signals to the DCS. The DCS will consist of several remote terminal units at three control stations and at ten filter control stations. The three control stations are located in the electrical room, the Raw Water Pump Station and in the Superpulsator Building. The operator will be able to communicate with the DCS and change operating parameters by means of a network monitor located in the control room. The network monitor will consist of two personal computers, two CRTs and two printers. The monitor will indicate alarm conditions, provide process control displays, graph selected parameters and print operating reports.

[A1] Vertically sliding valve which is used to open or close an opening in the wall.

[A2] Clarify water by directing flocculated water through stacks of inclined plates in a much smaller basin which provides the surface area for sedimentation.

PRODUCT LIFE CYCLES: A NEW APPROACH

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Ed Tel
Edmonton, Alberta

ABSTRACT

A new depreciation technique is developed called the mass-integrated method which is consistent with product life cycle analysis.

INTRODUCTION

The two basic methods currently being used to depreciate plant and equipment are the mass and the integrated properties. Neither method is compatible with life cycle analysis. Mass properties are used for age dependent items that retire in a specific time interval after they are placed into service. Figure 1 illustrates the retirements associated with additions that took place in 1980 and 1990 and have an average service life of 20 years. Integrated (or life span) properties assume that all investments at a location will retire at one time irrespective of when the component parts were originally capitalized. As shown in Figure 2, additions that occurred in 1980 and again in 1990 will all retire in the year 2000. Integrated properties could be used to represent a technology whose final demise occurs in a specific year, but the replacement of one technology by another usually takes place over the course of a number of years. What is required is a dispersed average year of final retirement and this is the feature provided by mass-integrated properties. Like integrated properties, this method establishes an average year of final retirement and like mass properties, retirements occur in a dispersed fashion as illustrated in Figure 3. A key element in implementing this technique is the utilization of the NX curves.[1]

These curves are derived from the normal distribution curve and are described by two parameters; an average service life and a unitized variance (also called the coefficient of variance). The shape of an NX curve closely approximates that of a normal distribution curve between a unitized variance ranging from 0 to approximately 0.1. Beyond this value, the curve becomes non-symmetrical until it reaches a value of one (1.0) at which point it is a negative exponential curve as shown in Figure 4.

In order for the absolute variance to remain approximately the same, the unitized variance has to change as one approaches the average year of final retirement. In reference to Figure 3, the parameters that were used to depreciate the 1980 gross additions was an average service life of 20 years and a unitized variance of 0.01. The 1981 additions would be depreciated using an average service life of 19 years and a unitized variance of 0.0105263 (20/19 x 0.01). This process of shortening the average service life by one year while proportionally increasing the unitized variance continues until the year of final retirement is reached. Essentially, each vintage is treated as a mass property with the overlay of each retirement profile appearing at the same location.

To illustrate how the mass-integrated property technique is applied, let us consider Account X in Table 1.

To obtain the survivor curve, the retirement rate method is used whereby the plant-in-service figures are treated as exposures.[2] For example, the $160 of retirements that occurred in 1992 (from whatever vintage) were derived from the 1991 exposures of $1,600. The conventional procedure for calculating an observed survivor curve using the retirement rate method is shown in Table 2.

An actuarial curve fitting program chose an NX curve with an average service life of 3 years and a dispersion of 0.24. These are the parameters that were used to calculate the depreciation expense in Figure 5.

One technique that is often used to study the substitution of one technology by another is the Fisher-Pry model but it has a couple of limiting features.

a) The Fisher-Pry equation describes the substitution of one technology by another along an "S" shaped curve which transforms into a straight line on log paper. In the opinion of the author, a better representation of the replacement process can be obtained by using the normal distribution curve.
b) The Fisher-Pry model establishes the time and the rate of transition for one technology to replace another but does not prescribe how the depreciation expense is to be calculated.

Alternatively, the features provided by the mass-integrated method are:

a) It is consistent with Equal Life Group (ELG) concepts of depreciating fixed assets.
b) The substitution curve is described by an NX Curve which is derived from the normal distribution curve.
c) Conventional curve fitting techniques can be used.

CONCLUSION

Due to the advancing rate of technological obsolescence, there is a trend away from age dependent depreciation methods towards methods that relate more to the substitution of one technology by another. The popularity of the Fisher-Pry method has demonstrated this transition and the trend will continue utilizing more sophisticated techniques such as the mass-integrated property method.

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(2) Bjerke, R. "The Turnover Method Uninvited" Society of Depreciation Professional Newsletter Volume 4, Number 1, January, 1991.

BIOGRAPHY

Ralph Bjerke: Depreciation Engineer for Edmonton Telephones - a position he has held for 16 years. Bachelor of Science in Electrical Engineering from the University of Saskatchewan (1964). Bachelor of Commerce from the University of Alberta (1976).

TABLE 1

GROSS ADDITIONS, RETIREMENTS AND PLANT-IN-SERVICE FOR ACCOUNT X			
YEAR	GROSS ADDITIONS	RETIREMENTS	PLANT-IN-SERVICE
1990	630	-30	600
1991	1110	-110	1600
1992	160	-160	1600
1993	0	-800	800
1994	0	-520	280
1995	0	-280	0

TABLE 2

DEVELOPMENT OF AN OBSERVED SURVIVOR CURVE FOR ACCOUNT X				
YEAR	RETIREMENTS	PLANT-IN-SERVICE	SURVIVOR RATIO	OBSERVED CURVE
-		*600	1.0000	
1990	30	600	0.9500	1.0000
1991	110	1600	0.8167	0.9500
1992	160	1600	0.9000	0.7758
1993	800	800	0.5000	0.6983
1994	520	280	0.3500	0.3491
1995	280	0	0	0.1222

* Inserted to establish a starting point.

MASS PROPERTIES

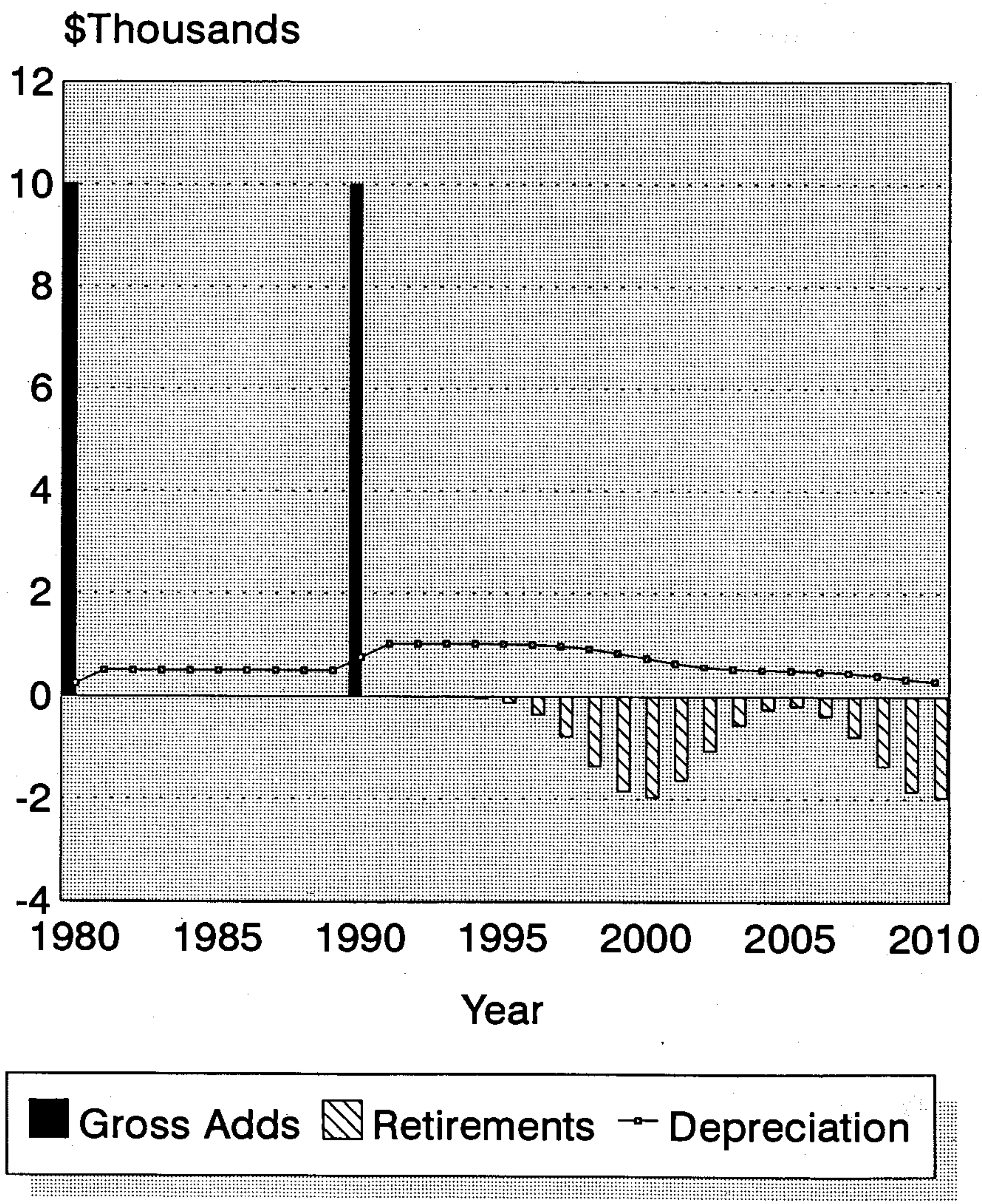

FIGURE 1

INTEGRATED PROPERTIES

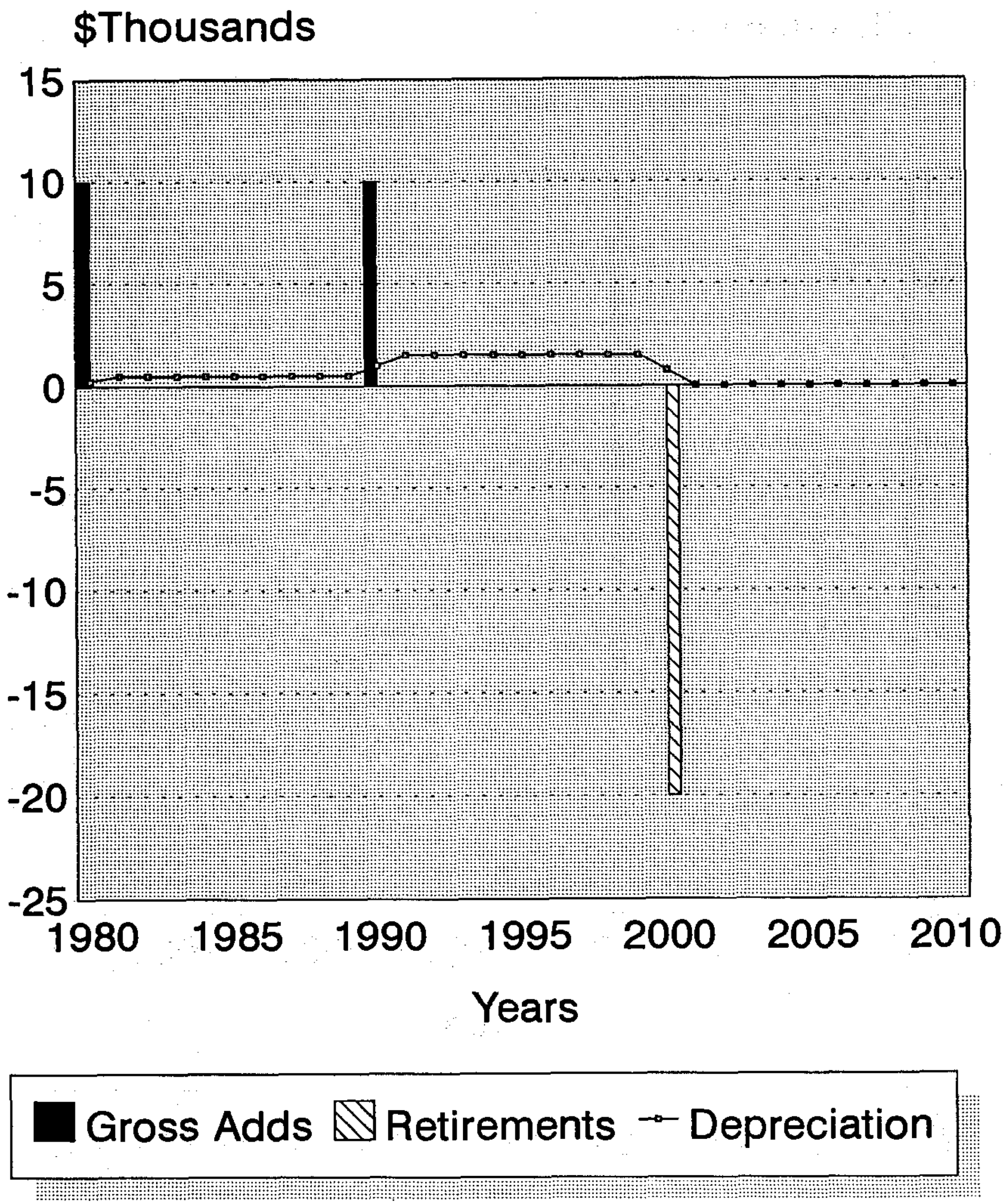

FIGURE 2

MASS-INTEGRATED PROPERTIES

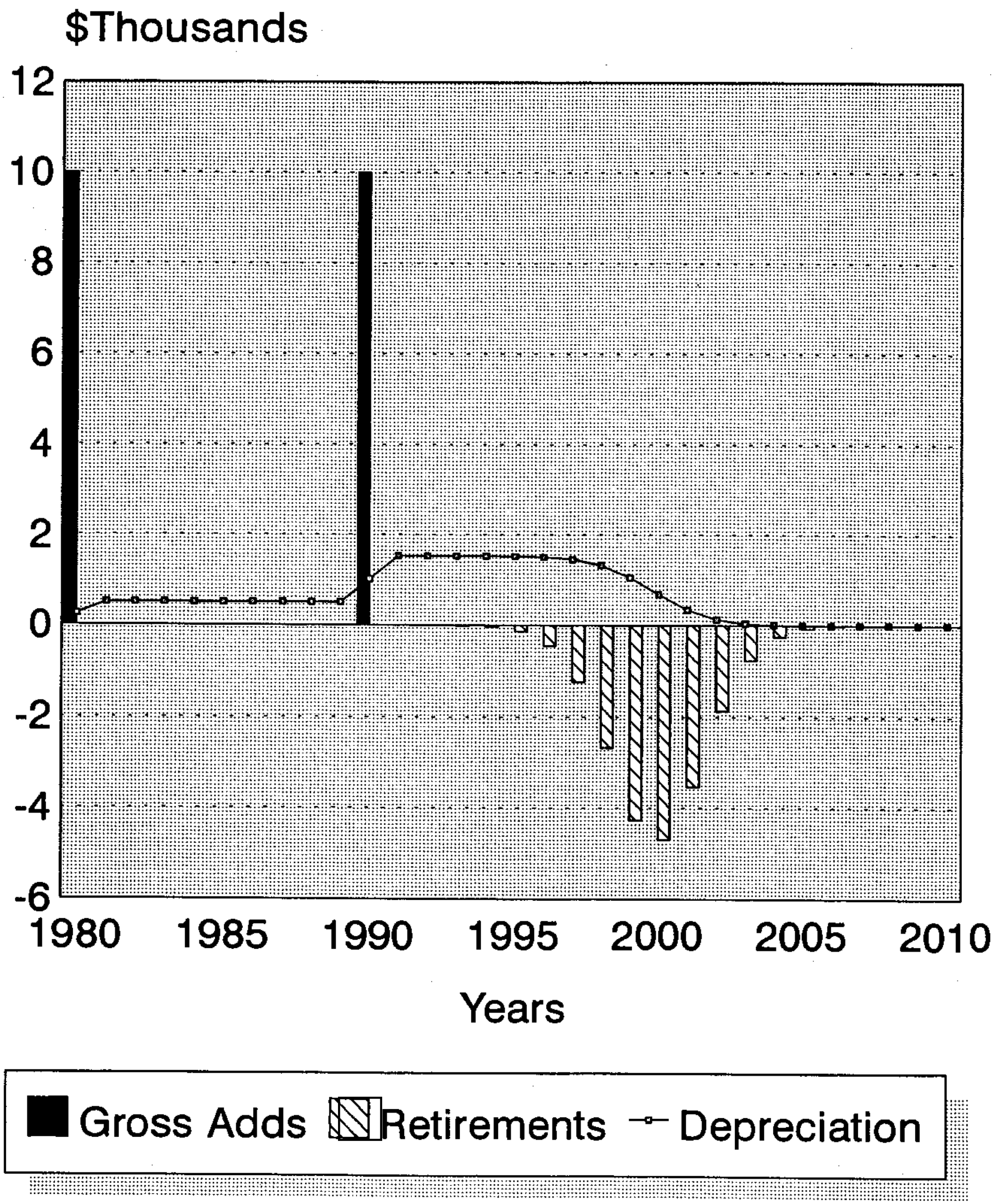

FIGURE 3

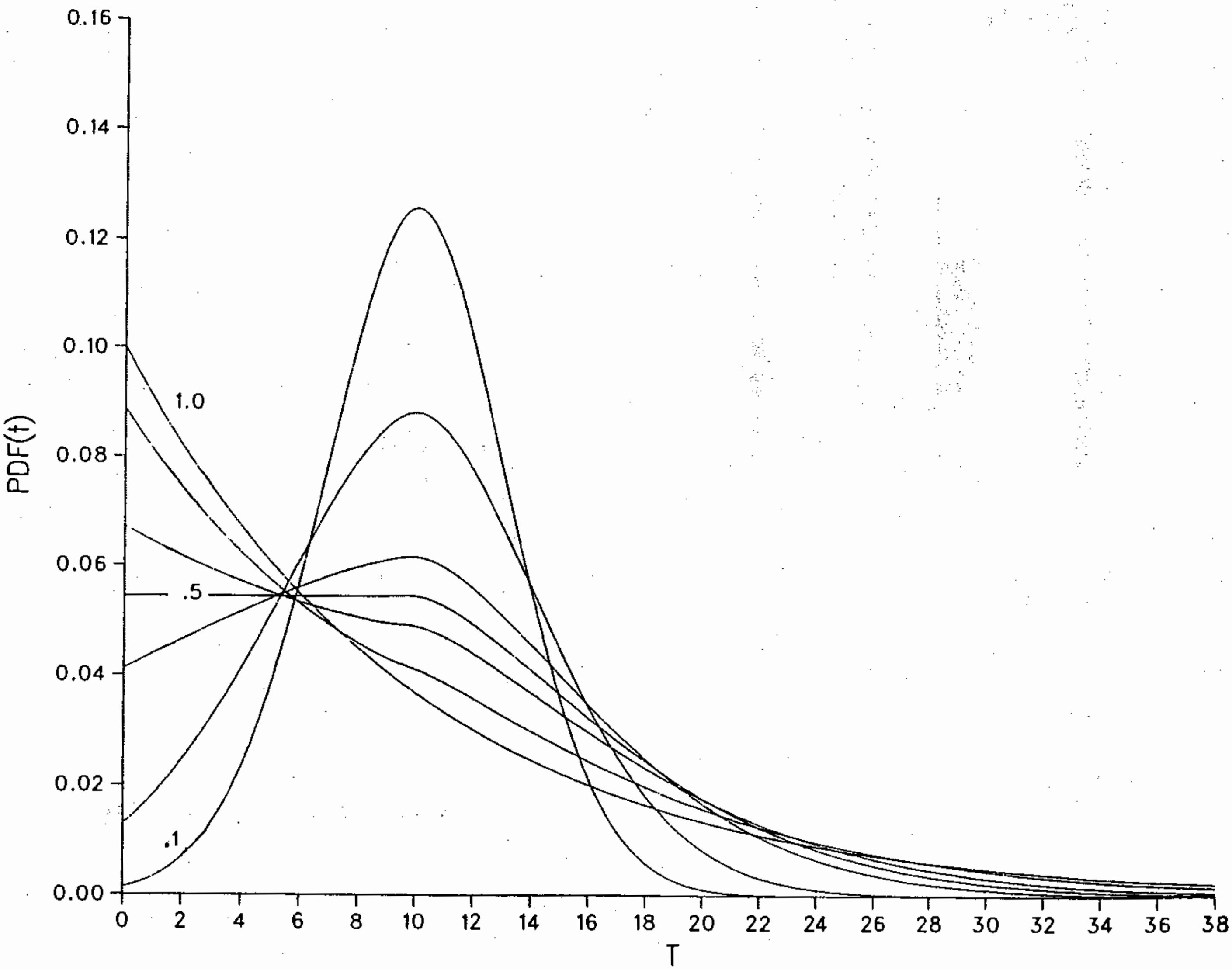
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FIGURE 4

ACCOUNT X

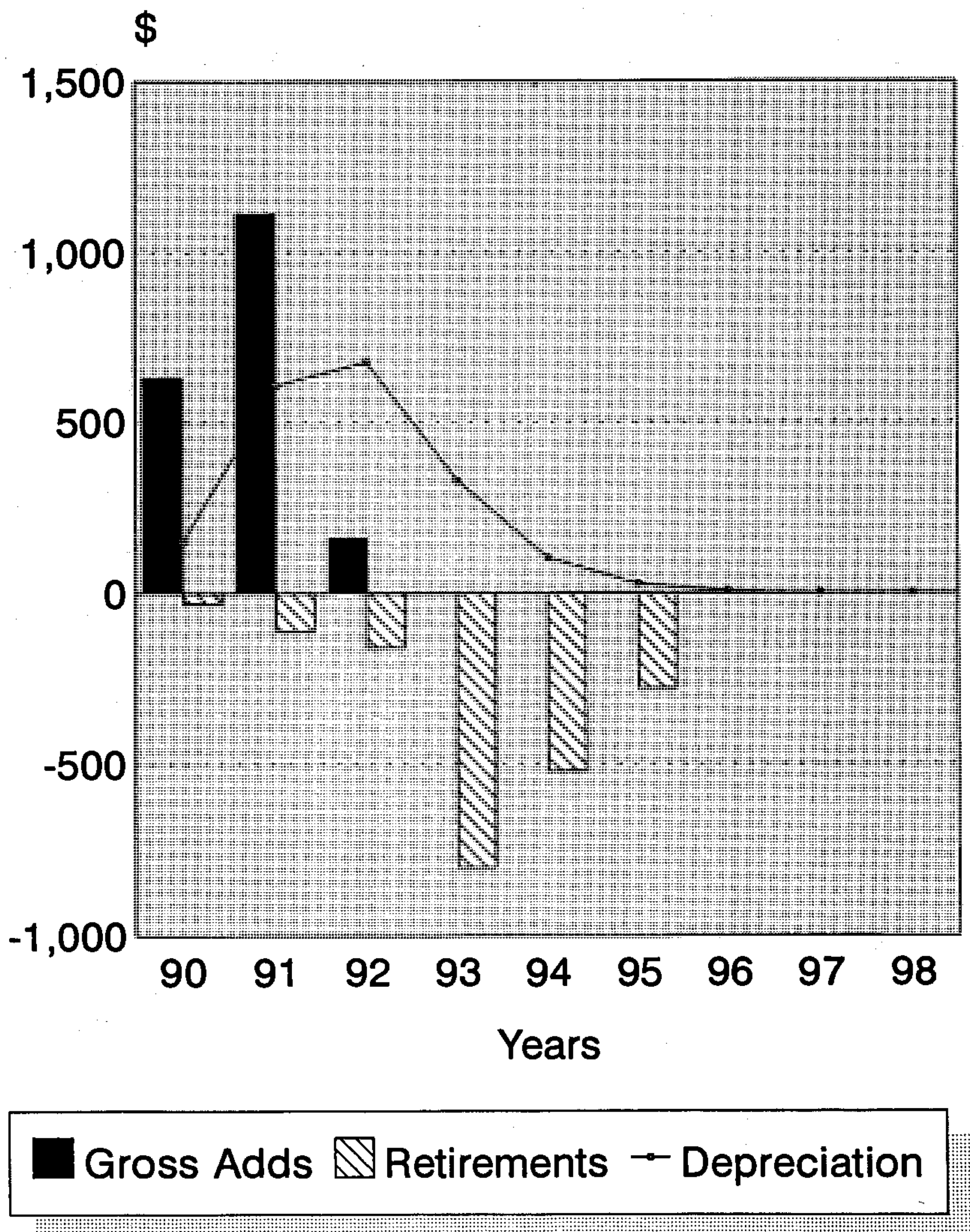

FIGURE 5

SOCIETY OF DEPRECIATION PROFESSIONALS CERTIFICATION COMMITTEE REPORT

Jerome C. Weinert, P.E.
AUS Consultants
Chairman

As chairman of the Society of Depreciation Professionals' (SDP) certification committee, I have spent time since the 1992 annual meeting outlining the procedures which the SDP might employ in a certification process, wherein individuals who desire to do so, could demonstrate their abilities in the field of depreciation and be recognized by the Society as having met the requirements established by the Society. The attached document represents a preliminary draft of the certification process, which was presented to the SDP membership at the 1993 SDP business meeting. In preparing this document, I extracted major sections of it from similar certification processes established by the American Society of Appraisers and the National Society of Rate of Return Analysts, thus there is **no** pride of authorship in this draft, so the SDP membership's recommendations will be gladly accepted.

A certification process may have a number of benefits to our Society. First, it elevated the practice of depreciation by establishing minimum standards. Secondly, the formal testing process, most likely at the Society's annual meetings, will encourage attendance at those meetings and the training sessions associated with our annual meetings. Finally, the recertification process will keep our members current and **participating** in the field, which should help in our attendance at the Society's annual meetings, in obtaining articles for the Society's Journal, and obtaining the membership's participation at the Society's functions as speakers, officers, and committee members and chairpersons.

Please feel free to address any comments or suggestions to Jerome C. Weinert at AUS Consultants, 606 East Wisconsin Avenue, Suite 210, Milwaukee, Wisconsin 53202. Telephone 414-271-8580, fax 414-271-8623.

It is the Certification Committee's intention to incorporate members' comments into a final draft proposal to be made to the Society's membership at the 1994 annual meeting.

CERTIFIED DEPRECIATION PROFESSIONALS (CDP) REQUIREMENTS

CANDIDATES

Any member of the Society of Depreciation Professionals, who is a practicing depreciation professional or engaged in the depreciation profession, who wishes to become designated by the Society of Depreciation Professionals (SDP) as a Certified Depreciation Professional, designated as CDP, may apply for such certification with the Society's Certification Committee.

CERTIFICATION REQUIREMENTS

Each candidate for Certification must fulfill the following requirements to qualify for certification as a Certified Depreciation Professional in the Society:

Membership: The candidate must be an active member of the Society of Depreciation Professionals.

Experience: To qualify for Certified Depreciation Professional, an individual must have a minimum of five years of full time depreciation experience; of that five years, at least two years of experience must be in the area of depreciation administration. Three years full time experience may be in related fields such as engineering, finance, planning, regulation, regulatory consulting, etc. Depreciation administration comprises any or all of the following activities: involvement or responsibility for the preparation of depreciation studies, the review of depreciation studies, development of depreciation analysis software systems, and/or the conduct of training and/or instruction in depreciation analysis and procedures.

Education: A college degree or its equivalent. Each year of practical depreciation or related experience equals one year of college equivalency. The Certification Committee recognizes career development and non-academic equivalency, e.g., courses, seminars, teaching, administrative/supervisory positions, membership in professional organizations, etc. Documentation of all academic and non-academic experience is mandatory and must be on file at the Society's headquarters. (Copy of diploma, current letter from college or transcript).

Examination

1. The evaluation of a candidate's technical depreciation proficiency and acquaintance with the Society's requirements for certification, principles and basic precepts of the profession is accomplished by means of a written examination.
2. A minimum passing score of 75% is mandatory to qualify for Certification. The examination will be constructed to reveal a candidate's knowledge, ability and expertise in depreciation matters. The technical tests will be in two parts: General Theory/Practice, and Problems or Case Examples. Study Guidelines and materials will be developed and made available from the Society. The following general areas will be covered in every examination:
   - Life Analysis
     - Service Life Concepts
       - Unit Property
       - Group Property
       - Average Service Life Concepts
     - Service Life Analysis
     - Statistical
       - Actuarial Analysis
       - Simulated Analysis
     - Non-Statistical
       - Life Cycle/Life Span
       - Units of Production
   - Grouping of Property
     - Broad Group
     - Vintage Group
     - Equal Life Group
   - Service Life Calculation
     - Average Service Life
     - Average Remaining Life

- Net Salvage Analysis
  - Net Salvage Concepts
    - Gross Salvage
    - Cost of Removal

Average Net Salvage Calculation
- Historical Net Salvage
- Future Net Salvage

Historical Experience vs. Future Expectation
- Elements of Historical Experience
- Future Expectations
- Forecasting Methods for:
  - Service Life
  - Net Salvage
- Theoretical Reserve
- Depreciation Methods
  - Average (Whole) Life Depreciation Methods
  - Remaining Life Depreciation Methods
  - Amortization of Reserve Variances
- Miscellaneous Related Areas
  - Plant Accounting Procedures
  - Reserve Accounting Procedures
  - Continuing Property Records Procedures

EXAMINATION PROCEDURES

SDP will adopt a procedure of Open Group Examinations for members wishing certification. All examinations will be held under the supervision of the SDP selected examiners and scheduled in conjunction with the Society's annual meeting.

REQUEST FOR SPECIAL EXAMINATIONS

Special examination requests must be approved and will be monitored by the SDP selected examiners. A minimum of 10 individuals must be available at a preselected and mutually agreeable site for Special Examinations to be conducted.

PREREQUISITES PRIOR TO EXAMINATION

The following items are essential for request for examination and must be received at the Society's headquarters 20 days prior to the examination date: Application, application fee of $150, Recommendation Form, verification of education. The application must be completely documented in order to demonstrate the candidate's qualifications to the Certification Committee. *If a candidate is unable to attend the scheduled exam, he or she must notify the Society headquarters five (5) days prior to the examination date or the candidate will be assessed a cancellation fee of $50.00.*

RETAKING EXAMS

If a candidate has taken an examination twice unsuccessfully, the individual must wait a minimum of one year before retaking the exam.

MANDATORY RECERTIFICATION

To assure that competent, relevant, current depreciation counsel will be available to the Public, the Society requires Certified Depreciation Professionals to recertify every five years. This mandatory program emphasizes professional participation in the Society, publishing scholarly papers and continuing education.

The Maintenance Criteria for Recertification is as follows:

1. Recertification credits will be granted on an accumulated hour system over a five-year period, with a total of 100 hours required to maintain certification.
2. A minimum of 40% of the 100 hours required to maintain certification shall be in the field of continuing education, speeches, instruction and other programs, participation in the depreciation profession or published articles and other literary contributions to the depreciation profession.
3. **Program or Activity** — **Hours**

Program or Activity	Hours
Continuing Education: Successful completion of courses related to the depreciation profession; per seminar hour	1
Participation at SDP sponsored Seminars; per seminar hour	1
Participation in educational programs of compeer societies will be granted the same recertification hours as are granted SDP sponsored programs; per seminar hour	1
Additional education accomplishments will be subject to review and judgment of the Recertification Board	Open

4. Speeches, Instruction and other Program Participation in the Depreciation Profession

Teaching depreciation related courses sponsored by recognized depreciation organizations or by an accredited university or college; each course	10
Each appearance as an instructor, or workshop leader, at an SDP Educational Program; per appearance	10
Each presentation include: panel leader, workshop leader or featured speaker at the SDP program; per appearance	8
Each presentation including instructor, panel and/or workshop leader at depreciation courses; per appearance	8
Featured guest speaker representing SDP at non-SDP function; per appearance	8
Additional accomplishments will be subject to review and judgment of the Recertification Board	Open

5. Published Articles and Other Literary Contributions to the Depreciation Profession

Contributing author to an SDP Journal; per article	25
Contributing author to SDP newsletter; per article	8
Article published on depreciation in a trade journal, book or magazine other than above; per article	25
Editorials, published letters to the editor and critiques of past articles on depreciation subjects, book	

reviews and other similar literary contributions to discipline journals	8
Additional published material relating to the depreciation profession will be subject to review and judgment of the Recertification Review Board	Open

6. Organizational Contributions

Attendance at SDP annual meetings; per meeting	5
SDP office held; per year	15
SDP committee chairperson; per year/ per committee	8

7. Examination

In lieu of the above, a member can elect to successfully pass a current technical examination	100

POWER PLANT REMOVAL COSTS

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ABSTRACT

Site-specific estimates suggest that steam generating stations will incur high removal costs and that diesel and combustion turbine stations will incur a small amount of removal cost. Estimates for nearly 400 steam generating units show removal costs of $29 per kW at the current price level and $84 per kW at retirement for gas and oil units, and $39 per kW and $57 per kW for coal units. Estimates for over 100 diesel and combustion turbine units show diesel removal costs of $3 per kW at the current price level and $26 per kW at retirement, and combustion turbine removal costs of $3 per kW at the current price level and $5 per kW at retirement.

These estimates suggest a much larger demolition obligation for steam generating stations than typically reflected in book depreciation rates, and that the net salvage factor for diesel and combustion turbine units should be slightly negative rather than the typical zero commonly used.

The financial, regulatory, and political significance of the estimated high removal costs of nuclear power plants has generated considerable interest in recent years, and the political significance has resulted in the Nuclear Regulatory Commission (NRC) eliminating the use of conventional depreciation accounting for the decontamination portion of the removal (decommissioning). While nuclear plant licensees are not precluded from utilizing conventional depreciation accounting for the demolition of non-radioactive structures and site restoration, state and federal utility regulators have not been favorably inclined to requests for this distinction.

The realization that steam generating units will be expensive to remove, relative to their original cost, predates the realization that nuclear units will be expensive. However, the nuclear issues have overshadowed this realization, but are unlikely to continue to do so. Numerous utilities have prepared cost estimates for steam generating units, and this presentation discusses the implications of a number of such estimates that are a matter of public record. These estimates cover nearly 400 gas, oil, coal, and lignite steam generating units, and over 100 internal combustion units. The earliest estimate was made in 1978, and for analysis purposes I have segregated the steam units between gas and oil units, and coal and lignite units, and the internal combustion units between diesel and combustion turbine units.

ACCOUNTING IMPLICATIONS

From an accounting standpoint, removal costs are a liability that is recorded as a contra-asset through depreciation accrual. The responsibility for removal is incurred at the time the facilities are constructed. While certain plants may have legal requirements for removal, power plant removal is normally dictated by safety considerations or by the need to remove existing facilities so that new generating units or other types of facilities can be located at the site.

The Securities and Exchange Commission requires certain financial statement disclosures relative to the liability for decommissioning nuclear plants, but has no similar requirement for other types of generating units or for other removal liabilities. As a result, utilities do not usually disclose the extent of their liability for steam and internal combustion units or whether the liability is currently being funded. The removal cost estimates discussed here suggest that the steam unit liability is material, but I am unaware that any of these cost estimates, expressed at the price level expected at the time removal will occur, have been allowed by regulators to be incorporated into depreciation rates. However, many of the estimates have been allowed to be reflected on a discounted basis or on the basis of the current price level.

EFFECT AND SIGNIFICANCE OF INFLATION

Power plant removal is labor intensive, and labor costs are sensitive to inflation. Inflation has significance to depreciation accounting, because the accounting rules of the Uniform System of Accounts promulgated by state and Federal regulators define salvage value and cost of removal. The following definitions are from the Uniform System of Accounts of the Federal Energy Regulatory Commission for electric utilities.

> "Salvage value" means the amount received for property retired, less any expenses incurred in connection with the sale or in preparing the property for sale; or, if retained, the amount of which the material recoverable is chargeable to materials and supplies, or other appropriate accounting.
>
> "Cost of removal" means the cost of demolishing, dismantling, tearing down or otherwise removing electric plant, including the cost of transportation in handling incidental thereto.

Both of the above definitions imply measurement at the price level at the time the salvage is received and the cost of removal is incurred. The effect of inflation is automatically incorporated in actual experience, but, when actual experience does not exist or is not appropriate, estimates expressed in terms of the expected price level at the time salvage would be received and cost of removal would be incurred are required.

For near-term removals, the effect of future inflation would be minimal. However, for steam generating units expected to be removed well into the future, future inflation is likely to have a material effect. For example, an inflation rate of five percent will double cost estimates every fourteen years.

VALUE OF PLANT SITE

Generating sites are valuable, and claims are sometimes made that site value should be offset against expected removal costs. There is no question that such sites are valuable, but this value has no significance to depreciation accounting. This is because depreciation accounting is a process of allocation, not a process of valuation, and because Uniform Systems of Accounts do not allow gains or losses from non-depreciable assets to be recorded in the depreciation reserve.

A utility has the following choices relative to disposal of a power plant:

- Perpetually guard and maintain the site.
- Remove the existing facility and replace it with another.

• Remove the facility and restore the site.
• Sell the site.

It is uncommon for a utility to defer action until the last generating unit at a site has been retired, provided removal is not dictated by the need for space for a new generating unit. Removal of the facilities may be by the utility, or may be by the purchaser of the site. It sold without prior removal of the facilities, the purchaser must remove them and will reflect the removal cost in the purchase price. For example, it the site with the facilities removed has a value of $100, and the removal cost estimated by the utility is $20, an offer for the site will be $80 if the purchaser also expects the removal cost to be $20. In this situation, the utility would either spend $20 for removal and obtain $100 for the site, or would not remove the facility and obtain $80 for the site. Either way, the utility would record $100 for the sale of the land in Account 421.1(gain) or Account 421.2(loss) and $20 for cost of removal in Account 108.

REASONS FOR HIGH STEAM UNIT REMOVAL COSTS

Existence of insulation containing asbestos, the boiler design, and the existence of ash ponds and flue gas desulphurization facilities are responsible for the high steam generating unit removal costs.

INSULATION CONTAINING ASBESTOS

The hazards of asbestos and the requirement for very careful handling are well known, and make removal and disposal of insulation containing asbestos very expensive. As a general rule, generating units constructed prior to the early 1970's can be expected to have insulation containing asbestos. Asbestos removal is done by specialized contractors, and demolition contractors will remove structures only after all asbestos has been removed. I am aware of two old power plants currently in the process of being removed for which the asbestos removal amounts to about one-third of the original cost of the plants.

BOILER DESIGN

Modern boilers are hung by their top from a multi-story steel superstructure. Older boilers are self supporting, resting on foundations. Power plans having the older style boilers lend themselves to removal using a wrecking ball, once the asbestos has been removed.

The large superstructures of modern generating units do not allow use of a wrecking ball for boiler demolition, and the explosive techniques commonly utilized for large buildings may not be safe. While blasting could be utilized to drop the boiler and its superstructure in a heap, the pile of materials would need to be cut up for removal. However, the pile would contain residual stresses that may preclude safety cutting the materials. Therefore, a piecemeal removal procedure that resembles the original construction process may be necessary for modern boilers. This method of boiler removal significantly increases removal costs, and the combination of the weight of the boiler itself and the superstructure results in a massive foundation that is expensive to remove. The costs will be even further increased if there is any asbestos insulation present.

Most existing generating units have boilers hung by their top, so can be expected to incur high removal costs.

ASH PONDS AND FLUE GAS DESULPHURIZATION UNITS

Ash ponds require sealing. Flue gas desulphurization units (scrubbers) provide additional facilities to be removed, and may provide some scrap. However, such units may also produce by-products that may require special handling in the same manner as ash ponds. Some removal cost estimators suggest that the existence of a scrubber will add one-quarter to one-third to the removal, cost estimate.

COST ESTIMATES

The cost estimates discussed herein were made in terms of the price level at the time of the estimate, and most of the studies included estimates at the price levels expected at the time of removal. In some instances, I made the estimates at time of removal, utilizing either inflation rates provided by the utility or the inflation rates being utilized at that time by other estimators.

The table below summarizes the results of the analysis of these studies for steam units, segregated by fuel type, and for internal combustion units, segregated between diesel units and combustion turbine units. As is evident, the removal liability for internal combustion units is not nearly as significant as for steam units. The net salvage factors are calculated suing the inflated removal cost estimates and the depreciable investments at the time of the study.

	Steam Units		Internal Combustion Units	
	Gas & Oil	Coal	Diesel	Combustion Turbine
Net Salvage Factor	(50.6)%	(46.9)%	(22.0)%	(5.4%)
Demolition Cost per kW				
1992 price level	$29	$39	$3	$3
Removal price level	$84	$157	$22	$5

Figures 1a and 1b show the removal cost per kW for oil and gas units plotted at the average unit capacity for each steam plant. Figure 1a is for the 1992 price level, and Figure 2b is for the price level expected at the time of the retirement of the last generating unit at the plant. Figures 2a and 2b show the same information for coal units.

Figure 1a demonstrates the expected sensitivity to the average unit capacity. Figure 1b illustrates a similar sensitivity, but the trend is not as clear because of the wide range of removal dates.

Figure 2a also illustrates a sensitivity to unit capacity, but the trend is not as clear as for gas and oil units. Figure 2b also illustrates a sensitivity to capacity, but again it is not very clear. Units with scrubbers influence the patterns for coal units, as such units are large and are more expensive to remove than units without scrubbers.

CONCLUSION

The magnitude of the net salvage factors suggest that the owners of steam generating units should evaluate their removal cost liability. Making such estimates and adequately supporting their validity in regulatory proceedings is not an easy task, and, if the experience of the owners of nuclear units is any indication, is not one to be taken lightly.

A number of state regulatory jurisdictions have already proved to be reluctant to allow adequate recognition of the negative net salvage expected to be applicable to steam generating units, and some have gone as far as to deny any recognition whatsoever. The industry experience in supporting the validity of nuclear decommissioning cost estimates and in obtaining regulatory approval of depreciation provisions will undoubtedly prove valuable to owners of steam generating units.

The magnitude of the net salvage factors suggest that owners of internal combustion units should depart from the assumption of zero net salvage commonly utilized for depreciation purposes for such units.

Figure 1a

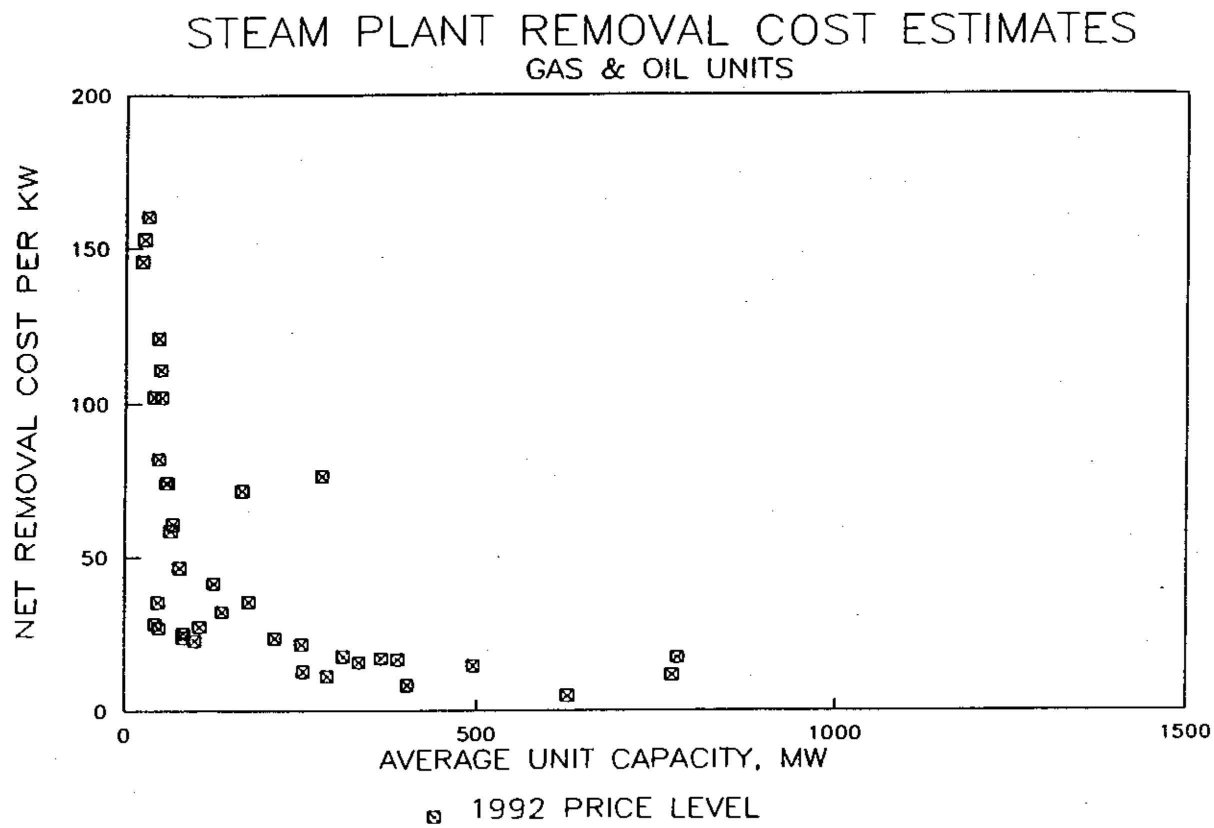


Figure 1b

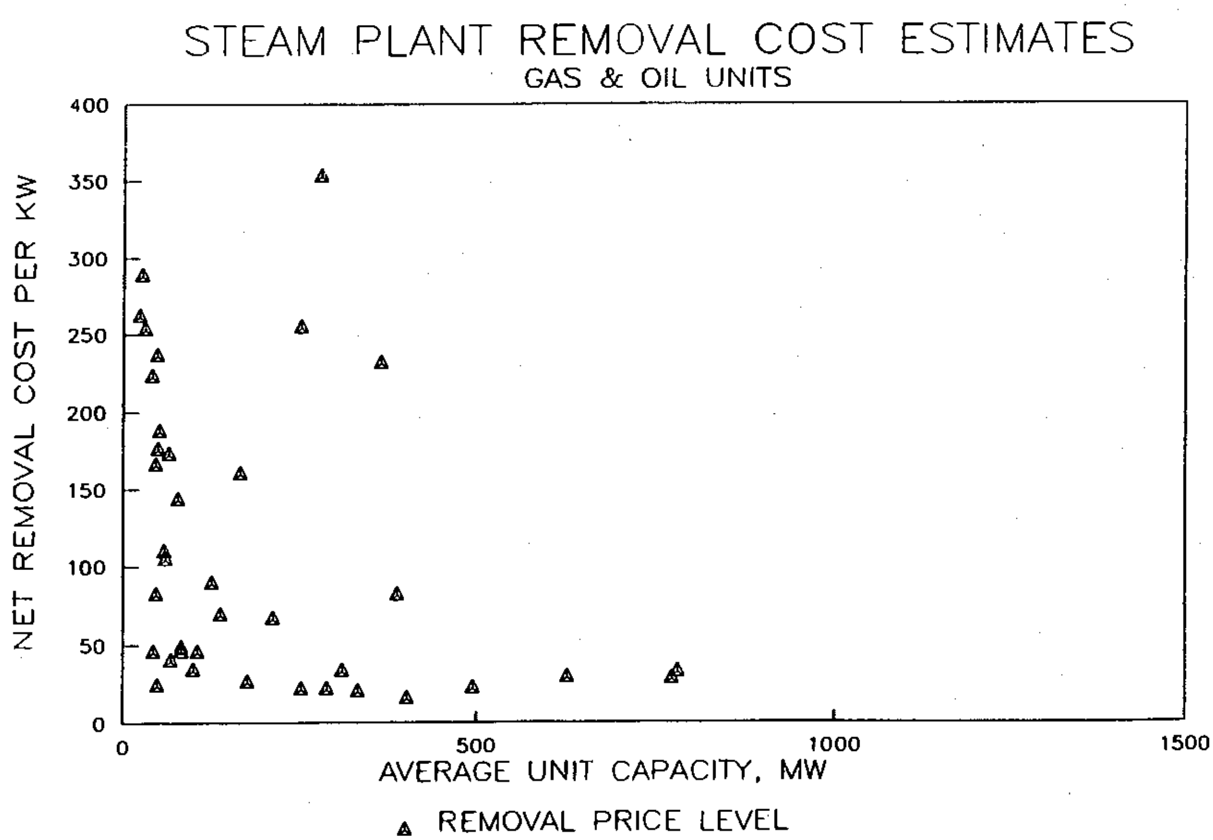


Figure 2a

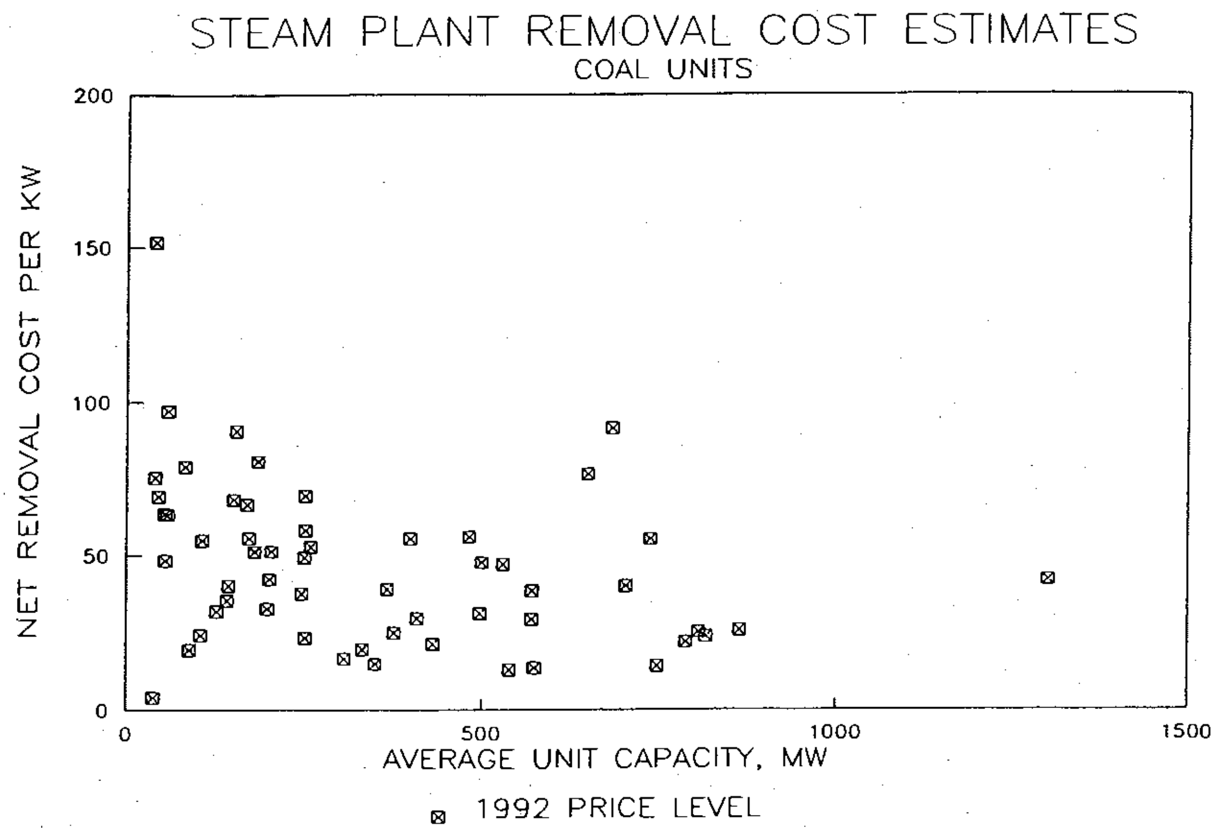
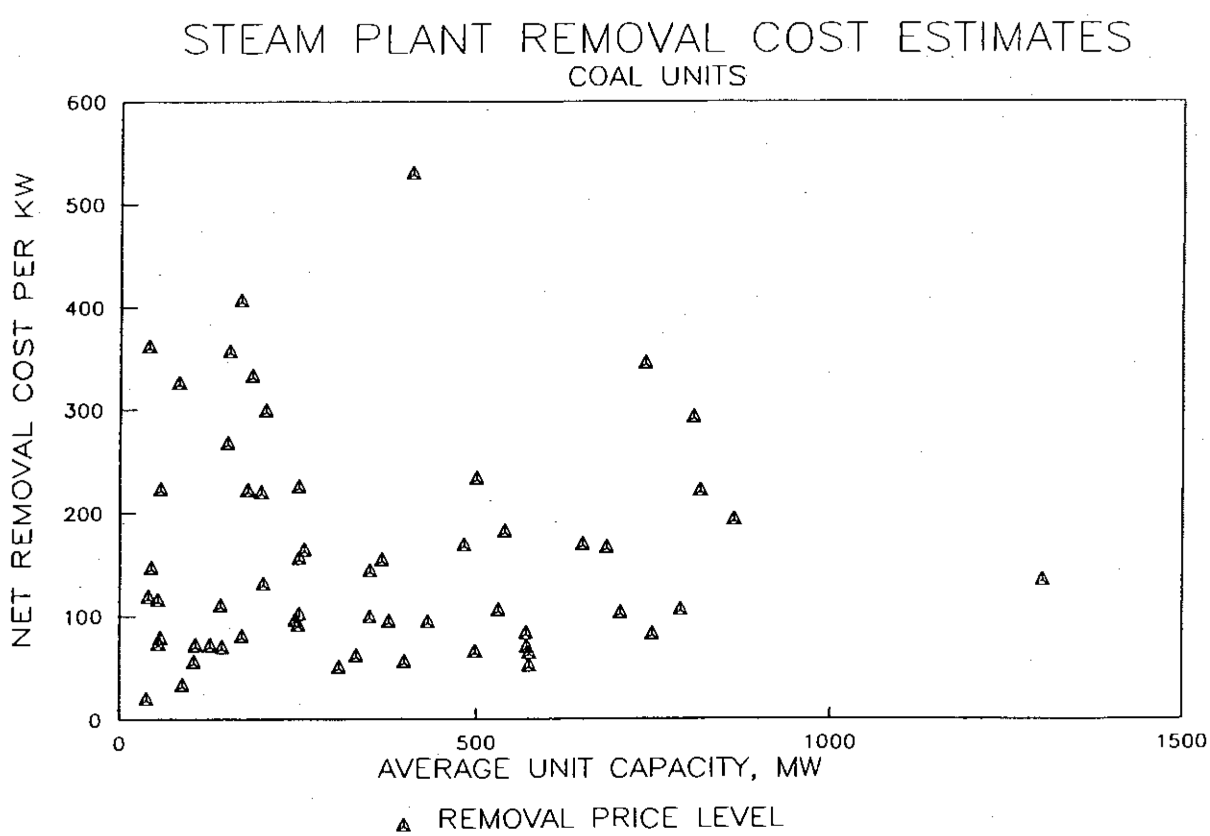


Figure 2b



A DIRECT APPROACH TO VALUE BASED DEPRECIATION

Thomas A. Nousaine
Ronald B. Kalich
Constance Brady

ABSTRACT

Most sources define asset depreciation as the loss in service value or the ability of an asset to produce goods or services that fill needs in the marketplace. Loss in service value is caused by many factors including wear and tear, inadequacy or obsolescence none of which necessarily occurs at a fixed rate. Therefore a reasonably precise depiction of loss in service value requires periodic appraisal which increases complexity and cost of administration. Analysis of market prices for used equipment shows that a simple rate schedule provides an easy to use and accurate measure of real loss in service value for assets used in the American economy today.

A DIRECT APPROACH TO VALUE BASED DEPRECIATION

All definitions of depreciation suggest that value of capital assets declines over time. Some causes of depreciation such as inadequacy or wear and tear are visually apparent and can often be accurately modeled with mortality based analysis or technical inspection of a given firm's assets. However, technological or market obsolescence is non-linear, visually opaque and based on technology advances in the economy as a whole. Therefore it is extremely difficult to measure loss in service value by any examination confined to the assets of a given firm.

Previous studies of industry wide trade-in blue book prices by asset age have shown a remarkable similarity in the loss of value curve shape between assets as dissimilar as computers, digitally based audio products and automobiles independent of actual life span.[1] The basic curve shape of service value loss in the American economy shows a relatively large loss in early years followed by a moderating and declining level in later years independent of product type, market use or technology.

We believe that the tremendous advances in electronics and the applications of electronically based products to all existing market needs is the underlying cause of this characteristic. Electronics have transformed the marketplace for all goods and services and created an environment in which they are indispensable. Investments in this equipment have exploded from 6% of all new plant equipment in 1950 to 20% in 1980 and 40% in 1991.[2] The flexibility which computers and digitally based equipment provide has tremendous impact on every firm on every product or service in every business.

Whereas most technology has simply been a replacement for prior technologies, electronic equipment provides the means for continuous increases in productivity and eclipses previous product boundaries. For example, improvements in computer processors and memory make electronic products competitors for office equipment and automotive engine management systems as well as improving current lines of personal computers. Because of the advancement in the underlying electronic equipment, as evidenced by increases in speed and power of Intel and Motorola microprocessors and the capacity of memory chips, (Figure 1) the generic service value curve for most productive assets is predicated on the electronics life-cycle curve.

The curve representing loss in asset value by age is the most precise representation of depreciation reserve requirement at that age. Therefore depreciation accruals should be targeted to match this curve at every age. Unfortunately Gompertz-Makeham and other techniques would require complex curve-fitting solutions for every accounting period. The more simplistic approaches of traditional accounting methods such as straight line, double-declining balance or sum-of-the-year digits, while easier to use, significantly misrepresent the actual pattern of loss in service value.

This conclusion is most easily drawn by comparing straight-line depreciation technique to the service value curve analysis provided in figure 2. While the double-declining balance and sum-of-years digits methods represent slightly larger early accruals, they still significantly understate loss in service value compared to the service value curve. Table 1 represents the lag in accumulated depreciation compared to service value at intervals of one year from age 0.5 through 8.5.

A basic rate-map by asset age (Table 2) based on an 8.5 year life will effectively model actual loss in service value for all assets, regardless of type, with minimal adaptations for assets lives of 3 to 5 years. The map provides an easy to use schedule and is very similar to the procedure used by the IRS for tax depreciation.[3] Small firms with low capital intensity will loss little accuracy by using MACRS rates for five year property. Application of the loss in value map assures accurate depreciation accounting and can be easily applied with standard, low cost electronic spreadsheets.

FOOTNOTES

[1]Nousaine, Thomas A.; Gacke, Cynthia M.; Kalich, Ronald B.; "Depreciation and Obsolescence: A Straight Line Approach," **JournaL of the Society of Depression Professionals**, Volume 4, Number 1, 1992.

[2]Carnevale, Anthony Patrick: **America and the New Economy**, pp. 73-74, Jossey-Bass Publishers, San Francisco 1991.

[3]Arthur Andersen, **1993 U.S. Master Tax Guide**, p. 327 Section 1243, Commerce Clearing House, Inc., Chicago, 1992.

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Hawken, Paul, **The Next Economy**, Holt, Rinehart & Winston, New York, 1983.

Carnevale, Anthony Patrick, **America and the New Economy**, Jossey-Bass Publishers, San Francisco, 1991.

Centren, Marvin; Pagano, Alicia; Port, Otis, **The Future of American Business**, McGraw Hill, New York, 1985.

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Memory Capacity and Microprocessor Computing Power

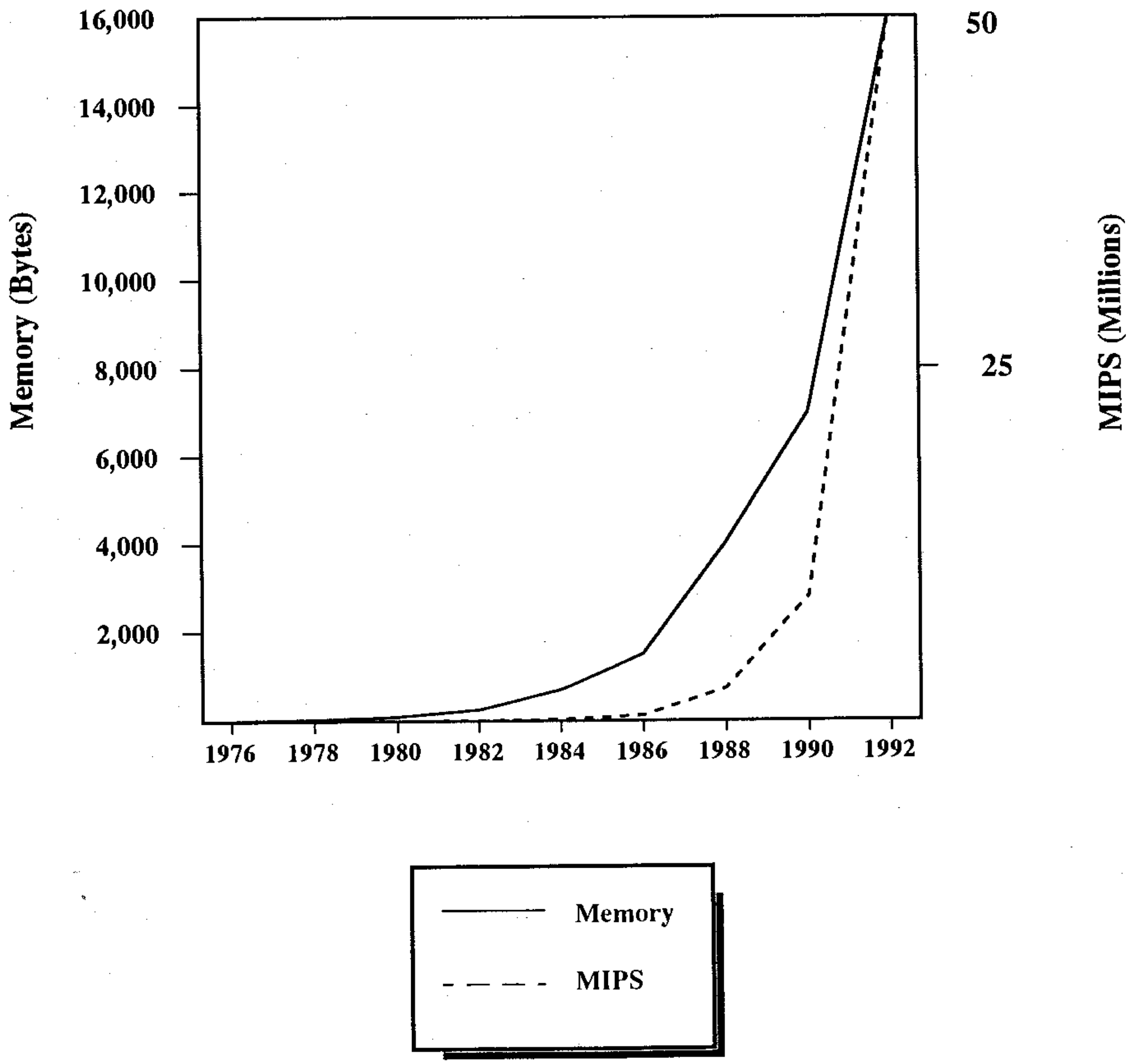

Figure 1

Reserve Requirement

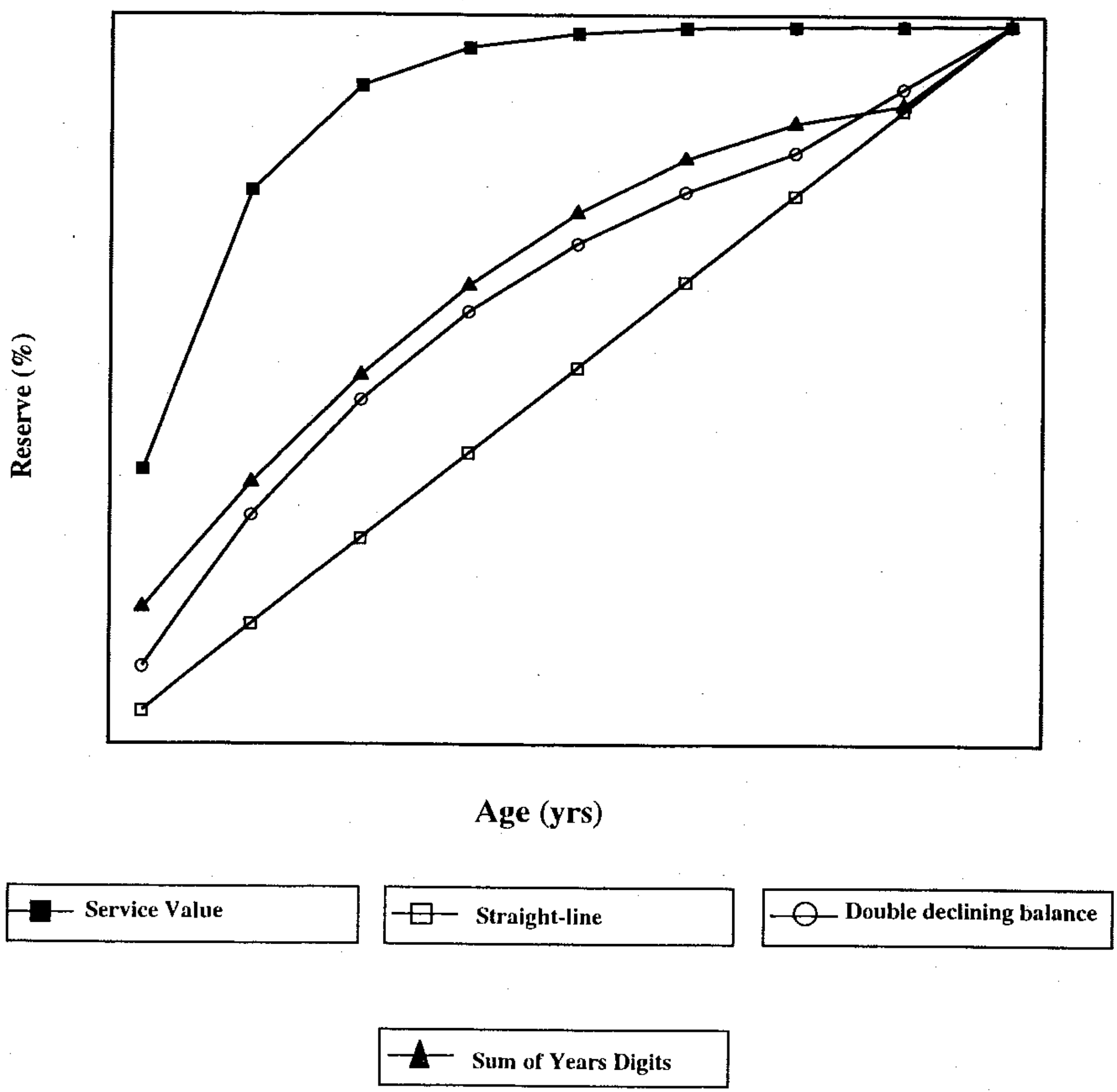

Figure 2

LAG IN ACCUMULATED RESERVE
vs.
SERVICE VALUE

	AGE								
	0.5	**1.5**	**2.5**	**3.5**	**4.5**	**5.5**	**6.5**	**7.5**	**8.5**
Straight-line	33.0%	59.6	62.1	55.6	45.9	34.9	23.3	11.7	0.0
Double Declining Balance	27.1%	44.6	43.0	36.2	28.9	22.6	17.4	8.7	0.0
Sum of Years Digits	19.1%	40.1	39.6	32.6	24.7	18.1	13.4	11.0	0.0

Table 1 represents reserve requirement "lag" depicted by Figure 2 and is:

Service Value Curve Reserve Requirement at age (x) less Standard Depreciation Accounting Method curve at age (x)

As shown by both Figure 2 and Table 1, each of the standard methodology curves undervalue or "lag" the service value curve at every age before the end of the asset's life.

Table 1

LOSS IN VALUE DEPRECIATION RATE MAP

Depreciation Rates (%)

Year	Actual Loss In Value	Recommended Rates Loss in Value	Recommended Rates 3 yr.	Recommended Rates 5 yr.	MACRS - General Depreciation System 3 yr.	MACRS 5 yr.	MACRS 7 yr.	MACRS 10 yr.
1	38.90	**35.00**	**35.00**	**35.00**	58.33	**35.00**	25.00	17.50
2	38.30	**35.00**	**35.00**	**35.00**	27.78	**26.00**	21.43	16.50
3	14.30	**15.00**	**30.00**	**15.00**	12.35	**15.60**	15.31	13.20
4	5.30	**10.00**		**10.00**	1.54	**11.01**	10.93	10.56
5	2.00	**2.00**		**5.00**		**11.01**	8.75	8.45
6	0.80	**1.00**				**1.38**	8.74	6.76
7	0.20	**1.00**					8.75	6.55
8	0.10	**1.00**					1.09	6.55
9	0.10							6.56
10								6.55

5 Year MACRS methodology rates compare favorably to recommended rates

Table 2

SPRINT - LOCAL
TELECOMMUNICATIONS DIVISION
SUPPORTS THE
SOCIETY OF DEPRECIATION
PROFESSIONALS

**U S WEST Communications
Capital Recovery
Supports the
Society of Depreciation
Professionals**