THE DEPRECIATION RESERVE REQUIREMENT FOR PUBLIC UTILITY COMPANIES IN THE UNITED STATES OF AMERICA

By

MELVIN EARL LEWIS

Submitted to the Graduate Faculty of The American University in Partial Fulfillment of the Requirements for the Degree of Master of Arts

The American University

Washington 6, D. C.

1947

L. M. Homberger
Melwood W. Van Scoyoc
Robert W. King.

P R E F A C E

This dissertation singles out a phase of the public utility rate base problem that is usually ignored or glossed over in discussions treating in general with public utility regulation. The controversy of "value" or a reproduction cost rate base versus historical or original cost provides abundant ground for a lengthy exercise in economics, law, political science and accounting; but in practice the issue is resolved -- sometimes by the use of original cost as the rate base and sometimes by the use of reproduction cost. It is at that point that this paper commences.

Before the rate of return can be calculated, it must be determined whether or not the rate base shall be taken at its depreciated amount. This treatise reviews the problem of a depreciated rate base versus an undepreciated rate base, and attempts to clear the air surrounding the problem by examining economic, accounting and legal aspects thereof.

Generally, a depreciated rate base is called for. Here the Depreciation Reserve becomes a vital part of rate regulation; it has a direct effect on the rate base. This thesis presents the various procedures and refinements of procedure which have been developed to arrive at an equitable depreciation reserve balance, usually termed the "reserve requirement"; the various methods and procedures are here analyzed and evaluated. In all analyses and evaluations the effect on the ratepayer, the investor, and on the company itself, is kept in mind.

Perhaps this survey will provide an insight into the detailed problems that lie behind the headline problems of public utility regulation. This dissertation should also prove of value in the clarification of the issues and ramifications involved in determining a proper figure for the depreciation reserve.

The writer is greatly indebted to Dr. L. M. Homberger for so generously sharing of his valuable time and wealth of knowledge. Acknowledgement is also made of the helpful advice, constructive criticism, and encouragement given the writer by Mr. Robert W. King, member of the staff of the Bureau of The Budget, and by Mr. Melwood W. Van Scoyoc, Assistant Chief of the Bureau of Accounts, Finance and Rates, Federal Power Commission.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

It should be kept in mind that this dissertation deals specifically and exclusively with the rate regulation viewpoint of the depreciation reserve problem among public utilities. For example, the problem is quite different from the viewpoint of the tax specialist; he is interested in eliminating depreciation accrued upon that part of fixed plant which represents the cost of interest during construction, taxes (Social Security and other taxes incurred during construction of fixed plant), and service pension accruals (likewise capitalized, being a cost of construction).

To the regulatory commission, however, this aspect is of no moment; all proper costs of construction are allowed as additions to the fixed plant figure, and the depreciation accrual is designed to cover all such items.

The basic problem of the depreciation reserve is the determination of whether or not the reserve is equitable; and the problem assumes a double importance because the annual charge for depreciation affects the amount of income available for return while at the same time the contra-credit increases the amount of accrued depreciation which in turn affects the depreciated rate base.

In the present treatment of the problem, in order to dispense with all possible complications, consideration of valuation problems will be avoided; determination of an equitable reserve requirement remains just as much a problem regardless of the valuation method used, be it book cost, cost of reproduction, or a trended cost method.

This dissertation, after introducing the subject, examines the nature of the depreciation reserve, and is then in position to survey and discuss the many and varied methods and procedures which have been developed to provide a fair solution to the question: What is the equitable reserve requirement? To further indicate the nature of the problem, the following simplified hypothetical illustration is cited:

Given: Three units costing $100 each
Average Service Life - five years
No salvage value
One unit retired after three years
One unit retired after five years
One unit retired after seven years

If one were to compute the reserve requirement at the end of, say, the fourth year, the result would depend on which method were used. The Prospective Formula Method advocated by the National Association of Railroad and Utility Commissioners (NARUC) produces a figure of $120; the Unit Summation plan gives a result of $137.30; and using the Expired Life basis, the result would be $160.

As might be expected, the methods developed run the gamut from extremely complicated statistical refinements, such as the asymptotic method, to judgment "methods" which make no attempt to be scientific or objective. The courts have not discouraged any of the methods, however, scientific or subjective. The various difficulties surrounding determination of the reserve requirement are therefore set forth in Chapter III, so that the various methods and procedures may be better evaluated.

The question naturally arises as to just how vital the reserve requirement problem is. It has proven a very important matter in the electric power and manufactured gas industries particularly. In those industries there was very little uniformity in the accrual of depreciation reserves up to 1922. From 1922 through 1936, the industries generally followed retirement accounting rather than depreciation reserve accounting. The result was that there was general underaccrual of depreciation, and when the Federal Power Commission's Uniform System of Accounts went into effect in 1937, most electric companies found that a substantial increase in depreciation reserve was called for. The NARUC at the same time reversed its former policy and recommended that the industries adopt the depreciation reserve accounting throughout, abandoning the retirement accounting which had been followed since 1922.[1]

The accumulated retirement reserves in the electric industry in 1941 amounted to about 10% of plant; the depreciation reserves in the telephone industry, using depreciation reserve accounting since before 1913, amounted to almost 30% of plant.[2-3] This is indicative of the importance of the problem; and the manner of determining reserve requirement, the scheme of transition from retirement to reserve accounting, and the type of reserve adjustments required, will all profoundly influence the public utility industry.

---

[1]National Association of Railroad and Utility Commissioners, Report of Special Committee on Depreciation, November, 1938.

[2]Luther R. Nash, "A New Depreciation Fallacy," Public Utilities Fortnightly, Vol. XXX, No. 12, December 3, 1942.

[3]Federal Power Commission, Statistics of Electric Utilities In The United States, 1944.

CHAPTER II

THE ECONOMICS OF THE DEPRECIATION RESERVE

A. Nature of the Reserve.

Definitions. Because of the technical nature of the public utility industry, its depreciation problem has been claimed as the primary jurisdiction in turn of the engineer, the accountant, the economist, the lawyer. And each has produced his own definitions of depreciation and the required reserve. However, as the courts have the final authority, it is to them that we should first look.

Prior to the institution of regulatory commissions, depreciation was considered a matter of managerial discretion. In fact, in Smyth v. Ames, 169 US 466 (1898), the Supreme Court mentioned a host of factors to be considered in establishing a fair value rate base, but said nothing at all about depreciation or accrued depreciation. Not until 1909, in Knoxville v. Knoxville Water Company, 212 US 1, did the Supreme Court apparently recognize depreciation as a regular cost of operation. In 1915, the Supreme Court approved the Master's Report in the case of Des Moines Gas Company v. City of Des Moines, 238 US 153, which Report considered accrued depreciation as involved in the "condition, life and age of the various parts." The policy of the courts has been to generalize, and it has therefore been impossible to fix upon any definite rule or formula or definition as being in accord with the courts' interpretation of depreciation and accrued depreciation.

One of the most definite statements on the subject of accrued depreciation by a court was given by the United States

District Court, W. D. of E. D., Arkansas, in the Case of Arkansas Water Company v. City of Little Rock, P.U.R. 1924, C-73,106: "It is the difference between the value of an article new and its present value ... "[1].

The definition of depreciation developed by the Interstate Commerce Commission has been widely accepted, and substantially the same language has been used in the Uniform Accounting Systems set up by the Federal Communications Commission, the Federal Power Commission, and the National Association of Railroad and Utility Commissioners: "Depreciation is the loss in service value not restored by current maintenance and incurred in connection with the consumption or prospective retirement of property in the course of service, from causes against which the carrier is not protected by insurance, which are known to be in current operation, and whose effect can be forecast with a reasonable approach to accuracy."[2]

Depreciation is a loss in service value[3] of plant, whether it be due to wear, tear, decay, action of the elements, inadequacy, obsolescence, or even to changes in consumer demand or changes in the regulations of regulatory bodies. As provision is made each year for the expiring service life, such provision or charge accumulates over the years in the reserve for depreciation account. As the service lives of various units of property finally expire -- as retirements occur -- the value which the expired units carried in the plant account is removed from the plant account and charged against the accumulated depreciation in the reserve for depreciation account.

[1] Wisconsin Public Service Commission, Depreciation - A Review of Legal and Accounting Problems, (submitted to the 45th Annual Convention of the NARUC) October 11, 1943.

[2] "In re Telephone & Railroad Depreciation Charges." 177 ICC 351.

[3] "Service value" is the difference between book cost and salvage value.

The depreciation reserve, then, typically contains credits or additions consisting of the periodic depreciation accruals, charges or deductions representing actual retirements as they occur, plus the relatively minor items of salvage and removal costs which are also factors in the determination of service lives on which the depreciation accruals are based. The balance in the depreciation reserve will then be the excess of past annual depreciation charges over net losses sustained by retirements.

The reserve requirement has been defined as the amount which, at any given date, under some specific method of depreciation accounting, should be represented by the reserve for depreciation based on service life and net salvage estimates used in estimating the current rate of depreciation.[4] The NARUC is partial to a method which uses a forecast of prospective retirements in order to reach a reserve requirement figure (subtraction of estimated future accruals to the reserve for depreciation from present book value leaves a **remainder** which is considered the reserve requirement);[6] other accountants, however, contend that the only equitable way to determine the reserve requirement is to reconstruct the depreciation reserve by working back to the earliest date that any of the present plant was in service;[7] others, accountants and engineers, favor application of typical life curves and mathematical formulae; still others are convinced that any mathematical or accounting approach is both incorrect and unfair, and insist on physical appraisals or estimates

---

[4]NARUC, Report of Special Committee on Depreciation, November, 1938.

[5]NARUC, Report of Committee on Depreciation, 1943.

[6]See Chapter III.

[7]See Chapter III.

of condition-percent in order to reach a figure that reflects the amount of depreciation actually accrued to date. These schools of thought are all examined in Chapter III.

It may be stated then that the reserve requirement is the balance required in the depreciation reserve if that reserve is to reflect existing "accrued depreciation."

Importance of accrued depreciation to the ratepayer. Public utility accounting is very much akin to cost accounting in this respect. In cost accounting, the object is to allocate total operating cost exactly among total units produced so that each unit will bear its proportionate share. One of the main considerations in dealing with the depreciation problem in public utilities, likewise, is to so allocate the cost of plant (which is constantly in process of being worn out or of becoming obsolete, in the service of the public) that such cost will be equitably borne by each year's ratepayers.

There is very little disagreement among experts as to the theory of the ratepayer bearing the cost of depreciation; but opinions differ drastically as to the method of prorating such depreciation cost, just as they had differed in methods of determining the reserve requirement -- the same problem is involved. Most methods utilize a fixed annual charge (straight line) or a progressively increasing or decreasing (interest methods) figure that will accumulate to 100% of book value (less net salvage) over the estimated service life of the asset. But there are variations, and one such variation advocates that in order to be accurate and to charge each year's ratepayers with the cost of capital assets "actually consumed" during that year, estimates of actual or "observed" depreciation must be compiled each year. A variation of this is the Retirement Method of accounting, which charges to a year's operations the amount of retirements actually occurring during that year.

If the reserve for depreciation (as built up by annual charges for accrued depreciation) at any particular time is too low, ratepayers of prior periods have been undercharged -- and either the future ratepayers will be penalized by increased depreciation rates, or else an adjustment will have to be made to surplus forthe deficiency in the accrual of depreciation. If the reserve for depreciation proves to be too high, ratepayers of prior periods have been overcharged. The problem then remains to determine whether the reserve is too high or too low -- in other words, we want the reserve requirement.

Importance of accrued depreciation to the investor. On the other hand, however, consider the effect of an inadequate depreciation reserve on the investor. The plant figure, with an inadequate deduction for accrued depreciation, will produce an excessive rate base, resulting in an allowed return in excess of the fair return. If the depreciation reserve were excessive and deducted in full, the opposite result would occur, and allowed return would be below the fair return; however, the depreciation reserve became excessive presumably because of excessive depreciation accruals, and this latter would have the effect of decreasing net income, thus understating actual net income and counteracting the effect of the low figure for allowed return.

One more effect of the depreciation reserve must not be overlooked. An adequate depreciation reserve contributes to the financial integrity of the utility company, and has an indirect but definite effect on rates of return, particularly where the rate of return is affected by the cost of capital to the company. The depreciation charges that build up the depreciation reserve have the effect each period of releasing an equivalent amount of funds[8] which is normally used either to acquire new equipment or to retire fixed debt. Either of these alternatives has the effect of keeping to a minimum the amount of securities outstanding, reducing interest requirements and contributing to sound financial structure. Only passing mention need be made of the notorious abuses of depreciation accounting in the early days of the American utilities, when depreciation charges and reserves were kept purposely low in order to obtain all possible "profits." The result was large dividends to the promoters and disaster to investors who came afterwards.

It might also be added that a soundly-financed utility is not only of benefit to its stockholders; it will also be in a better position to keep its plant up to date and render a consistently high quality of service to the ratepayers.

<u>Ownership of the Depreciation Reserve</u>. In the Knoxville Water Company Case, 212 US 1 (1909), the United States Supreme Court indicated that it is the right of the investors in a public utility to require management to set up reserves out of operating income. But a great deal of confusion exists as to the equity of the depreciation charges that make up the reserve for depreciation.

When the ratepayer, in buying utility service, pays rates designed to cover a yearly depreciation charge in addition

[8] See any accounting text. See below, p. 12.

to other operating expenses of the utility, he is not thereby purchasing a share in the fixed equipment of the company; he is not contributing to the cost of that fixed equipment; in other words, the fact that the ratepayer pays the annual depreciation charge does not mean that he is, even to a small extent, contributing capital to the company. The owners, the investors, have first contributed capital — have first purchased fixed equipment -- before the company goes into operation and before depreciation charges are levied.

Nor is the ratepayer, by paying the depreciation charge, contributing specifically toward plant replacement, as the depreciation charge is not designed exclusively to finance replacements of plant — even if there is no intention of ever replacing retired plant, a charge for accruing depreciation is still proper.

The depreciation charge is a real cost of operation, covering that period's loss in service value of depreciable property.[9] The rates paid by customers are designed to afford the company sufficient revenue to cover their operating costs and a fair return on their investment. The revenues may be broken up, for purposes of illustration, and a part used to meet the payroll, a part for maintenance, a part for accruing depreciation, etc. The excess of revenue over all such expenses, of course, is profit, or return, and is added to the company's surplus. If no deduction had been made for depreciation, the profit would have been larger by the amount of such depreciation deduction — and that much more would have been added to surplus -- and

---

[9] NARUC, Report of Committee on Depreciation, 1938.

that much more would have been available for dividends. However, in order to preserve intact the capital investment, each year's depreciation charge is deducted as an expense, thus reducing the amount of profit transferred to free surplus. In effect, what has happened is just that the investors have taken that part of the period's income and placed it in an earmarked part of surplus, the depreciation reserve account.

Shying clear of further accounting precepts, the nature of the investor's interest in the depreciation reserve may be quite clearly seen from the point of view of equity. If a person loans money to someone, he can expect in return not only the interest on the money but the amount of the original loan as well. It might be said that he expects a return <u>on</u> as well as a return <u>of</u> his capital. The same applies to the public utility investor. While his capital is in service, he is entitled to a return on same; and he is likewise entitled to the annual depreciation charge which, over the life of his fixed equipment, will eventually return his investment to him. And the depreciation reserve, representing the accumulated depreciation charges (less actual retirements of equipment), thus becomes a handy medium for determining the amount of "unreturned capital" remaining, on which the investor is still entitled to a return.

It may be said, then, that regardless of the techniques used in constructing the reserve for depreciation, it (or assets in equivalent amount) belongs to the investor, and not to the ratepayer.

<u>Utilization of the Depreciation Reserve</u>. One writer

has asked: to what extent are depreciation funds available for construction of new plant? After pointing out that the depreciation reserve does not represent liquid assets, and has been constantly drawn upon for replacements of plant and other expenditures, he answers, "the obvious answer seems to be that only current appropriations to the reserve are available."[11]

It must be pointed out that the depreciation reserve is not an asset at all; it is a proprietary account, a reservation of free surplus, as explained in a preceding paragraph. But the conclusion reached by Mr. Meigs above is correct; the annual accrual or depreciation charge, being treated as an expense, decreases the amount of net profit added to free surplus -- without having caused any expenditure of cash, as do the other expenses. The amount of depreciation expense for the period then becomes a "source of funds." These funds find their way to other uses; some of these are payment of current bills, retirement of long-term debt, purchase of new equipment -- or even payment of a dividend, assuming there exists free surplus. Such is the effect and disposition of the current depreciation charge.

In some rare cases, a company desires, or is required, to set up a depreciation fund in addition to a depreciation reserve. The annual charge for depreciation, offset by a contra-credit to the reserve, remains unchanged; but an additional entry is made, withdrawing cash from bank and placing the required amount in a bank account or trust fund labelled depreciation fund.

---

[11]R. J. Meigs, "Are Depreciation Reserves Available for Improvements?" Public Utilities Fortnightly, Vol. XXXV, No. 1, January 1, 1945.

A depreciation reserve which has been handled properly should, at any time, reflect the total of depreciation charges thus far paid by the public, less net charges for actual retirements. As such, the reserve balance will show the amount of depreciable investment for which the investor has already been reimbursed and on which no return is allowable. This is, in the opinion of the writer, the only thing of which we can be sure when we see the reserve balance. It will not necessarily reflect the extent to which the equipment has depreciated; and that is one of the highly controversial aspects of the problem.

Adjustments to the depreciation reserve. The general rule governing correction or adjustment of the reserve is that it be made through the surplus account, so as not to distort current operating results.[12] But there are complications to be considered, particularly if the amount involved in the adjustment is substantial.

In case a reserve requirement is computed, and the actual balance in the depreciation reserve is far in excess of the requirement, recourse may be had to two adjustment methods. The quickest and simplest is to reduce the reserve by transferring the excess to surplus -- but, if the reserve balance represents return of investment for which the consumer has been charged in the past, such transfer to free surplus gives the utility an unfair addition to their free surplus. Another method is to make up for the excessive reserve balance by reducing future depreciation charges; this is more equitable than the first method -- as between the

---

[12] National Association of Railroad and Utility Commissioners, Report of Committee on Depreciation, 1943.

ratepayer and the investor -- but some inequity still exists as between the past ratepayers who paid excessive depreciation charges and the future ratepayers who will benefit from that fact. The legal doctrine seems to be that "where excessive reserves have accumulated, the annual depreciation charges in the future may be adjusted."[13]

The problem most frequently met, however, involves an inadequate depreciation reserve. This is usually the case when a company switches from retirement accounting to reserve accounting. Methods suggested to increase an inadequate reserve balance include augmenting future annual depreciation charges by enough to eventually bring up the reserve balance to the required balance, transferring some free surplus to the depreciation reserve, or even more drastic -- reducing the stated value of outstanding stock and transferring the resulting capital surplus to depreciation reserve.[14] It has been pointed out[15] that the earnings and dividend history should be studied, as depreciation charges might have been kept purposely low in order to pay out excessive amounts of dividends.

When the 1943 and 1944 reports of the NARUC recommended that utilities adopting reserve accounting adjust their depreciation reserve to conform to the reserve requirement as computed on a straight line accrual basis, it raised a storm of protest

13 Wisconsin Public Service Commission, Depreciation - a Review of Legal and Accounting Problems, October, 1943.

14 Irston R. Barnes, The Economics of Public Utility Regulation, Yale University, F.S.Crofts & Co., New York (1942).

15 Wisconsin Public Service Commission, op. cit.

from some utility officials who feared impairment of their surplus in order to build up the depreciation reserve.[16] One writer[17] points out that retirement reserves (using the retirement method) in electric power companies amount to something over 10% of plant in service, whereas in the telephone field where depreciation reserves were used, such reserves are close to 30% of plant in service; and speaking for the utilities, that writer says, "They naturally are not reconciled to the wiping out of 20% of their investment, which would be the effect of applying the reserve requirement theory."

One of the serious objections to the adjustment of depreciation reserves was raised in connection with legal considerations. Those companies who had followed the flexible standard of retirement accounting (and accumulated inadequate reserves for depreciation) were merely adhering to the policies promulgated by the several uniform systems of accounts in effect prior to 1937; and the contention now is that the companies should not have to make any adjustments retroactive to years prior to 1937. One outstanding author stated that the NARUC proposal for retroactive adjustment is "both logically and morally indefensible."[18] The writer of this dissertation has come across a recent court decision which rather definitely indicates the legality of

---

16 C. E. Packman, "A Suggested Solution of the Depreciation Problem," Public Utility Fortnightly, Vol. XXXIII, No. 12, June 8, 1944. (Mr. Packman is Controller, Middle West Service Company, Chicago; Vice Chairman, Accounting Section, American Gas Association.)

17 Luther R. Nash, "A New Depreciation Fallacy", Public Utility Fortnightly, Vol. XXX, No. 12, December 3, 1942.

18 George O. May, Financial Accounting, The MacMillan Company, 1944. (Chapter IX).

"retroactive adjustments." The United States Supreme Court, in the New York Telephone Company Case, handed down a decision in March 1946, upholding the original cost provisions promulgated by the Federal Communications Commission in its Uniform System of Accounts adopted January 1, 1937. Parts of certain telephone station equipment were sold by the American Telephone and Telegraph Company to the New York Telephone Company between 1925 and 1928; the New York Company put the equipment on its books at the "structural cost" (something akin to reproduction cost), which was permitted by the regulations of the Interstate Commerce Commission in effect at that time. The Federal Communications Commission required the company to write-down the equipment to original cost (to the original owner, American Telephone and Telegraph Company), in keeping with the regulations which came into effect in 1937, and the Supreme Court upheld the Federal Communications Commission. This would certainly appear to be a clear-cut case involving a "retroactive adjustment".

B. Effects of an Improper Depreciation Reserve, if an Undepreciated Rate Base is in Use.

Though Supreme Court and lower court decisions seem to be consistent in requiring that accrued depreciation be deducted in computing fair value,[19] there are two types of exceptions that concern us here. One type involves the use of an undepreciated rate base (or a rate base using a depreciation reserve other than the one accumulated by the annual depreciation charges to operations).

[19] Public Service Commission of Wisconsin, op. cit.

Certain commissions and lower courts have bent over backward to ignore the inequity involved in not recognizing the accumulated depreciation charges as a proper deduction from the rate base;[20] the result is the granting of a return on capital that has already been returned to the investor. This will be discussed later.

The other exception is one that has apparently been sanctioned by the Supreme Court; it permits the use of an undepreciated rate base in those cases where the sinking fund method of depreciation accounting is followed. Such were the facts in the case of Los Angeles Gas and Electric Corporation v. R. R. Commission of California, 289 U.S. 287, decided by the Supreme Court on May 8, 1933. The same decision was rendered by the D. C. Court of Appeals previously in the case of the Public Utilities Commission of the District of Columbia v. Capital Traction Company, 17 F (2d) 673. The use of an undepreciated rate base appears quite proper when the sinking fund method of depreciation is being followed, as that method (by compounding interest on the reserve balance) gives due weight to accrued depreciation charges.

There follows, below, a simplified example demonstrating how use of depreciated rate base will produce the same result as use of an undepreciated rate base, if the latter is in conjunction with the sinking fund method of depreciation, which (1) treats the

[20] Commission ruling in case of James A. Murray v. Public Utilities Commission of Idaho, PUR, 1915 F., 441: "...if it can be demonstrated that the plant is in good operating condition, and giving as good service as a new plant, then the question of depreciation may be entirely disregarded." In the same vein is this Court decision: "...If, in fact, the capacity has remained the same, depreciation should not be a function of the rate base at all." (258 US 165).

reserve for depreciation as a source of funds and (2) considers computed interest on the reserve balance as a deduction from the annual depreciation charge (or, in effect, reduces the amount of the investors' return, the investors being charged interest for the use of reserve capital).[21]

1)	GIVEN:	Cost of Invested Capital	$80,000	-	5%
2)		Reserve for Depreciation	20,000	-	4%
3)		Undepreciated Total	$100,000		4.8%(Avge).

		Depreciated	Undepreciated
4)		Depreciated	Undepreciated
5)	Year's expenses	$10,000	$10,000
6)	Depreciation Expense		
7)	(say 2 1/2% x $100,000)	2,500	2,500
8)	Interest on Reserve (2)	-	(-800)
9)	Return: 5% x $80,000 (1)	4,000	
	4.8% x $100,000 (3)		4,800
	Total Cost to the Ratepayers	$16,500	$16,500

It may be stated in summary that if the sinking fund method of depreciation is in use, an undepreciated rate base may produce the same result as a depreciated rate base which does not entail an interest charge on the reserve balance.

The above provides an answer to those who recommend adoption of the sinking fund method of depreciation accrual on the grounds that such method avoids the necessity of determining a reserve requirement.[22] True, the undepreciated rate base is utilized, but the amount of the reserve for depreciation, as the base for computation of interest to be deducted from the consumers' rates, is still a vital figure. The depreciated and undepreciated results will both remain equal, regardless of how large

[21] This scheme has been utilized a number of times by the Public Utilities Commission of the District of Columbia.

[22] NARUC, Report of Committee on Depreciation, 1944.

or how small the depreciation reserve is. But if the reserve were 40% instead of 20% as given, the cost to the ratepayers would be $1,000 less. So the size of the depreciation reserve does have a definite effect on rates, even though an undepreciated rate base is used.

Here, as well as in all other depreciation methods, we are faced with the necessity of having the reserve accurately reflect the accumulated depreciation charges as assessed prior and current ratepayers -- in order that capital returned to the investor will not earn a return.[23] One state commission[24] deducted from the rate base the total amount credited to the company's depreciation reserve, even though such reserve was admittedly in excess of past depreciation requirements. The Commission's decision was quoted as follows: "... we do not know how much of the excess in the depreciation reserve has resulted from excess depreciation allowances or incorrect accounting practices. However, to the extent that the excess has resulted from excessive and duplicate depreciation charges at the expense of the ratepayers, we believe the company is estopped from claiming that the residual of the amounts so collected should not be deducted from the property and plant account for rate-base purposes."[25]

Excessive vs. Inadequate Reserves. If, as indicated

---

23 Of course, if such capital is reinvested in new plant, it is added to the plant account total; but that has no effect on the accumulated total in the depreciation reserve.

24 Wisconsin Public Service Commission, "Re Mondovi Telephone Company", Public Utilities Reports, 1933 B., 325.

25 Willard J. Graham, Public Utility Valuation, Chicago University Press, 1934.

in the foregoing paragraphs, an important consideration in evaluating the propriety of a depreciation reserve is the accuracy with which the reserve reflects the accumulation of past amounts of depreciation charged consumers, does it make any difference if the reserve is excessive or if it is inadequate? The question might well be put in economic terms: as a plant becomes older and loses efficiency, it moves toward the margin -- it becomes a high-cost producer; hence its "value" has decreased. This decrease in value may be indicated by the increasing depreciation reserve balance. But, simultaneously, the decreased "value" means a lowered rate base, which decreases the amount of allowable return. This latter item, being a "cost of production," tends to offset the upward trend of costs.

If the reserve is excessive, past consumers have been overcharged for depreciation, but to what extent did the resultant decrease in rate base offset such overcharges by lowering allowable return? A similar question applies to an inadequate reserve. Before pursuing this aspect further, it is well to peruse the other considerations involved.

One body of opinion favors adequate reserves, and reserves (like the straight line reserve) that build up quickly.[26] This reduces the risk borne by the investor (of errors in estimates of service life; of obsolescence; etc.) and may reduce the amount of securities that would otherwise be outstanding. The industry,

---

[26] Ganson Purcell, stating views of the Securities Exchange Commission, before the National Association of Railroad and Utility Commissioners, March 8, 1944. Quoted by O. Ely in "Depreciation: Will NARUC Reconsider?", Public Utilities Fortnightly, Vol. XXXIV, No. 1, July 6, 1944.

however, appears to prefer small reserves,[27] particularly if company surplus is to be utilized in building the reserve up to the computed figure, and the objection is understandable: in case of future corporate reorganizations or even rate cases, sight may be lost of the investors' special contribution to the depreciation reserve. One of the complications involved would be proper segregation of investors' and consumers' shares in the reserve after retirements were charged against the reserve balance.

One other difficulty in connection with improper accruals is a practical one. Every method of depreciation, in theory, writes off the service value of the asset over the life thereof. In practice, particularly where group rates are used, no record is kept of the progress of depreciation accruals against any particular assets. To take an extreme case for an example: if a company is accruing depreciation at 10% per year on an item expected to live twenty years, it may well be able to accrue double the service value of the item over its actual service life. Though in general practice, depreciation rates used by utilities are not interfered with by the regulatory bodies, it is the writer's opinion that such rates should be given much more careful consideration -- mainly because of the lack of any automatic accounting check on growth of the reserve.

A simplified, hypothetical illustration, given below, will show the effect of the depreciation charge on the relationship between allowed return and net income (or income available for return).

GIVEN: (1) Undepreciated Rate base - $10,000 (2) Beginning balance in Reserve (cases A through E) - $ 400

[27]Edison Electric Institute, "Conclusions on NARUC Depreciation Report," Public Utilities Fortnightly, Vol.XXXIII,No.7. March 30, 1944.

(3) Rate of Return on Depreciated Rate base - 6%
(4) Yearly Net Income, before deducting depreciation - $700

	A	B	C	D	E
(5) Yearly Depreciation Charges - $	25	75	100	200	300
(6) Depreciated Rate base:					
End of 1st year	9575	9525	9500	9400	9300
End of 2nd year	9550	9450	9400	9200	9000
End of 10th year	9350	8850	8600	7600	6600
(7) Yearly Net Income (after depreciation)	675	625	600	500	400
(8) Allowable Return:					
1st year	574.50	571.50	570	564	558
2nd year	573	567	564	552	540
10th year	561	531	516	456	396

Note the typical effect of an excessive depreciation accrual by comparing columns C and E in the above illustration. There is a two-hundred dollar difference in the yearly accrual; this has a direct effect on net income (7), but allowable return (8) is affected percentagewise only, there being a difference between C and E in the first year of ($200 x 6%) $12.00. In other words, allowed return is reduced six dollars every time net income is reduced one-hundred dollars.

The theorem to be deduced from the above illustration is that excessive depreciation accruals can be used as a tool to reduce the net income figure of a utility company if it might otherwise have exceeded allowed return. In the above illustration, net income exceeded allowed return in every case except in columns D and E, which had the highest depreciation charges, and in D it took about six years -- in E, ten years -- before the cumulative effect of the high depreciation charges brought the allowed return down below the net income figure.

CHAPTER III

METHODS OF DETERMINING RESERVE REQUIREMENT

Consideration given to the reserve for depreciation up to this point might lead one to inquire as to why the matter of a reserve requirement could not be expeditiously settled by merely fixing the reserve requirement figure as the balance in the reserve for depreciation account. The answer is that not everyone is content to view the problem from the standpoint of accounting simplicity. Depreciation accounting, be the method straight-line, on the compound interest curve, or on an actuarial basis, is a pure and simple amortization proposition, and by no stretch of the imagination (in the writer's opinion) could an accountant suggest that the reserve for depreciation balance reflected accrued depreciation; it reflects only accrued amortization of book cost of depreciable plant.

It is important in all businesses, particularly utilities, to charge-off to operations the service value (book cost less salvage) of items of plant -- during the service life of those items of plant. Depreciation accounting accomplishes this. In the utility field, however, an ideal solution would require that reserve requirement reflect "accrued depreciation" -- rather than "accrued amortization" -- in order to equitably distribute the cost of depreciation (see p.5 for definition) among the ratepayers of different periods, and also to equitably reimburse the owners by using "depreciated" rather than "amortized" book cost as the rate base. This observation appears eminently fair; but the difficulties involved in determining "accrued depreciation" are manifest. To what extent are such factors as inadequacy, obsolescence, changing requirements of regulatory bodies, etc., susceptible to objective quantitative determination? A number of conditions may account for deferred maintenance; is it humanly possible to objectively determine the dollars and cents effect of such a policy during any accounting period? Deferred maintenance normally reduces eventual service life of equipment, but would the research needed to make a good estimate of the effect of this one phase of depreciation be worthwhile? Also, there is the ever-present temptation, because the "observed depreciation" methods lack a pre-determined amortization program, to manipulate depreciation charges to produce whatever net income figure best serves the purposes of the utility management.

The writer of this treatise has been able to classify the various opinions as to the reserve requirement into two groups, as indicated in the preceding paragraphs. The battle lines are fairly clearly drawn, with the utility companies generally in favor of "observed depreciation", and the regulatory bodies generally trying to support the reserve for depreciation as the determinant of the reserve requirement. There are also methods which attempt to compromise between the two extremes — such as the Retirement Forecast Method, and the actuarial methods in general. The principle of the latter, for example, conforms to the general accounting methods' in that it writes-off to operations the service value of plant over the service life of that plant — but it also admits the fact that depreciation charges, if they are to fall equitably on each year's ratepayers, should be made only as such depreciation occurs. To attain this latter objective, the actuarial methods utilize "life tables" (or "mortality tables"). The Life Tables are also designed to answer the critics of the "observed depreciation" methods, by introducing an element of objectivity in the translation of accruing depreciation into dollars and cents.

Before proceeding to the survey of the various methods of determining reserve requirement, perhaps the opinion of the U. S. Supreme Court in this matter ought to be investigated.

"Depreciation, or loss in value, is essentially a legal concept."[1] That author goes on to say that depreciation, as a concrete economic concept (however measurable in quantitative units of value), is not a natural phenomenon controlled by any natural law. Therefore we must look to law to select the meaning "best according with our social experience in this stage of our social development."[1] The U. S. Supreme Court in McCardle v. Indianapolis Water Company (272 US 400), in 1927, made a rather definite statement on the subject: "The testimony of competent valuation engineers who examined the property and made estimates in respect of its condition is to be preferred to mere calculations based on averages and assumed probabilities." This apparent recognition of "accrued depreciation" as something independent of the balance in the reserve for depreciation account was admitted in at least two later cases[2] by the Supreme Court -- Smith v. Illinois Bell Telephone Company (282 US 133) in 1930, and Los Angeles Gas and Electric

---

1 Scharff, Leerburger & Jeming, Depreciation of Public Utility Property, 1940.

2 Perry Mason, Principles of Public Utility Depreciation, Monograph #1 of American Accounting Association (1937).

Corporation v. R. R. Commission (289 US 287) in 1933.

On the other hand, the late Justice Brandeis, in a dissenting opinion (United Railways & Electric Company v. West, 280 US 234, 1930), did state his belief that depreciation claimed by the utility should be consistent with that shown in its published statements.

Despite this apparently overwhelming weight of opinion in favor of observed depreciation, most regulatory bodies still feel that a clear-cut decision has never yet been rendered. One such body[3] points out that the "observation method" seems to have received Court sanction mainly in those cases where the regulatory bodies used arbitrary methods or industry-wide averages, ignoring the particular maintenance policy or other individual factors of the particular company involved.

In further support of the stand of the regulatory bodies, it might be added that in at least five cases,[4] three of which are fairly recent, the Supreme Court has stated that it is concerned primarily with the constitutionality of the depreciation figures rather than with the details of rate estimates and methods. The cases are: Van Dyke v. Geary (244 US 39) in 1917; Georgia Railway & Power Company v. RR Commission (262 US 625) in 1923; and the cases of Clark's Ferry Bridge Company v. PSC (291 US 227), Dayton Power & Light Company v. P.U.C. (292 US 290), and Columbus Gas & Fuel Company v. P.U.C. (292 US 398) in 1934.

As far as the courts of law are concerned, then, it appears that the matter of determination of reserve requirements remains

---

[3] PSC of Wisconsin, op. cit.

[4] Perry Mason, op. cit.

very much subject to controversy.

A. Methods Based on Depreciation as an Economic and Physical Function. The nomenclature of the various methods advocated under this heading reveal that, in essence, they all have a common denominator, viz., the opinion that depreciation is and must be treated as an economic fact -- a sort of adjustment to "value". The methods are called "Inspection Method", "Observed Depreciation Method", "Operating Efficiency Method", "Estimated 'Actual' Depreciation Method", and "Percent Condition Method", to mention the typical ones. As one author points out,[5] the decrease in value of a piece of equipment caused by contingencies or by technological, economic and social changes hardly accrues uniformly -- nor even in accordance with carefully constructed formulae. The same author points out that roughly 20% of utility retirements are due to physical causes (which can be predicted with a degree of accuracy), whereas some 80% are due to non-physical causes which "have so far defied classification or consistency in their effects".

It might be well to briefly consider some of the problems encountered. Those who are convinced that the reserve requirement, to be equitable, must reflect "actual" depreciation, generally malign the attempts of actuaries to forecast the progress of depreciation in terms of fiscal periods. They point to the paucity of useful data on actual service lives of utility plant. Most steam turbines now in operation were installed since 1920, each utilizing

---

[5] Luther R. Nash, "A New Depreciation Fallacy", Public Utility Fortnightly, Vol. XXX No. 12, December 3, 1942.

differing principles of design.[6] In recent years, important technological changes have taken place in "more than fifty percent of the depreciable plant of a modern electric power system,"[7] e.g., switching equipment and relays associated with high-voltage transmission, impregnated pine poles, lightning arresters, new types of street-lighting equipment, customers' meters, high permeability wound-core transformers, and high-pressure and high-temperature boilers and turbines.

The interplay of economic forces is also a complicating factor. An example can be drawn from the gas industry.[8] Installations and retirements of water gas sets vary in many cases with the price of gas, coal, and oil. As the sets are relatively inexpensive, an increase in installations occurs when coal prices advance.

Another contention is that "continuously progressive loss in usefulness or service value does not take place in the major units of utility property."[9] This author points to cases of restored serviceability in which there actually occurs a "reversal of the progress of depreciation", such as line transformers which burn out from overloads from time to time, but when rewound with new, higher-permeability cores, are better than they were new -- and at two-thirds the original cost. The same process occurs when faulty parts of customers' meters are replaced with improved parts.

---

6 Cooperating Committees on Depreciation, American Gas Association and Edison Electric Institute, An Appraisal of Methods for Estimating Service Lives of Utility Properties. February 14, 1942.

7 Nash, op. cit.

8 Cooperating Committees on Depreciation, AGA and EEI, op. cit.

9 Luther R. Nash, op. cit.

A similar instance involves the steam turbo-generator units in the power station group; those units require new blades every 10 years or so, which cost about one-sixth of original cost of the entire unit. The frame and body continue serviceable indefinitely, but with the addition of the new blades, usually made of improved quality steel, the unit is better than new. A final example of this "cyclical depreciation" is the condenser attached to turbine units; the nonferrous tubes need replacing about every 10 years and cost about a quarter of the total original cost of the unit. The body is unimpaired, and with new tubes of better resistancy to corrosion and erosion, the unit becomes better than new.

Another item of plant that "defies" depreciation is distribution copper, which, it is pointed out, sometimes has a salvage value in excess of its original cost, particularly in a time of war-created shortages.

Typical of the viewpoint of the observed-depreciation school, is Nash's discussion of underground conduit and manholes as being free from the ravages of depreciation. He admits that the cable may eventually be replaced, but vitrified or similar duct laid in concrete is considered to have perpetual life. Confronted with the possibility of streets or neighborhoods being relocated, or the possibility of a radical change in the power supply program, it is admitted that the value of the particular ducts will drop from 100% to zero. But rather than admit that the gradual amortization of book cost would have provided a cushion against this sudden retirement, the observed-depreciation school would only utilize this case as a justification for "retirement accounting" methods -- which write-off retirements if and when they occur, such indeed being the depreciation history in this particular illustration.

The point of view is somewhat reminiscent of the farmer who had a twenty-year-old axe which he claimed never depreciated -- aside from replacing the head and handle four or five times, the axe was still as good as the day he bought it!

The methods which consider depreciation an economic function vary in range from the strict "retirement accounting" method alluded to above (which provides for no reserve at all, places entire burden of the retirement at the end of service life) to more conservative plans such as the one advocated by the Edison Electric Institute:[10] Factors to be used in determining reserve requirement were suggested to include "previous history of retirement costs and accumulated reserves; character, age and physical condition of the property; past and prospective rate of growth; economic conditions in the area served; technical developments; liability to loss from storms, etc.; and requirements heretofore imposed by regulatory authorities." A short review of the main trends of thought in the observed-depreciation school follows:

<u>Retirement Accounting</u> method uses the "Immortal Plant Theory"[11] which contends that a diversified and well-maintained plant is just as valuable as a new plant, therefore there should be no accrual of depreciation. The entire cost of a unit is charged to operations at the time of actual retirement from service.

<u>Cost to Restore</u> method assumes a partial loss in value during use of a unit, to the extent of cost to restore to a so-called

---

[10] Public Utility Fortnightly, "Edison Institute Conclusions on NARUC Depreciation Report," Vol. XXXIII, No. 7, March 30, 1944.

[11] Irston R. Barnes, <u>op. cit.</u>

new condition at any time. Such partial loss in value is neutralized each time the unit is restored to "new" condition by maintenance or replacement of parts. The greatest portion of the original book cost of the unit is charged to operations at the time of actual retirement of the unit.[12]

Retirement Reserve method involves creation of a reserve, by arbitrary charges to retirement expense over a period of time, which will be sufficient to absorb charges due to property retirements, trying to equalize the effect of such charges over several rather than just one fiscal period. The charges to retirement expense, even though spread over a number of periods, are not designed to cover accruing depreciation, but rather to partially cushion the shock of an imminent retirement.

Observed Depreciation method is more a generic term than a "method" of determining depreciation. It "assumes a loss in value to the extent that physical deterioration actually occurs and to the extent that obsolescence, inadequacy, change in use, and public requirements actually occur from time to time, with partial restoration of value by maintenance or replacement; and with complete loss of remaining value occurring at the time of retirement."[13]

Deferred Maintenance method measures accrued depreciation in terms of what it would cost to restore the plant to efficient operating condition. Another approach is to deduct from cost-new any maintenance which has been neglected or deferred, to get the present value figure.[14] "Certain of the railroad, gas and electric

[12] Maurice R. Scharff, op. cit.

[13] Leerburger, op. cit.

[14] Wisconsin PSC, op. cit.

companies ..... contend that no depreciation should be deducted for valuation purposes ..... unless there is deferred maintenance affecting the quality of service....."[15]

The one factor that brands all of the above methods and prevents any intensive investigation of their characteristics, is their arbitrary and subjective quality. None of them require any planned, systematic method of writing-off a cost that is inexorable. Described below is a plan, known as the Retirement Forecast Method, which I believe brings the two schools of thought closer together than any other plan disclosed by my survey; its advantage lies in the fact that it recognizes age and expired service life as factors in computing reserve requirement, but nevertheless gives most weight to the normal function of management in planning property replacements.

Retirement Forecast Method of Gauging Depreciation.[16] The depreciation reserve, under this method, is made up of three parts:

(1) Cumulative accruals on all depreciable property, except property included under Part (2). Accruals to Part (1) of the reserve will be at low annual rates, to cover loss due to physical deterioration only.

(2) Cumulative accruals on property scheduled for retirement within ten years from date. When obsolescence, inadequacy, governmental requirements, etc., point to approaching retirement, the date of withdrawal from service is forecast by company engineers, and the depreciation rate on this property is adjusted upward to

---

15 Willard J. Graham, Public Utility Valuation, U. of Chicago Press, 1934.

16 Max. C. Mason, "Retirement Forecast Method of Gauging Depreciation," Public Utilities Fortnightly, January 17, 1945.

meet the retirement date.

(3) Allowance for unexpected retirements. This is strictly a matter of judgment by management.

The procedure as above described is simple, in that the rates used in Part (1) are based on predictable physical service life. Part (2) is a feature that appears to be valuable in bringing about a coordination between the company's engineering staff's estimates of future retirements and the recorded depreciation per books.

Opinion. In the early days of utility regulation, the weight of judicial authority seems to have been in support of the straight Retirement Theory of accounting for retirements. In U.S. v. Kansas Pacific Railway Company (99 US 455, 459) in 1878, and in San Diego Land and Town Company v. Jasper (189 US 439, 446) in 1903, the U. S. Supreme Court held that the company could not provide for depreciation in excess of actual expenditures for maintenance and for replacement of property actually retired.[17] It was not until 1909 (Knoxville v. Knoxville Water Company, 212 US 1, 13) that the Supreme Court held that a utility should include in rates an amount in addition to current maintenance and replacements, "for making good the depreciation and replacing the parts of the property when they come to the end of their life." As was pointed out earlier, court decisions to date have not been clear-cut enough to end the controversy between the observed-depreciation school (which appears to be an outgrowth of the Retirement Theory) and the depreciation-accounting or amortization school.

Typical of the divergent points of view are the following:

[17] Scharff, Leerburger, and Jeming, op. cit.

One outstanding proponent of the observation method[18] states that actual incidence of depreciation can be determined by observation and special studies, and believes that "competent" observers will invariably agree on any particular item of valuation. The NARUC[19] however, points to the pitfalls of over-simplification of the problem. Inspection of property to determine percent condition is unsatisfactory, as the eye cannot see imminent obsolescence and inadequacy. A thorough and objective study would have to include an analysis of production statistics, load factors, growth of service requirements, and management plans.[20] Also, they continue, sight must never be lost of the fact that, regardless of maintenance and repairs, service capacity is gradually being consumed, and this accumulating loss must be considered.

Though the arbitrary-charge feature of the observed depreciation method has been abused on occasion by fraudulent operators to permit illegal dividend payments, there is an inherent difficulty in the plan in that there is no compulsion to retire property that has become obsolete, inefficient, or uneconomical, thus delaying the write-off of depreciation at the discretion of management. The contention is made[21] that as a general rule retirement-reserve methods result in an inadequate reserve, failing to adequately reflect loss in service-value of the plant. Two illustrations of this contention follow:

The railroads had used retirement accounting for track equipment. When the Interstate Commerce Commission, under Order

---

18 Ibid (Scharff).

19 NARUC, Report of Special Committee on Depreciation, November 1938.

20 NARUC, Report of Special Committee on Depreciation, November 1938.

21 Ibid.

No. 15,100, prescribed institution of depreciation accounting, the railroads were faced with the "possibility of being forced to write off against surplus 'expired value' of ties and rails which has never been charged to operating expense. In normal periods this would amount to about 50% of original cost. Under present conditions of deferred maintenance it is probable that 55% to 65% of the service value of such equipment no longer exists, although no corresponding charge has been made to operations."[22]

The Bell Telephone System has used depreciation accounting at least since 1913. The combined balance sheet for the System, according to its Annual Report to the Federal Communications Commission for 1937, shows total utility plant of $4,400,000,000, with a depreciation reserve balance of $1,200,000,000, for a reserve ratio of 27.3%.

The electric utility industry almost universally used retirement accounting. According to an industry-wide balance sheet compiled by the Federal Power Commission, covering privately-owned companies having total assets of over $1,000,000, as of December 31, 1934,[23] there was total utility plant of $13,400,000,000 with a retirement reserve of $1,155,000,000, for a reserve ratio of only 8.6%, compared to the more conservative (if not more accurate) ratio of 27.3% for the telephone companies.

B. Accounting or Systematic Amortization Methods of Recording Depreciation. There will be included under this section the more

22 Willard J. Graham, Public Utility Valuation, U. of Chicago Press, 1934.

23 Companies adhered to retirement-accounting procedures generally from 1922 through 1936, when Federal Power Commission's Uniform System of Accounts went into effect.

commonly used methods of recording depreciation; they are important because many regulatory commissions consider the balance in the depreciation reserve account, as built up under one of these methods, as the only proper reserve requirement figure. The actuarial methods, based on mortality studies, are put into a separate section; they are hybrids, in that they definitely have the characteristic of systematic amortization but also attempt to conform to the observed depreciation school of thought by amortizing book cost on a curve that will follow the actual progress of depreciation. There will also be included in this section a discussion of the age-life methods of computing reserve requirement, the service value concept, and the effect of group versus unit accounting for depreciation.

When the Committee on Depreciation of the NARUC in its 1943 report concluded that the straight line method of depreciation accounting could be expected to "measure with reasonable accuracy the actual depreciation of physical plant," a Columbia University professor[24] took issue with the language used. Though he advocates the use of the straight line method, he does so not because it measures "actual depreciation," but because he considers it satisfactory for "arriving at an appropriate accounting allowance." So it appears that even in the depreciation accounting methods there is difference of opinion as to the propriety of the result of application of accounting principles.

There are two important deterrents to the use of the

---

24 James C. Bonbright, "A Symposium on the NARUC Depreciation Report," Journal of Land and Public Utility Economics, Vol. XX, May, 1944.

depreciation reserve book balance as the reserve requirement figure. The first is the tendency to depletion of the reserve by what is known as "infant mortality" (premature retirements). A group of items with an average life of 50 years will cause a 2% annual accrual to the reserve for depreciation. If the group consisted of fifty items costing $20 each, the annual accrual would be $20. If two items were prematurely retired at the end of the second year, the cost of the two items would be charged against the reserve balance, and in this case would leave a zero balance. The result, as of the end of the second year, is definitely an understated reserve.

The second deterrent to the use of the depreciation reserve book balance is the fact that it may or may not represent the balance of annual depreciation accruals less net retirements; it may represent in large part a variety of distorting adjustments.

It is interesting to find that one regulatory body, the New York Public Service Commission, amended its Uniform System of Accounts in November 1943 and set up a formula to charge a part of every retirement to income or surplus instead of to the reserve for depreciation.[25] This action was not taken to counteract the effect of premature retirements as discussed above, but it is nevertheless a novel and effective way to prevent undue depletion of the reserve balance. (In the case cited, companies had been on the retirement-reserve basis, and their reserves were inadequate.)

An answer to the problem of the reserve balance reflecting items other than legitimate depreciation accruals might be found in

[25] O. Ely, News and Comment, Public Utility Fortnightly, Vol. XXXIV, No. 1, July 6, 1944.

a definition: the reserve requirement should be the "amount of the depreciation reserve which should have been accumulated by operating expense charges."[26] By far the most widely used methods of depreciation accounting are the straight line method and the sinking fund method.

The straight line method "assumes a progressive loss of service value proportional to the passage of time ..... with no intermediate restoration of value (by repairs, etc.), and cumulation to complete loss by the time of retirement."[27] A more objective definition would be that the straight line system is only the amortization, by equal annual charges, of the service value of property, over the estimated service life of such property. A depreciation scheme would still be "straight line" if it were based on estimated service capacity instead of estimated service life; in that event, depreciation would be amortized by an equal charge to each unit of output.

The sinking fund method likewise amortizes service value over the estimated life of the property, except that in place of the straight line basis the compound interest curve is utilized. An annuity is computed which, at a given rate of interest over the estimated service life of the property, will aggregate the service value (book cost less net salvage) of the property. For illustration, an item costing $1,000, with salvage of $50, ten-year life, using the 6% sinking fund method:

FORMULA: $$(\$1,000 - \$50) \times \frac{.06}{(1.06)^{10} - 1} = \$72.08 \text{ annuity.}$$

---

[26] Wisconsin P.S.C., op. cit.

[27] Scharff, Leerburger and Jeming, op. cit.

Year	Sinking Fund Method		Compound Interest Method	Cumulative Balance in Depreciation Reserve
	Annuity	Interest		
	(a)	(b)	(c)(a+b)	
1	$ 72.08	$ --	$ 72.08	$ 72.08
2	72.08	4.32	76.40	148.48
3	72.08	8.90	80.98	229.46
4	72.08	13.76	85.84	315.30
5	72.08	18.91	90.99	406.29
6	72.08	24.37	96.45	502.74
7	72.08	30.16	102.24	604.99
8	72.08	36.30	108.38	713.36
9	72.08	42.80	114.88	828.24
10	72.08	49.69	121.77	950.01
Totals	720.80	229.21	950.01	

In the illustration, the "compound interest" method is also shown, being the same as the sinking fund method except that under the latter method the yearly charge is split between depreciation expense (annuity) and interest. In the given case, use of the straight line method would have produced an equal annual charge of $95.00.

The straight line method is normally preferred to the sinking fund method[28] because of the former's ease of handling. There are two major characteristics that make the straight line method far superior to the sinking fund method. One is that the straight line reserve accumulates faster -- builds up quicker in the early years; this provides an extra safety factor, and also provides that much extra funds for plant growth. The second is that there is no compounding of inaccuracies under the straight line system as there is under the sinking fund method. Under the latter, any error is increased progressively from year to year, so that an error in estimating life or even salvage can be serious.

[28] NARUC, Report of Committee on Depreciation, 1943.

Due to the very nature of the compound interest process, of course, the longer the period involved, the greater the effect of inaccuracies. In the illustration on the preceding page, involving only a ten-year life, if the item had been retired at the end of the 9th year, this 10% error would have resulted in a deficiency of $95 in the reserve under the straight line method (10%), and a deficiency of $121.77 under the sinking fund method (13%). Assume, however, an item with a seventy-five-year life; the 6% annuity factor for seventy-five years is .0007686. In fifty years, after 66 2/3% of estimated life, (under the straight line method 66 2/3% would have been amortized by that time) the total accumulated charges or amortization would have amounted to only 22.317% -- leaving 78% of book-cost-less-salvage to be charged off in the last third of estimated life. In a chart produced by the NARUC Depreciation Committee in its 1938 report (Page 20), an item with a fifty-year life was illustrated; if the item had been retired at the age of forty (a 20% error in estimating life), under the sinking fund method the total accumulated amortization to that time would only have amounted to 50% of book-cost-less-salvage.

In future illustrations, resort will be had primarily to the straight line method, because as shown above, it is superior in accuracy and far easier to manipulate than the sinking fund method.

Techniques. It may be sufficient, from an accounting point of view, to determine whether or not a particular method will fully amortize service value of an asset over the life thereof;

but from the regulatory standpoint, it is important to follow the course of the reserve balance from year to year, particularly if that balance is to constitute the reserve requirement. The effect of "grouping" (a number of items under a single group rate) must be investigated, as must the application of the "age-life" method (to compute reserve requirement from book records).

Depreciation accounting may be divided generally into two principal groups -- the Individual Unit Method, where depreciation accruals are based on individual estimates for each unit in a property account, and the Group Method, where the accrual is based on average life of all the units in a property account. As a practical matter, the unit methods are apparently best suited for property comprising large units, such as buildings and big equipment. The group methods are apparently best suited for use with types of property consisting of a large number of smaller units, like poles and meters, all having similar life characteristics. Consistent use of the group method is generally prescribed by regulatory bodies for use by utility companies. For instance, the Federal Communications Commission's Uniform System of Accounts for telephone companies prescribes the group plan, and the telephone companies therefore use average rates of depreciation for each different property account, even if the account consists of a small number of units, such as buildings; thus all buildings will accrue depreciation charges at an average rate of about 2%, all underground conduit will take an average rate of about 1%, and so forth.

An exception is the accounting prescribed by the Interstate Commerce Commission for rolling stock and vehicles of bus and truck operators.[29] This is called the Separate Unit Method, and requires an estimate of average life for a group of similar units usually bought at or about the same time; the depreciation reserve records, though, must show how much reserve has been built up against each individual item at any particular time. Accrual of depreciation charges against an item ceases when its reserve has built up to cost-less-net-salvage; on the other hand, if at the time of retirement, the reserve is less than required, the difference is charged to operations.

The most theoretical method of all is the Unit Summation Method, much akin to the Separate Unit Method just described. The unit summation plan applies a straight line rate of depreciation to each unit -- in accordance with the actual life expectancy of each such unit. If one thousand items of a similar make and character are in service, and two or three of the items are prematurely retired, the unit summation plan requires that rate of depreciation on those two or three items shall have been high enough to provide for their premature mortality. The highly developed prescience demanded by this method, of course, makes it a strictly academic one. Also the amount of detailed work involved in handling units makes the plan impractical. But, in the writer's opinion, the method's results will reflect accurately -- more accurately than any averaging or group method -- the actual straight line reserve requirement. Retirement of an item merely involves elimination of its corresponding amount in the depreciation reserve -- and such amount has been accrued in the reserve and is available to offset the retirement. Under the group plan, though,

[29] NARUC, Report of Committee on Depreciation, 1943.

"upon the retirement of any depreciable property, its full service value is charged to the reserve whether or not the particular item has attained the average service life."[30-31] Consequently, under the group plan, premature retirements will deplete the reserve, and accuracy is delayed until later years, when accruals continue past the average age on items not retired until much older than the average age on which the rates were based.

The basic concept of the unit summation plan is valid, and the writer of this dissertation sees a definite affinity between this and the actuarial methods which will be discussed later. Performance studies may permit construction of fairly reliable life tables which will thus give weight to both premature and over-age retirements.

The following illustration will serve to illustrate the operation of the Group Depreciation Method as compared to the Unit Summation Method, and also to introduce the concept of "service capacity" which may justify the lower reserve requirement produced by the group method:

GIVEN: 3 units costing $100 each; no salvage value.
All purchased the same date:

	Service Life
Unit #A	3 years
B	5 years
C	7 years
Average Life -	5 years (20% rate)

---

30 Interstate Commerce Commission, Revised Classification of Accounts for Telephone Companies, January 1, 1933.

31 Federal Communications Commission, "Rules & Regulations, Part 31," Uniform System of Accounts. Paragraph 31.01-3(p).

GROUP METHOD

Year	Reserve for Depreciation A/C: Accrual 20% x Plant (1)	Balance Accrued (2)	Retirements (3)	Balance (Reserve Requirement) (3) - (2)
1	$60	$ 60	$---	$ 60
2	60	120	---	120
3	60	180	100	80
4	40	120	---	120
5	40	160	100	60
6	20	80	---	80
7	20	100	100	---

UNIT SUMMATION METHOD

Year	Individual Accruals	(Total)	Balance Accrued	Retirements	Reserve Requirement
1	$33 plus $20 plus $14	$67	$ 67	---	$ 67
2	33 plus 20 plus 14	67	134	---	134
3	34 plus 20 plus 15	69	203	100	103
4	$20 plus $14	34	137	---	137
5	20 plus 14	34	171	100	71
6	$14	14	85	---	85
7	15	15	100	100	---

In this example, the unit method, recognizing that unit A would retire before average life was reached, accrued depreciation charges faster than the group method. The group method reached its lowest point, as compared with the unit method, at the end of year #3 when Unit A was retired prematurely -- when the 20% depreciation rate had only accumulated 60% of its cost. Strictly speaking, as mentioned before, the reserve requirements produced by the group method were all inadequate in terms of the Unit Summation Method which (using uncanny foresight) amortized each unit in accordance with its actual life.

However, the Unit Summation Method has been criticized, and properly so, as "developing, unnecessarily and improperly, a regressive series of rates.[32] The higher depreciation accruals

[32] Henry M. Long, "Need the 'Straight Line' Reserve be Excessive?", Public Utility Fortnightly, Vol. XXXVII, No. 7. March 28, 1946.

in the early years result in lower accruals in the latter years.

Also, there is yet another point of view to be considered in determining whether the reserve requirement under the group method is too low or the unit method too high. If service capacity is considered, then the results under the group method are proper. It is quite true that Units A, B, and C cost $100 apiece. But what was actually purchased was $300 worth of service capacity; that $300 worth of service capacity was not equally divided between the three units of property, but in the ratio of 3::5::7 -- according to the actual service rendered. Thus, in terms of service capacity Unit A, serving 3 years, was worth 3/15ths of $300, or $60; Unit B, serving 5 years, was worth 5/15ths of $300, or $100; and Unit C, serving 7 years, was worth 7/15ths of $300, or $140. And this is exactly what occurs under the group method; it is accomplished through the device of applying the average rate of depreciation equally to the units during their respective periods of service. Thus, Unit A accrued 20% for 3 years - or $60; Unit B accrued 20% for 5 years - or $100; and Unit C accrued the 20% average rate for 7 years - or $140.

This service capacity concept, though novel, appears reasonable. However, it will definitely require one accounting compromise in order to maintain consistency. In the pricing of retirements, "service capacity" cost will have to be utilized rather than original book cost. Thus, the retirement of Unit A would have to be at $60 instead of $100; Unit B would be retired at $100; and Unit C would retire at $140. The three methods would then compare as follows:

RESERVE REQUIREMENTS (see Page 44)

Year	Unit Method	Group Method	Service Capacity Method
1	$ 67	$ 60	$ 60
2	134	120	120
3	103	80	($180 - 60)= 120
4	137	120	160
5	71	60	($200 -100)= 100
6	85	80	120
7	---	---	($140 -140)= ---

Though the annual depreciation accruals under the group method are identical with those under the service capacity method, the two methods definitely part company at the time of first retirement (year #3 above) -- unless all retirements were at the exact "average" date (year #5 above). The unconventional accounting used in the service capacity method above has created an illusion of disparity with the group method, which is not a fact. In effect, the two methods produce identical results -- all along the line, as shown in the following chart:

DEPRECIATED PLANT IN SERVICE - GROUP METHOD

Year	Plant in Service End of Year	Reserve Requirement End of Year	Net Depreciated Plant
1	$300	$ 60	$240
2	300	120	180
3	200	80	120
4	200	120	80
5	100	60	40
6	100	80	20
7	---	---	---

DEPRECIATED PLANT IN SERVICE - SERVICE CAPACITY METHOD

Year	Plant in Service End of Year	Reserve Requirement End of Year	Net Depreciated Plant
1	$300	$ 60	$240
2	300	120	180
3	($300 - 60)= 240	120	120
4	240	160	80
5	($240 -100)= 140	100	40
6	140	120	20
7	---	---	---

The above demonstrates that the service capacity method produces the same results as the conventional group method. It may then be asserted that the group method produces a reserve requirement figure that reflects accrued depreciation on the basis of service capacity.

One of the most widely used techniques for reaching a reserve requirement figure is the "age-life" method. This method relates the "age" of an item (years in service to date) to the estimated "life" of such item, in order to compute the percentage of expired service capacity (or "accrued depreciation"). For example, if an item of property has been in service for five years, and it has an estimated life of ten years, its reserve requirement would be 50% -- the relation of "age" to "life".

Dealing with one unit, the age-life procedure is to all intents and purposes identical with the unit summation method; its affinity to the unit summation method will be pointed out in a later illustration.

But the age-life procedures, because of their simplicity, are largely used in dealing with grouped property. Confronted with the need for determining "reserve requirement", many utility companies as well as regulatory bodies resort to use of the age-life technique. This makes it unnecessary to go back to the beginnings of the company, and to accrue depreciation charges each year based on the then-existing plant balance, and to deduct retirements from such accrued depreciation charges. In fact, the popularity of the age-life method is due in large part to the fact that all retired property can be ignored completely; it is concerned only with the actual ages and the estimated lives of plant actually in service as of the study date.

It can be immediately seen that results under the age-life method will vary from those under the straight line group method. The reserve balance under the straight line group method will have been "depleted" or reduced at the time of the first "infant" or premature retirement -- it will be recouped by application of the uniform depreciation rate against those units which survive beyond average life; but under the age-life method, no recognition is given such premature retirement -- on the other hand it will be found that the average "life" of the surviving units will be more than the original figure used in the straight line method, which was based on the total original property for which the reserve exists. For instance, if five units were involved, one to serve three years, one five years, one six years, one seven years and one for nine years, the group average would be six years. A uniform annual rate of 16 2/3% applied under the straight line method would amortize the cost by the time of the last retirement in the ninth year. But under the age-life method, results would differ as soon as the first premature retirement occurred in the third year. Average life of the four surviving units would be 6 3/4 years; after the second unit retired, the average life of the three surviving units would increase to 7 1/3 years; thus the average life figure would progressively increase until the final surviving unit - 9 years.

This progressively increasing average indicates that the depreciation accrual in successive years will decrease -- in inverse ratio to the life average. For instance, in the 8th year, with one unit surviving, there would be the uniform rate of 16 2/3% to be accrued for years 8 and 9 on the straight line basis: on an age-life basis the rate would be only 11.1% for years 8 and 9. That means, of course, that as of the beginning of year 8, 66 2/3% has been accrued (100% - 33 1/3%) under the straight line basis, whereas under the age-life basis 77.8% has been accrued (100% - 22.2%).

Advocates of the straight line group plan therefore contend that the reserve requirement computed on the age-life basis will always be excessive.[33]

Actually, the results under age-life techniques will follow a definite pattern: one, they will coincide with results under the straight line group method (prior to the first retirement); second, they will produce a reserve figure higher than under the straight line group method, but lower than under the unit summation method (until after the next to last retirement); and third, they will then coincide with results under the unit summation method until final retirement of the last surviving unit.

Before presenting a series of illustrations to show the behavior of the various methods discussed, mention must be made of the "Prospective Retirement" method. This plan is favored by the NARUC, and has been used rather widely in problems involving determination of a reserve requirement. For instance, the Federal Communications Commission,[34] in ordering the "crossover" from "emergency" to "regular" rates of depreciation, requires a re-determination of the reserve requirement on a "regular" (rather than "emergency")

---

33 Long, Henry M., <u>op. cit.</u>

34 FCC Order # 89-A, April 1946.

basis. As a test, the Illinois Bell Telephone Company used the prospective retirement method to find the new reserve requirement; Federal Communications Commission approved the use of this method, and it is being used in all Bell companies now for this purpose.

The reserve requirement under the prospective retirement method can be determined at any particular time by the following formula: Plant A/C Total - (Average Remaining Life x Rate of Depreciation x Plant A/C Total) = Reserve Requirement

The concept is a logical one. The reserve requirement figure here is merely the difference between the cost of plant now in service and the amount that is expected to be amortized over the remaining life of such plant.

The practical value of the prospective retirement method is of course lessened considerably if rates of depreciation are changed for the future over what they were in the past. However, if such rate changes are accompanied by corresponding changes in remaining life estimates, there should be no distorting effect on the reserve requirement figure reached.

Three sets of hypothetical illustrations follow, to show the behavior of the various methods discussed above. The illustrations make use of a static plant account, a decreasing plant account, and in one instance an increasing plant account. The effect of "infant" or premature retirements is also illustrated.

<u>Illustration #1</u>

In the following illustration, the reserve requirements for each year are shown, as produced under four different methods. Plant in this example either remains static or decreases; as a result, method II (age-life) produces the same reserve as method I (straight line group), until occurrence of the first retirement in year two. Reserves under the age-life method then approach those accumulated under method III (unit summation), until a "next-to-last" unit is retired in year eight of the illustration, after which both methods produce identical results. (NOTE: At the end of year 8, 2 units remain in service, but each of these have different ages or installation dates; under age-life procedures, each is treated separately, and hence agrees with the unit summation results in method III.)[35] Method IV (prospective retirement) produces lower reserve requirement figures than does the age-life method or the unit summation method, and is akin to the straight line group method in its use of the uniform rate of depreciation (in this illustration, 20%). Method IV does not coincide with method I from the time of the first replacement until after the last replacement is made; this is due to the fact that in method IV the remaining life factor recognizes each replacement as it occurs, instead of averaging the four replacements beforehand. For instance, unit "H" (which had the longest life) was not installed until year 7, so the preceding years' weightings turned out results higher than those in method I.

GIVEN: 4 units @ $100 each installed at beginning of year #1. 4 replacements, same cost. No net salvage. Average life - 5 years.

---

[35] Actually, the illustrations could very well have been limited to a single group of units, rather than to a succession of them. The principles indicated by a single group are just as applicable to successions of groups as they are to the single group, because the aggregate reserve requirement for a complete plant is nothing more nor less than a composite of the individual results of numerous groups in various stages of useful life progression.

Original Units	Life	Replacements	Life
A	2 years	E	2 years
B	4	F	4
C	6	G	6
D	8	H	8

NOTE: See Appendix I for details of computations.

Reserve Requirements, as Computed by Four Methods

End of Year	Method I Straight Line Group	Method II Age-Light Procedure	Method III Unit Summation	Method IV Prospective Retirement
1	$ 80	$ 80	$104	$ 80
2	60	100	108	60
3	140	200	212	200
4	20	114	116	80
5	100	183	187	160
6	80	155	159	140
7	160	220	225	160
8	40	92	92	40
9	80	121	121	80
10	20	50	50	20
11	40	62	62	40
12	60	75	75	60
13	80	87	87	80
14	---	---	---	---

Illustration #2

This illustration differs from the preceding one in that it gives effect to an "increasing" plant, the four units each being installed in succeeding years. The premature retirements in this case have a particularly serious effect on the straight line group method reserve. This is due, in this particular instance, to the fact that only one unit enters the plant account each year; in Illustration #1, where the four units were in plant from the start, more of a reserve could be accumulated. A more general statement on the effect of premature retirements on the reserve in a growing plant will be included after Illustration #3. (NOTE: Strictly speaking, under Method I (straight line) and

Method IV (prospective retirement), a 50% rate should have been used in year 1, and revised to 33 1/3% in year 2 when unit B was installed, and so forth, but for purposes of this illustration, it is assumed in advance that this type of unit will carry a 20% rate regardless of the experience with units A, B, and E.)

Note that Method III (unit summation) coincides with Method II (age-life) every year except the third, which is the only year in which more than one unit was installed. Averaging the lives of the two units installed in that year brings Method II results down below Method III, where short-lived unit E gets its full weight. (See footnote 35).

GIVEN: 4 units @ $100 each, installed in successive years
4 replacements - same cost
no net salvage - average life is 5 years.

Original Units	Year Installed	Life	Replacements	Year Installed	Life
A	1	2 yrs	E (for A)	3	2 yrs
B	2	4 yrs	F (for E)	5	4 yrs
C	3	6 yrs	G (for B)	6	6 yrs
D	4	8 yrs	H (for C)	9	8 yrs

NOTE: See Appendix II for details of computations.

Reserve Requirements, as Computed by Four Methods

End of Year	Method I Straight Line Group	Method II Age-Life Procedure	Method III Unit Summation	Method IV Prospective Retirement
1	$ 20	$ 50	$ 50	$ 80
2	-40	25	25	40
3	20	100	117	140
4	---	121	121	60
5	-20	100	100	60
6	60	171	171	120
7	140	242	242	200
8	20	113	113	80
9	80	154	154	80
10	140	196	196	140
11	---	37	37	---
12	20	50	50	20
13	40	62	62	40
14	60	75	75	60
15	80	87	87	80
16	---	---	---	---

Illustration #3

The illustration below assumes a mortality trend opposite from that in the two preceding illustrations. The first installations all stay in service past average life, so that there will be no premature retirements -- until the reserve shall have had time to build up enough to cover such retirements. Comparison between the straight line group method and the unit summation method shows a reversal in results in this case. During the first four years, the reserve under the straight line method will actually exceed the unit summation reserve.

At the end of the 5th and 6th years, when two "infants" were retired (aged 2 and 4 years), the effect was still serious enough to pull down the reserve balance on the straight line basis below the reserve on the unit sum basis.

GIVEN: 4 units @ $100 each, installed in successive years
4 replacements -- same cost
no net salvage -- average life is 5 years.

Original Units	Year Installed	Life	Replacements	Year Installed	Life
A	1	8	E (for D)	6	6
B	2	6	F (for C)	7	6
C	3	4	G (for B)	8	4
D	4	2	H (for A)	9	2

NOTE: See Appendix III for details of computations.

Reserve Requirements, as Computed by Two Methods

End of Year	Straight Line Group Method	Unit Summation Method
1	20	13
2	60	42
3	120	96
4	200	200
5	180	204
6	160	171
7	140	129
8	120	96
9	200	200
10	180	204
11	140	158
12	80	87
13	---	---

In this respect, an interesting study has been made by the Public Service Commission of Wisconsin,[36] showing the effect of "infant" mortality and of plant growth on the ratio of the reserve to the plant account, using straight line depreciation accounting.

Unless a company continues to expand, the time eventually arrives when annual property retirements approximately equal the annual charges for depreciation, the reserve thereafter tending to remain level or "stabilized".[37] Taking four sets of mortality characteristics (shown below), the Wisconsin Commission arrived at "normal reserve ratios" which would prevail after the plant and reserve had "stabilized."

Mortality Characteristics (average life: 8 years)[38]
Percent Surviving at End of Year after Placing

Age in Years	A (High "Infant" Mortality)	B (Straight Line Method)	C (Fairly Normal for Outside Plant)	D (Hypothetical)
0	94	97	99	100
1	84	90	98	100
2	73	84	95	100
3	66	78	91	100
4	58	72	85	100
5	53	66	80	100
6	46	60	70	100
7	42	53	60	100
8	37	47	40	---
9	33	41	28	
10	29	35	20	
11	27	28	15	
12	24	22	10	
13	21	15	5	
14	19	9	3	
15	16	3	1	
16	14	---	---	
17	13			
18	11			
19	10			
20	8			
21	7			
22	5			
23	4			
24	3			
25	2			
26	1			
27	---			

36 Wisconsin Public Service Commission, A Review of Legal and Accounting Problems of Depreciation, October 11, 1943. (Submitted to the 45th Annual Convention of the NARUC.)

37 Irston R. Barnes, The Economics of Public Utility Regulation, 1942.

38 Wisconsin P. S. C., op. cit.

The results arrived at for the 4 sets of figures shown are as follows:

Normal Reserve Ratios, After Stabilization

	A	B	C	D
Assuming no plant growth and zero net salvage	12.00%	33.22%	41.88%	50.00%
Assuming 6% plant growth and zero net salvage	7.59	28.39	37.92	46.19

A glance at the above results shows that the higher the "infant" mortality the more the reserve will be depleted, and the lower its ratio to plant account.

Also, growth of plant results in a lower reserve ratio. This is due mainly to the depleting effect of "infant" or premature retirements on the reserve balance -- and the faster the rate of growth, the more new plant is added, the greater the occurrence of the "infant" mortality.

C. Mortality Curves and Statistical Methods.

One of the vulnerable spots in "amortization" or depreciation accounting is the use of an average figure for estimated life of a group of units. Results of studies at the Iowa State College[39] give credence to this conclusion. The work at Iowa State dealt with experiments to determine "mortality laws of physical property." Seven type curves were developed from a large number of actual survivor curves. Actual survivor curves were taken from various company records, e.g., they used the history of 2,423 wooden poles of the New York Telephone Company, of 23 pumping stations in Massachusetts, of 17 pumping engines in Chicago. One of the samples used in the study involved 30,009

39 Edwin B. Kurtz, The Science of Valuation and Depreciation, Ronald Press, 1937.

coal-tar-treated wood telegraph poles, the experience of which between 1852 and 1905 had been published in Archiv für Post und Telegraphie, Nr. 16, August 1905, by Geo-Oberpostrat Christiani, Berlin.

These seven type curves showed that life expectancies remaining at the average point varied from a maximum of 8.9% in some curves to as much as 40.7% of average life in other curves, which certainly reduces the validity of the average figure.

The techniques designed to overcome the shortcomings of the simple average all involve the use of life curves to recognize mortality dispersion in various types of physical property. This is particularly applicable to large groups of homogeneous units like poles, ties, meters, and cable.

A mortality curve, or life table, can be constructed from (1) a retirement history of all units installed in a given year, (2) a study of a given year's retirements, identifying each such retirement with year of installation, and (3) retirement experience during a given period of years.[40] The resulting curve will reflect past history, but its statistical reliability for application to future property units remains doubtful -- due of course to the vagaries of time and its concomitants, but also due to the fact that only one sample was utilized.

The Gompertz-Makeham formulae have been utilized to meet this deficiency. The Gompertz formula covers statistical liability to death from natural causes; it fits the human mortality curve over part of its range, and approximates the curve for property

[40] NARUC, Report of Special Committee on Depreciation, November, 1938.

retired due to age (wear and decay).[41] Makeham extended the Gompertz formula by adding a term representing death due to chance without any previous disposition to death (or deterioration); this was to cover accidental deaths in humans, and retirements due to accidents, obsolescence, etc., in property. The combination of the two formulae thus is designed to reflect all the varied forces that make for depreciation of property, and to produce a curve that will closely coincide with experience.

The statistical methods may be divided into the actuarial methods and the turnover methods. Both methods provide a factual analysis of past service experience, which becomes the basis for prediction of average service life. The difference between the two, in addition to the procedures utilized, lies in the fact that from the actuarial methods can be constructed a mortality curve, or life table; from the turnover methods, no such inference can be made as to the probable dispersion of retirements.

One procedure under the actuarial method is to tabulate the number of units retired each year from a given year's installations, and by relating the units thus retired in each successive year to the balance remaining in service, a retirement ratio is arrived at for each age. These retirement ratios for successive ages combine into a survivor table, or mortality curve. As noted in a preceding paragraph, this data can also be obtained by applying the procedure to a given year's retirements, or to retirement experience during a given period of years. The main objection to this technique seriously limits its usefulness and

---

41 Ibid.

applicability to general utility property; "installation date" of utility property is difficult to determine and a costly thing to compile, if available. This is partly due to faulty, or lack of detailed, records (e.g., in the case of poles and meters) and partly due to the long life of some types of property (e.g., mains, some of which may have been installed 75 to 100 years ago and are still in service).

The turnover method is so called because it arrives at average service life by determining the number of years required for the property to effect a complete replacement, or "turnover". Here the procedure is to set a starting date, and work backward, accumulating each preceding period's retirements until they equal the plant in service as of the starting date. The months or years required to accumulate such balance is the turnover period. The data required are merely the total units in service at a given date, and the total additions and retirements for preceding periods; the identification of retirements as to age-at-retirement is not attempted here. It can be seen that this method is of no value unless the property studied has already passed through at least one life cycle. Also, where the property in use has been increasing, the backward accumulation of retirements will reach the total required more quickly -- because of the presence of "infant" or premature retirements for the more recent larger additions; this results in a too short turnover period, requiring an adjustment for such plant growth.

Thus, though the turnover method utilizes data that is more generally available than that required by the actuarial method, it requires a long period of retirement experience, it distorts life estimates (unless an adjustment is made for plant growth), and it does not produce a life curve.

There are four main types or variations of turnover methods in use.[42] (a) The "original turnover method" requires historical data on additions and retirements for one life cycle, and produces one estimate of average life. (b) The "Nash formula"[43] requires data for a term of years long enough to provide an acceptable index of rate of growth and typical retirement experience. (c) The "half-cycle ratio method" uses data for only half a life cycle in order to produce an estimate of average life. (d) The "asymptotic" or "limiting ratio" method requires data for from 5 to 10 years back (or longer), so that a trend of addition and retirement ratios (as a percentage of total units in service) can be determined. This method requires a bit more explanation.

The asymptotic method was developed by Joseph Jeming, a statistician associated with Maurice R. Scharff, Consulting Engineer, New York City, and was presented at the National Accounting Conference of the Edison Electric Institute in 1939.[44] It is based on the fact that in a static plant, the ratio of plant retirements to total units in service will approach a constant level or "limiting value" eventually, assuming that the units and

---

42 Cooperating Committees of A.G.A. & Edison Electric Institute, op. cit.

43 So called because developed in detail by L. R. Nash in "Public Utility Depreciation Accounting", Journal of Land & Public Utility Economics, October 1926.

44 "An Asymptotic Method of Determining Annual & Accrued Depreciation".

their replacements all have similar life characteristics. The "limiting value" of the retirement ratios is the reciprocal of the average life, or $\frac{1}{\text{average life}}$. For instance, given a static plant account, with a twenty-year average life, retirements (and replacements) will stabilize at $\frac{1}{\text{average life}}$ or $\frac{1}{20}$ or 5% per year (of plant account balance). In applying the asymptotic method, addition and retirement ratios are computed for each year under study, and a trend deduced which can be projected into the future.

It is felt by many[45] that the mathematical approach of the actuarial and turnover methods involves an "unnecessary burden which does not add to the reliability of the results."[46] In fact, the various actuarial and turnover techniques each may produce widely divergent results, as was shown in the study made by an investigating committee,[47] even though the data used in the study were "above average in their suitability for analysis."[48]

The difficulty is not so much due to the mathematical principles involved as to the failure of property behavior to conform to the assumptions of the statistical approach! Certain assumptions inherent in the statistical process can rarely be anticipated exactly; e.g., that mortality characteristics will continue in the future as they have in the past; that sufficient reliable data is available; that the retirement history available is sufficient to reveal significant mortality characteristics; and that the rate of plant growth or reduction has been uniform.

---

45 Cooperating A.G.A. and E.E.I. Committees, op. cit.

46 Ibid.

47 Ibid.

48 Ibid.

It appears reasonable to state that a basic law of mortality for public utility property can never be assumed as long as such property is subject to the vagaries of a changing technology, irregular growth, and the control of regulatory bodies which may alter service requirements, or impose other regulations on the utility.

(It may be noted that these statistical methods were considered by the investigating committee[49] as valuable primarily as a "guide to judgment.")

---

[49] Ibid.

CHAPTER IV

Conclusion

A. Removal of a number of obstacles to proper depreciation procedures would clear the air considerably with respect to the determination of the depreciation reserve requirement.

1. Need for accounting uniformity. Considerable progress has been made in this respect, with the widespread adoption of Uniform Systems of Accounts and "property units", recommended by the NARUC and promulgated by the FPC and FCC in 1937. This defining of fixed capital units of property will doubtless make for consistency in treatment of maintenance and capital items; it will also permit of more reliable statistical data for depreciation studies.

Two factors complicate the struggle for complete uniformity. One is the existence of property which antedates the adoption of uniform accounting; the other is due to technological changes that constantly occur. (For instance, "Line Transformers" originally covered a transformer plus a fused cutout. Later, lightning protection was added, and included in this account. Later, static capacitors were installed in many distribution systems, and were also included in the same account.)[1]

2. Need for a clear judicial policy. The Supreme Court has generally limited itself to generalities rather than come out in favor of any particular valuation procedure. Much

---

[1] Cooperating Committees on Depreciation, A.G.A. & Edison E.I., An Appraisal of Methods for Estimating Service Lives of Utility Properties (prepared for the NARUC), February 14, 1942.

has been read into Supreme Court decisions by advocates of the various valuation theories, but it is reasonable to assume that the Court's decision in each case was based primarily on the fairness of the end-result and only secondarily--if at all--on the valuation method employed. This is developed in the discussion of the Hope Case below. (a)

However, the Supreme Court has apparently followed a less neutral path in ruling on depreciation procedures. It apparently sanctions deduction of "observed depreciation," even though that figure may differ from accrued book depreciation. This will also be discussed below. (b)

The decision of the Supreme Court in any particular rate case, even though it was only the end-result that was actually approved, has invariably been interpreted as a sanctioning of the methods used in arriving at that end-result. The effect has been to encourage the divergent schools of thought to remain divergent and to shy from reconciliation or compromise.

The tendency of the Court to favor "observed depreciation" has in my opinion encouraged if not fostered rate litigation; and the failure of the Court to insist on consistency between accrued depreciation and depreciation charged consumers is, in my opinion, a definite error.

a. The Hope Case. (FPC v. Hope Natural Gas Company, 64 U.S. 281) (1944). This case has been hailed as beginning a new era in Public Utility regulation.[2] According to

---

2 John Bauer (Director, The American Public Utility Bureau, N.Y.C.), "Depreciation in Relation to Prudent Investment," Pub. Util. Ftntly, Vol. XXXIII, No. 9, April 27, 1944.

one writer,[3] the Supreme Court's decision in the Hope Case ended the rule of "ritualistic" valuation based on Smyth v. Ames; instead of using the formula, "Rate base X Rate of Return," to find the amount a company <u>may</u> earn, the new method is to take a direct approach, and from a consideration of pertinent economic phenomena, to find the amount a company <u>must</u> earn to protect the best interests of both consumer and investor. If this is so, then the reserve requirement loses much of its significance as a factor in rate-making.

(In this case, FPC had ordered a rate reduction of over $3,000,000 predicated on a prudent investment ratebase. Supreme Court sustained the FPC order, resolving the issue on the reasonableness of the end-result. Supreme Court apparently had sanctioned FPC'c reasoning that the rate cut would not imperil the financial integrity of the company, nor threaten its position to attract capital on favorable terms, if required.)

In the opinion of the writer, there is nothing really new or radical in the Court's attitude in this case. In each of the following cases,[4] the Supreme Court has stated its interest in the constitutionality of the end-results rather than in the correctness of details of methods used:

1917--Van Dyke v. Geary 244 U.S. 39

1923--Ga. Rwys. & Power Co. v. RR Comm. 262 U.S. 625

---

[3] Carl I. Wheat (Special Counsel, FCC), "Does Hope Case Mean Direct Approach to 'Fair Return'?", <u>Pub. Util. Fortnightly</u>, Vol. XXXIII, No. 9, April 27, 1944.

[4] Perry Mason, <u>Principles of Public Utility Depreciation</u>, Monograph #1, American Accounting Association, 1937.

1934—Clark's Ferry Bridge Co. v. PSC

291 U.S. 227

1934—Dayton Power and Lt Co. v. PUC

292 U.S. 290

1934—Columbus Gas & Fuel Co. v. PUC

292 U.S. 398

This is apparently just another Supreme Court decision which evades any commitment as to a preferred method of arriving at a reserve requirement and a rate base.

b. The Court, in the writer's opinion, has been a very disturbing influence in its championing of "observed depreciation." For instance, in McCardle v. Indianapolis Water Company, 272 U.S. 400 (1927), the Supreme Court said that physical inspection was preferable to statistical computations in determining accrued depreciation.[5] True, this may be in keeping with legal theory and the U.S. Constitution, which looks to the particular property under consideration rather than to artificial or statistical conclusions representing such particular property. But there is a definite germ of weakness in this position. "Custom-made" mortality studies, based on the life experiences of an individual company's plant, can obviously not attain the reliability or accuracy of studies using larger samples—e.g., on a regional or industry-wide scale (with possible adjustment for major individual peculiarities.)[6]

c. The Supreme Court has also supported

---

[5] NARUC, Report of Special Committee on Depreciation, 1938.

[6] See p. 26.

deduction of "observed depreciation" even though same was inconsistent with the amount of accrued book depreciation. (Indianapolis Water case, mentioned above; Clark's Ferry Bridge Co. v. P.S.C., 291 U.S. 227, 1934; Lindheimer v. Illinois Bell Telephone Company, 292 U.S. 151, 1934.)

The writer is convinced that this attitude is patently inequitable. Book depreciation, by the very fact of its having been charged to operations (passed on to the ratepayer), is disqualified as a ratebase item. To the extent that "observed depreciation" is less than accrued book depreciation, the company is allowed to earn a return on property for which it has already been reimbursed by the ratepayers.

The strongest judicial voice raised against this policy of the Court was Justice Brandeis' dissent in United Rwys. v. West, 280 U.S. 234 (1930), where he stated his belief that depreciation claimed by the utility should be consistent with that shown on their books.

B. At first blush, the various schemes and procedures used to determine the "actual incidence" of depreciation appear to be sincere and worthwhile struggles for a scientific and objective approach to utility depreciation accounting. One of the writers[7] who has concentrated on this problem has written hopefully, that just as man could not objectively measure heat until he found the answer in measuring the length of a column of mercury in a tube, so may the processes of depreciation one day be understood and charted objectively by a highly-developed science of psychometry.

---

7 Scharff, op. cit.

This writer's conclusion is that not only are the various refinements of techniques and procedures to arrive at "exact" actual accrued depreciation figures unjustified and undesirable, but the general principle of using "actual" accrued depreciation is not particularly desirable. In the writer's opinion, accuracy in determining incidence of depreciation or decline-in-value, is not nearly as important as the financial considerations involved.

A straight-line or other amortization method which writes off a healthy chunk of book value during the early years of a unit's service does not violate public utility theory (net book value will be written off over the unit's service life), and on the other hand it makes for greater financial integrity. As discussed in Chapter II[8], reserves for depreciation that build up quickly reduce the risk borne by the investor of errors in estimates of useful service life, and will tend to reduce the amount of securities that would otherwise be outstanding. It is also to be noted that increased early charges for depreciation will reduce the amount of dividends available to the investors; in a new company particularly, this is a valuable check against any tendency to milk the company and so handicap the financial struggle of the company. In the introductory chapter (p. 3) it was pointed out that the use of other than a definite amortization plan invariably resulted in a minimum depreciation reserve that was sometimes too low for the good health of the company. Under "observed depreciation" procedures, lacking a predetermined and definite amortization program as it does, there

[8] Pages 9 and 20 .

is always a temptation to manipulate depreciation charges to suit the whims of management.

The writer feels that, because of the importance of healthy financial habits, "observation methods" of depreciation accounting are not desirable.

In fact, in the writer's opinion, systematic amortization of an inexorable cost like depreciation is so essential to sound management, that it overrides whatever advantages there may be in schemes devised to base the reserve purely on "actual" (realized) depreciation. Sound principles of management dictate that predictable retirements be provided for -- systematically in advance -- rather than wait for the sudden physical metamorphosis from "serviceable" to "scrap" and then try to burden that particular period with the shock of deferred depreciation realized.

This objection to non-amortization methods of depreciation accounting carries over, in the writer's opinion, to the various statistical and actuarial methods, whose refinements are aimed at charting the actual incidence of depreciation. In addition to the reasons set forth on page 61, the fact remains that in public utility finance, it is more important to provide adequately for depreciation from a financial standpoint than to concern ourselves with the highly philosophical concept of "actual incidence" of depreciation.

By the same reasoning, the rather interesting argument that the straight line depreciation method (group) accurately reflects service capacity value (pp. 45, 46) is not too important a consideration.

A study of the effect of premature retirements ("infant mortality") on the depreciation reserve begins on Page 55. Of the most widely-used reserve requirement techniques, the straight line group method and the prospective retirement method both are affected by such premature retirements. Under age-life procedures, though, based as they are on plant in service as of a fixed date, all previous retirements are ignored. The average life of the survivors naturally being greater than the average of the original group, the effect is lowered depreciation rates for future accrual, which means an increased reserve requirement figure. The opinion of the writer is that although the straight line group method (or the prospective retirement method, using a uniform depreciation rate as in the straight line method) may prevent a regressive process in the depreciation rate from year to year by recognizing all of the original group in computing its rates, the age-life method has much to commend it in its relative simplicity of application; it requires only the ages and life estimates of plant actually in service at the study date, and its results under usual circumstances will not vary much from straight line results -- with the error in the direction of conservatism.

In the opinion of the writer, a reserve requirement first determined by age-life procedures and thereafter kept current by the straight line method will generally prove fairest to all concerned; to a great extent, this procedure will insure a measure of financial integrity that is the mark of a soundly-run public utility -- able to keep its equipment up to date, and its service to the public mutually profitable.

A P P E N D I C E S

APPENDIX I

(Supporting data for results tabulated on Page 51)

GIVEN: 4 units @ $100. 4 replacements, same cost. Average Life - five years.

YEAR	January 1st Additions or Replacements	December 31st Retirements	Plant Account Balance Jan 1	Plant Account Balance Dec 31
1	A, B, C, D		$400	$400
2		A	400	300
3	E		400	400
4		E, B	400	200
5	F, G		400	400
6		C	400	300
7	H		400	400
8		F, D	400	200
9			200	200
10		G	200	100
11			100	100
12			100	100
13			100	100
14		H	100	-0-

****

I. RESERVE REQUIREMENT, COMPUTED BY THE STRAIGHT-LINE GROUP METHOD

End of Year (1)	Annual Accrual (20% of Jan 1 Plant Balance) (2)	Retirements (3)	Balance (Reserve Requirement) (2) - (3)
1	$ 80		$ 80
2	80	$100 - A	60
3	80		140
4	80	200 - E, B	20
5	80		100
6	80	100 - C	80
7	80		160
8	80	200 - F, D	40
9	40		80
10	40	100 - G	20
11	20		40
12	20		60
13	20		80
14	20	100 - H	-0-

II. RESERVE REQUIREMENT, COMPUTED ON AGE-LIFE BASIS

End of Year (1)	Surviving Units (2)	Age in Years (3)	Average Life of Survivors (4)	Dec 31 Plant Balance (5)	RESERVE REQUIREMENT (3)÷(4) x (5)	
1	A, B, C, D	1	2, 4, 6, 8 = 5	$ 400	1/5 x 400=	$ 80
2	B, C, D	2	4, 6, 8 = 6	300	2/6 x 300=	100
3	B,C,D	3	6	300	3/6 x 300= 150	
	E	1	2	100	1/2 x 100= 50	200
4	C, D	4	6, 8 = 7	200	4/7 x 200=	114
5	C,D	5	7	200	5/7 x 200= 143	
	F, G	1	4, 6 = 5	200	1/5 x 200= 40	183
6	D	6	8	100	6/8 x 100= 75	
	F, G	2	5	200	2/5 x 200= 80	155
7	D	7	8	100	7/8 x 100= 87.5	
	F, G	3	5	200	3/5 x 200=120.0	
	H	1	8	100	1/8 x 100= 12.5	220
8	G	4	6	100	4/6 x 100= 67	
	H	2	8	100	2/8 x 100= 25	92
9	G	5	6	100	5/6 x 100= 83	
	H	3	8	100	3/8 x 100= 38	121
10	H	4	8	100	4/8 x 100=	50
11	H	5	8	100	5/8 x 100=	62
12	H	6	8	100	6/8 x 100=	75
13	H	7	8	100	7/8 x 100=	87
14	H	8	8	100	8/8 x 100=	100

III. RESERVE REQUIREMENT, COMPUTED BY UNIT-SUMMATION METHOD.

End of Year	Individual Accruals During Year				Reserve Requirement		
					Total of Accruals	Retire-ments	Reserve
1	A-50	B-25	C-16 2/3	D-12 1/2	$ 104	-	$ 104
2	A-50	B-25	C-16 2/3	D-12 1/2	104	$ 100	108
3	E-50	B-25	C-16 2/3	D-12 1/2	104	-	212
4	E-50	B-25	C-16 2/3	D-12 1/2	104	200	116
5	G-16 2/3	F-25	C-16 2/3	D-12 1/2	71	-	187
6	G-16 2/3	F-25	C-16 2/3	D-12 1/2	72	100	159
7	G-16 2/3	F-25	H-12 1/2	D-12 1/2	66	-	225
8	G-16 2/3	F-25	H-12 1/2	D-12 1/2	67	200	92
9	G-16 2/3		H-12 1/2		29	-	121
10	G-16 2/3		H-12 1/2		29	100	50
11			H-12 1/2		12	-	62
12			H-12 1/2		13	-	75
13			H-12 1/2		12	-	87
14			H-12 1/2		13	-	100

****

IV. RESERVE REQUIREMENT, COMPUTED BY THE "PROSPECTIVE-RETIREMENT" METHOD.

(1) End of Year	(2) Dec 31 Plant Balance	(3) Average Remaining Life (See Sch.A below)	(4) Estimated Future Deprec'n Accruals (3)x20%x(2)	(5) RESERVE REQUIREMENT (2) - (4)
1	$ 400	4 years	$ 320	$ 80
2	300	4	240	60
3	400	2 1/2	200	200
4	200	3	120	80
5	400	3	240	160
6	300	2 2/3	160	140
7	400	3	240	160
8	200	4	160	40
9	200	3	120	80
10	100	4	80	20
11	100	3	60	40
12	100	2	40	60
13	100	1	20	80
14	100	-0-	-0-	100

****

Schedule A - supporting Column (3) above.

UNITS.	Remaining Life at End of Year -													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	1													
B	3	2	1											
C	5	4	3	2	1									
D	7	6	5	4	3	2	1							
E			1											
F					3	2	1							
G					5	4	3	2	1					
H							7	6	5	4	3	2	1	-
Totals	16	12	10	6	12	8	12	8	6	4	3	2	1	-
Avgs.	4	4	$2\frac{1}{2}$	3	3	$2\frac{2}{3}$	3	4	3	4	3	2	1	-

APPENDIX II

(Supporting data for results tabulated on Page 52)

GIVEN: 4 units @ $100, installed in successive years.
4 replacements, same cost. Average Life, 5 years.

YEAR	January 1st Additions or Replacements	December 31st Retirements	Plant Account Balance Jan 1	Plant Account Balance Dec 31
1	A		$ 100	$ 100
2	B	A	200	100
3	C, E		300	300
4	D	E	400	300
5	F	B	400	300
6	G		400	400
7			400	400
8		C, F	400	200
9	H		300	300
10			300	300
11		G, D	300	100
12			100	100
13			100	100
14			100	100
15			100	100
16		H	100	-0-

* * * * * * * * * *

I. RESERVE REQUIREMENT, COMPUTED BY THE STRAIGHT-LINE GROUP METHOD

End of Year (1)	Annual Accrual (20% of Jan 1 Plant Balance) (2)	Retirements (3)	Balance (Reserve Requirement) (2)-(3)+(4)
1	$ 20	$	$ 20
2	40	100	-40
3	60		20
4	80	100	-0-
5	80	100	-20
6	80		60
7	80		140
8	80	200	20
9	60		80
10	60		140
11	60	200	-0-
12	20		20
13	20		40
14	20		60
15	20		80
16	20	100	-0-

II. RESERVE REQUIREMENT, COMPUTED ON AGE-LIFE BASIS.

End of Year (1).	Surviving Units (2).	Age in Years (3).	Avge Life of Survivors (4).	Dec.31 Plant Balance (5).	RESERVE REQUIREMENT (3) ÷ (4) x (5)		
1	A	1	2	$ 100	1/2 x $100=		$ 50
2	B	1	4	100	1/4 x 100=		25
3	B	2	4	100	2/4 x 100=	50	
	C,E	1	C-6) E-2) = 4	200	1/4 x 200=	50	100
4	D	1	8	100	1/8 x 100=	12.5	
	C	2	6	100	2/6 x 100=	33.3	
	B	3	4	100	3/4 x 100=	75	121
5	F	1	4	100	1/4 x 100=	25	
	D	2	8	100	2/8 x 100=	25	
	C	3	6	100	3/6 x 100=	50	100
6	G	1	6	100	1/6 x 100 =	16.6	
	F	2	4	100	2/4 x 100 =	50.0	
	D	3	8	100	3/8 x 100 =	37.5	
	C	4	6	100	4/6 x 100 =	66.7	171
7	G	2	6	100	2/6 x 100=	33.3	
	F	3	4	100	3/4 x 100=	75.0	
	D	4	8	100	4/8 x 100=	50.0	
	C	5	6	100	5/6 x 100=	83.3	242
8	G	3	6	100	3/6 x 100=	50.0	
	D	5	8	100	5/8 x 100=	62.5	113
9	H	1	8	100	1/8 x 100=	12.5	
	G	4	6	100	4/6 x 100=	66.7	
	D	6	8	100	6/8 x 100=	75.0	154
10	H	2	8	100	2/8 x 100=	25.0	
	G	5	6	100	5/6 x 100=	83.3	
	D	7	8	100	7/8 x 100=	87.5	196
11	H	3	8	100	3/8 x 100=	37.5	37
12	H	4	8	100	4/8 x 100=		50
13	H	5	8	100	5/8 x 100=		62
14	H	6	8	100	6/8 x 100=		75
15	H	7	8	100	7/8 x 100=		87
16	H	8	8	-0-	8/8		-0-

III. RESERVE REQUIREMENT, COMPUTED BY UNIT-SUMMATION METHOD.

End of Year	Individual Accruals During Year				TOTAL of ACCRUALS	Retire-ments	RESERVE REQUIREMENT
1	A-50				$ 50	$ -	$ 50
2	A-50	B-25			75	100	25
3	E-50	B-25	C-16 2/3		92	-	117
4	E-50	B-25	C-16 2/3	D-12 1/2	104	100	121
5	F-25	B-25	C-16 2/3	D-12 1/2	79	100	100
6	F-25	G-16 2/3	C-16 2/3	D-12 1/2	71	-	171
7	F-25	G-16 2/3	C-16 2/3	D-12 1/2	71	-	242
8	F-25	G-16 2/3	C-16 2/3	D-12 1/2	71	200	113
9		G-16 2/3	H-12 1/2	D-12 1/2	41		154
10		G-16 2/3	H-12 1/2	D-12 1/2	42		196
11		G-16 2/3	H-12 1/2	D-12 1/2	41	200	37
12			H-12 1/2		13		50
13			H-12 1/2		12		62
14			H-12 1/2		13		75
15			H-12 1/2		12		87
16			H-12 1/2		13	100	-0-

IV. RESERVE REQUIREMENT, COMPUTED BY THE "PROSPECTIVE-RETIREMENT" METHOD.

(1) End of Year	(2) Dec 31 Plant Balance	(3) Average Remaining Life (See Sch. A below)	(4) Estimated Future Deprec'n Accruals (3)x20%x(2)	(5) RESERVE REQUIREMENT (2) - (4)
1	$ 100	1	$ 20	$ 80
2	100	3	60	40
3	300	2 2/3	160	140
4	300	4	240	60
5	300	4	240	60
6	400	3 1/2	280	120
7	400	2 1/2	200	200
8	200	3	120	80
9	300	3 2/3	220	80
10	300	2 2/3	160	140
11	100	5	100	-0-
12	100	4	80	20
13	100	3	60	40
14	100	2	40	60
15	100	1	20	80
16	-0-	0	-0-	-0-

****

Schedule A - Supporting Column (3) above.

UNITS — Remaining Life at End of Year -

UNITS	#1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A	1															
B		3	2	1												
C			5	4	3	2	1									
D				7	6	5	4	3	2	1						
E			1													
F					3	2	1									
G						5	4	3	2	1						
H	—	—	—	—	—	—	—	—	7	6	5	4	3	2	1	0
Totals	1	3	8	12	12	14	10	6	11	8	5	4	3	2	1	0
Averages	1	3	$2\frac{2}{3}$	4	4	$3\frac{1}{2}$	$2\frac{1}{2}$	3	$3\frac{2}{3}$	$2\frac{2}{3}$	5	4	3	2	1	-0-

APPENDIX III

(Supporting data for results tabulated on Page 54.)

GIVEN: 4 units @ $ 100, installed in successive years.
4 replacements, same cost. Average Life, 5 years.

YEAR	January 1st Additions or Replacements	December 31st Retirements	Plant Account Balance Jan 1	Dec 31
1	A		$ 100	$ 100
2	B		200	200
3	C		300	300
4	D		400	400
5		D	400	300
6	E	C	400	300
7	F	B	400	300
8	G	A	400	300
9	H		400	400
10		H	400	300
11		G	300	200
12		F	200	100
13		E	100	-0-

RESERVE REQUIREMENT, COMPUTED BY THE STRAIGHT-LINE GROUP METHOD.

End of Year (1)	Annual Accrual (20% of Jan 1 Plant Balance) (2)	Retirements (3)	Balance (Reserve Requirement) (4) (2 - 3)
1	20		$ 20
2	40		60
3	60		120
4	80		200
5	80	D- $100	180
6	80	C- 100	160
7	80	B- 100	140
8	80	A- 100	120
9	80		200
10	80	H- 100	180
11	60	G- 100	140
12	40	F- 100	80
13	20	E- 100	-0-

RESERVE REQUIREMENT, COMPUTED BY THE UNIT-SUMMATION METHOD.

End of year	Individual Accruals During Year				TOTAL of ACCRUALS	Retire-ments	-RESERVE-REQUIREMENT
1	A-12½				$ 13	$ -	$ 13
2	A-12½	B-16 2/3			29	-	42
3	A-12½	B-16 2/3	C-25		54	-	96
4	A-12½	B-16 2/3	C-25	D-50	104	-	200
5	A-12½	B-16 2/3	C-25	D-50	104	100	204
6	A-12½	B-16 2/3	C-25	E-12½	67	100	171
7	A-12½	B-16 2/3	F-16 2/3	E-12½	58	100	129
8	A-12½	G-25	F-16 2/3	E-12½	67	100	96
9	H-50	G-25	F-16 2/3	E-12½	104		200
10	H-50	G-25	F-16 2/3	E-12½	104	100	204
11		G-25	F-16 2/3	E-12½	54	100	158
12			F-16 2/3	E-12½	29	100	87
13				E-12½	13	100	-0-

********** **********

B I B L I O G R A P H Y

Reports

Cooperating Committees on Depreciation, American Gas Association and Edison Electric Institute. An Appraisal of Methods for Estimating Service Lives of Utility Properties, for Submittal to Committee on Depreciation, National Association of Railroad and Utility Commissioners, February 14, 1942.

Federal Communications Commission. Order #89-A, April, 1946.

________. Uniform System of Accounts, Part 31, Rules and Regulations. 1937.

Federal Power Commission. Statistics of Electric Utilities in the United States. 1944.

Interstate Commerce Commission. In re Telephone and Railroad Depreciation Charges, Case 177 ICC 351.

________. Revised Classification of Accounts for Telephone Companies, January 1, 1933.

National Association of Railroad and Utility Commissioners. Report of Committee on Depreciation. 1943.

________. Report of Committee on Depreciation. 1944.

________. Report of Special Committee on Depreciation, November, 1938.

Wisconsin Public Service Commission. Depreciation--A Review of Legal and Accounting Problems. A Report Submitted to the 45th Annual Convention of the National Association of Railroad and Utility Commissioners, October 11, 1943.

Books

Barnes, Irston R. The Economics of Public Utility Regulation. New York: F.S. Crofts & Co., 1942.

Graham, Willard J. Public Utility Valuation. Chicago, Illinois: Chicago University Press, 1934.

Kurtz, Edwin B. The Science of Valuation and Depreciation. New York: Ronald Press, 1937.

Mason, Perry. Principles of Public Utility Depreciation, Monograph #1, American Accounting Association, Chicago, Illinois, 1937.

May, George O. Financial Accounting. New York: Macmillan Co., 1944.

Scharff, Maurice R., Leerburger, F. J., and Jeming, Joseph. Depreciation of Public Utility Property. New York, 1940.

Articles

Bauer, John. "Depreciation in Relation to Prudent Investment," Public Utilities Fortnightly, Vol. XXXIII, No. 9, April 27, 1944.

Bonbright, James C. "A Symposium on the N. A. R. U. C. Depreciation Report," Journal of Land and Public Utility Economics, Vol. XX, May, 1944.

Edison Electric Institute. "Conclusions on the N. A. R. U. C. Depreciation Report," Public Utilities Fortnightly, Vol. XXXIII, No. 7, March 30, 1944.

Ely, O. "Depreciation: Will N. A. R. U. C. Reconsider?" Public Utilities Fortnightly, Vol. XXXIV, No. 1, July 6, 1944.

Long, Henry M. "Need the 'Straight-Line' Reserve be Excessive?" Public Utilities Fortnightly, Vol. XXXVII, No. 7, March 28, 1946.

Mason, Max C. "Retirement Forecast Method of Gauging Depreciation," Public Utilities Fortnightly, Vol. XXXVII, No. 2, January 17, 1946.

Meigs, R. J. "Are Depreciation Reserves Available for Improvements?" Public Utilities Fortnightly, Vol. XXXV, No. 1, January 1, 1945.

Nash, Luther R. "A New Depreciation Fallacy," Public Utilities Fortnightly, Vol. XXX, No. 12, December 3, 1942.

________. "Public Utility Depreciation Accounting," Journal of Land and Public Utility Economics, Vol. II, October, 1926.

Packman, C. E. "A Suggested Solution of the Depreciation Problem," Public Utilities Fortnightly, Vol. XXXIII, No. 12, June 8, 1944.

Wheat, Carl I. "Does Hope Case Mean Direct Approach to 'Fair Return'?" Public Utilities Fortnightly, Vol. XXXIII, No. 9, April 27, 1944.